Jan. 16, 1945. H. W. BALZER 2,367,635

TELEPHONE SYSTEM

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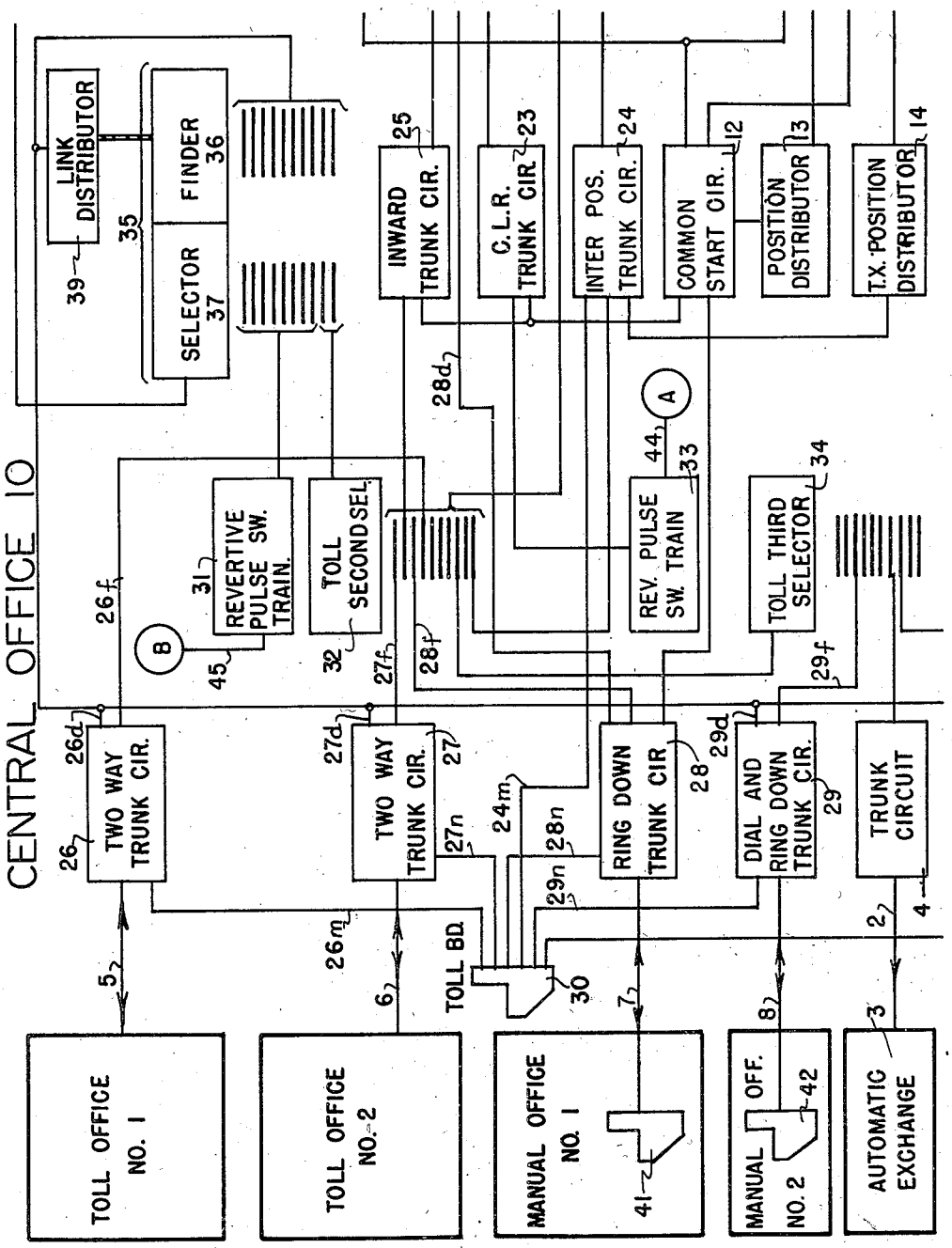


FIG. 1.

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TELEPHONE SYSTEM

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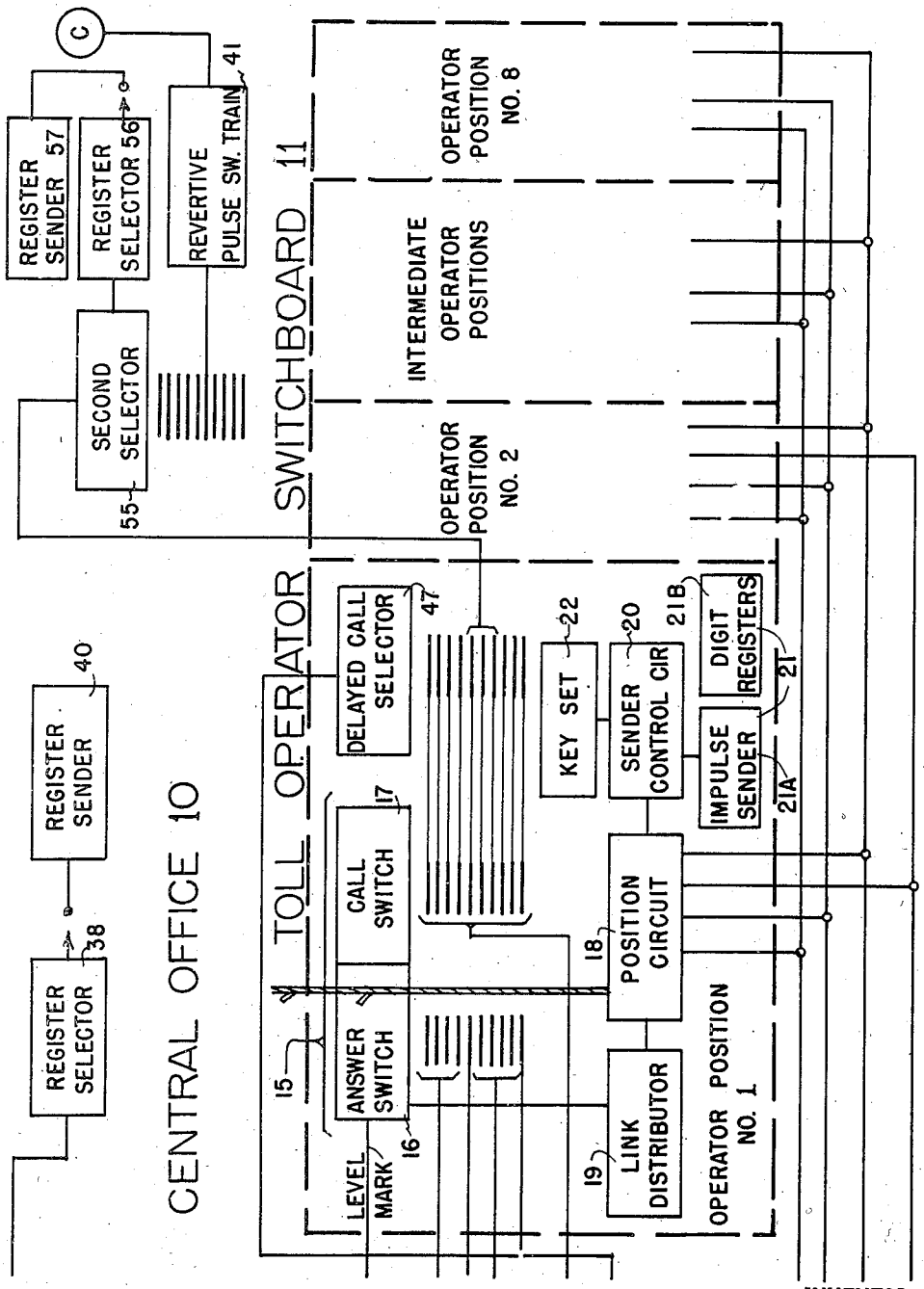


FIG. 2

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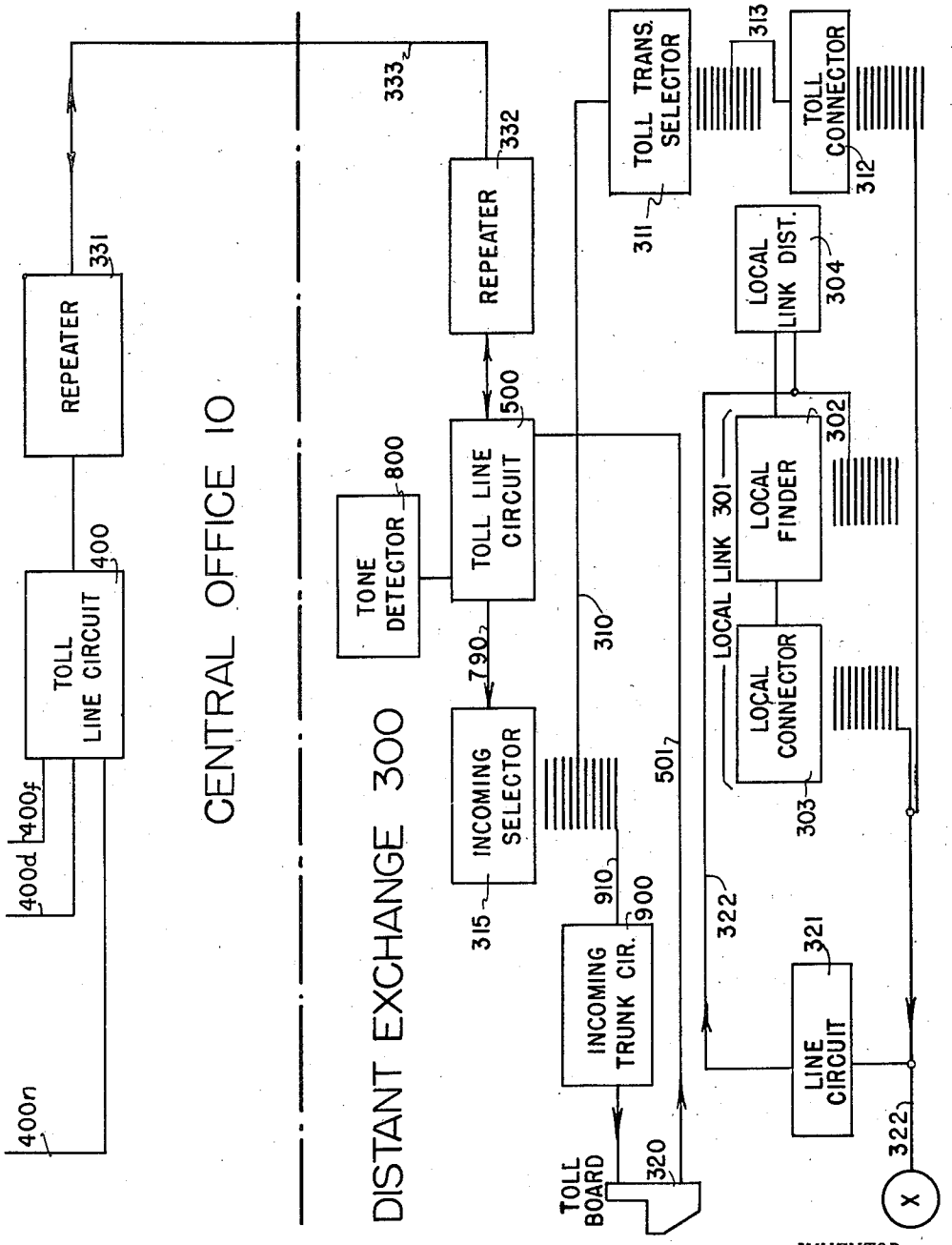


FIG. 3

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TELEPHONE SYSTEM

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FIG. 4

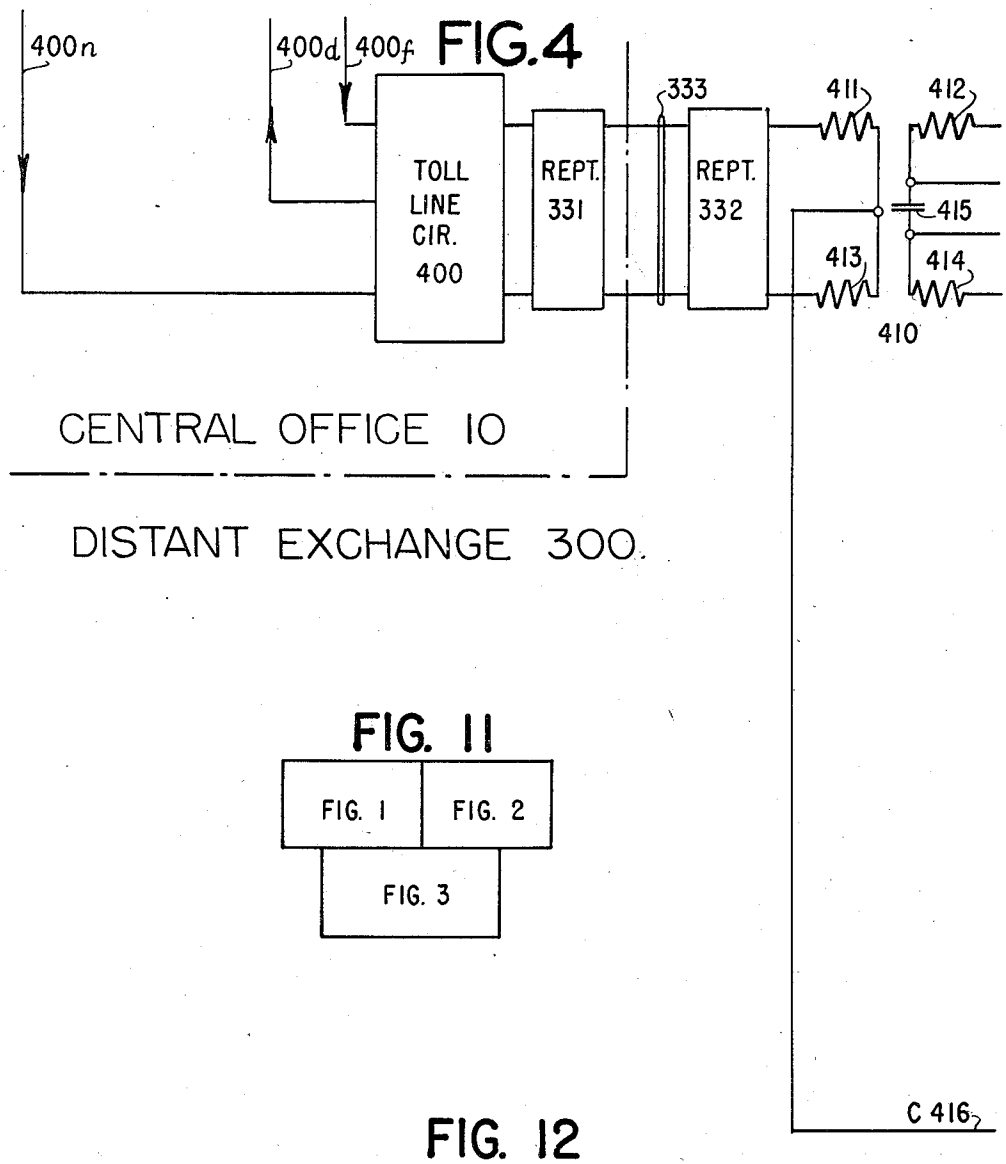
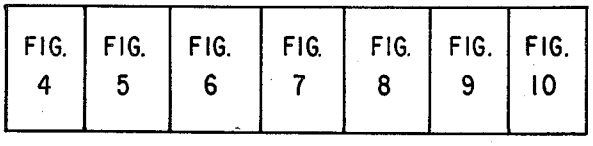


FIG. 11

FIG. 12



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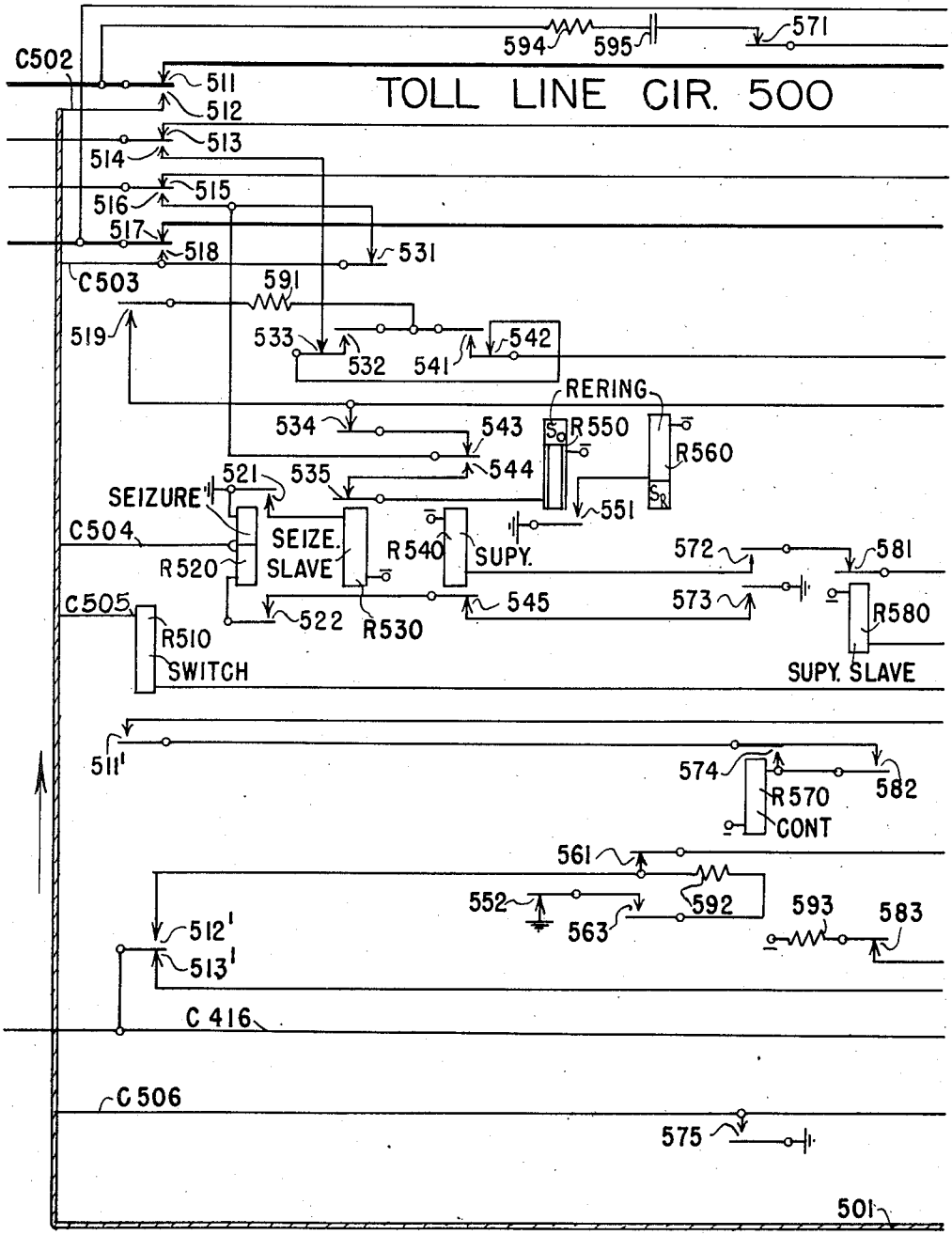


FIG. 5

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TELEPHONE SYSTEM

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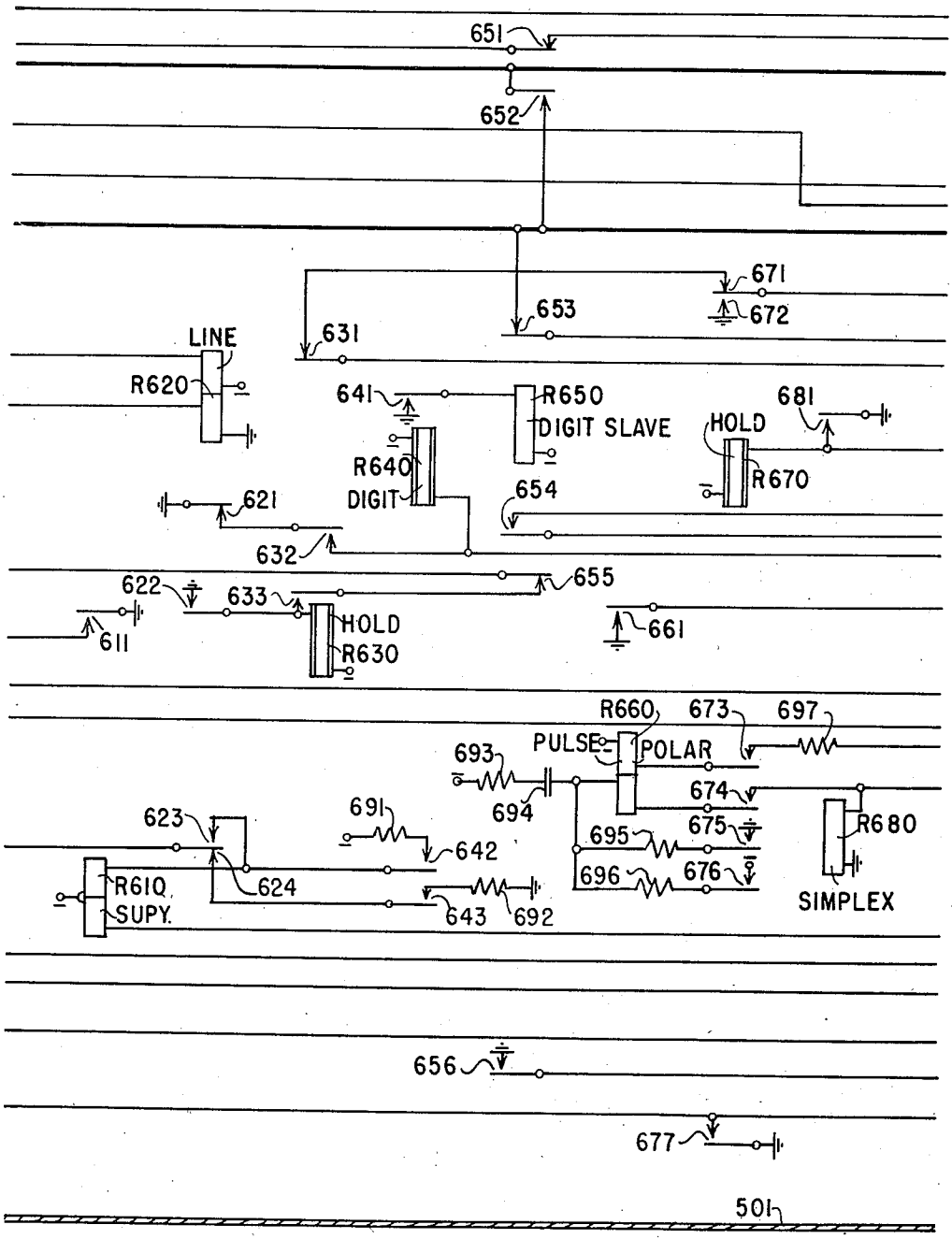


FIG. 6

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TELEPHONE SYSTEM

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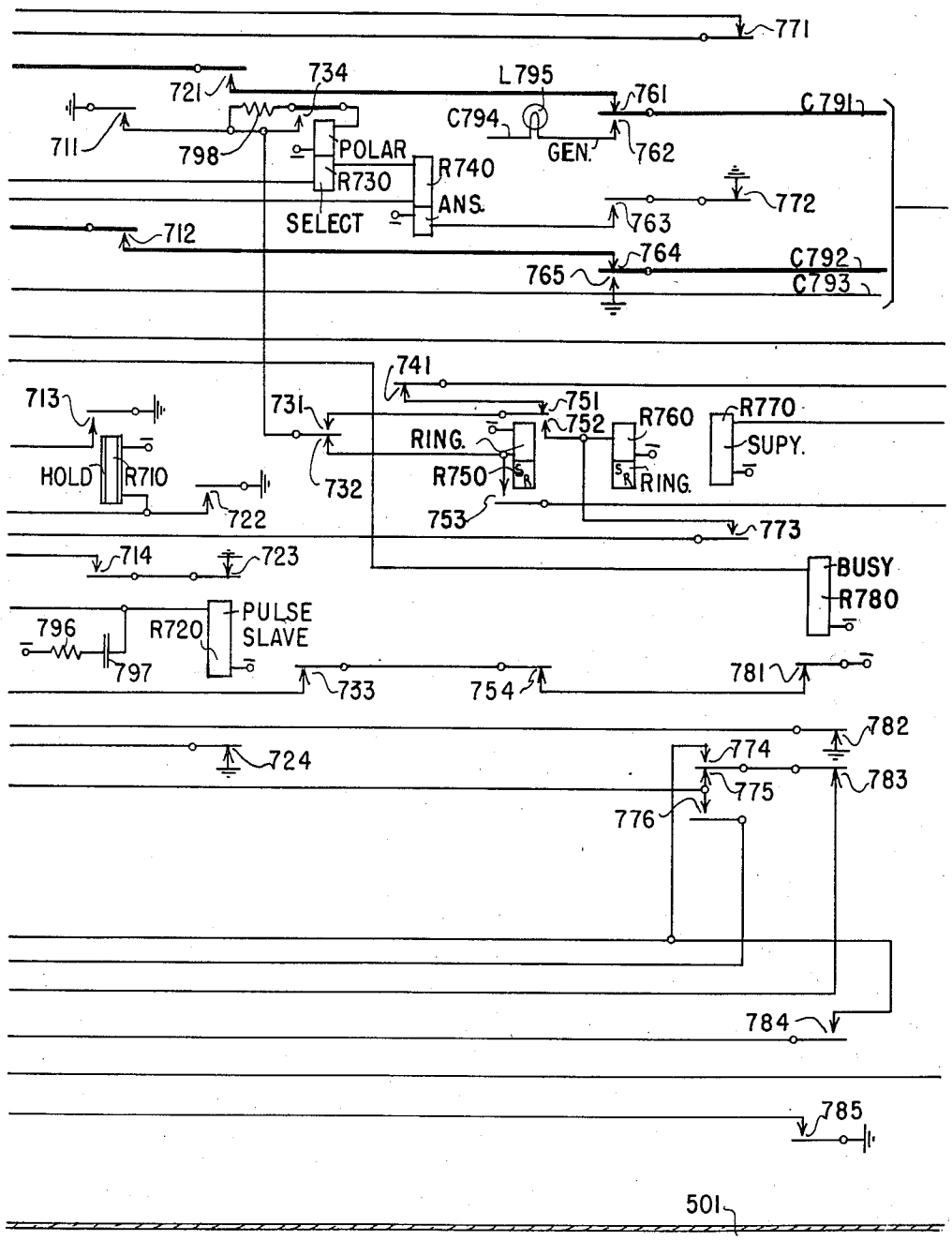


FIG. 7

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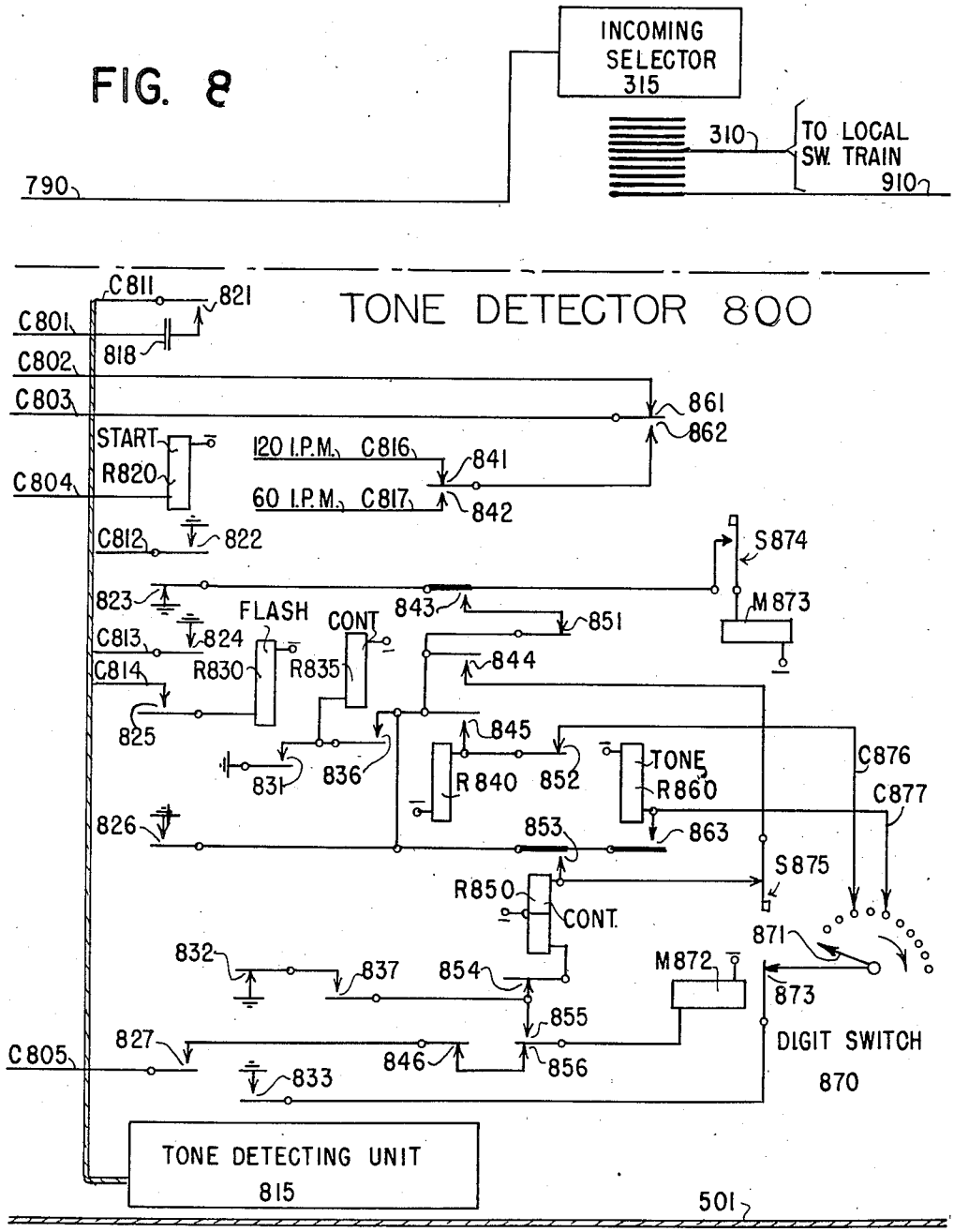
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TELEPHONE SYSTEM

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FIG. 8



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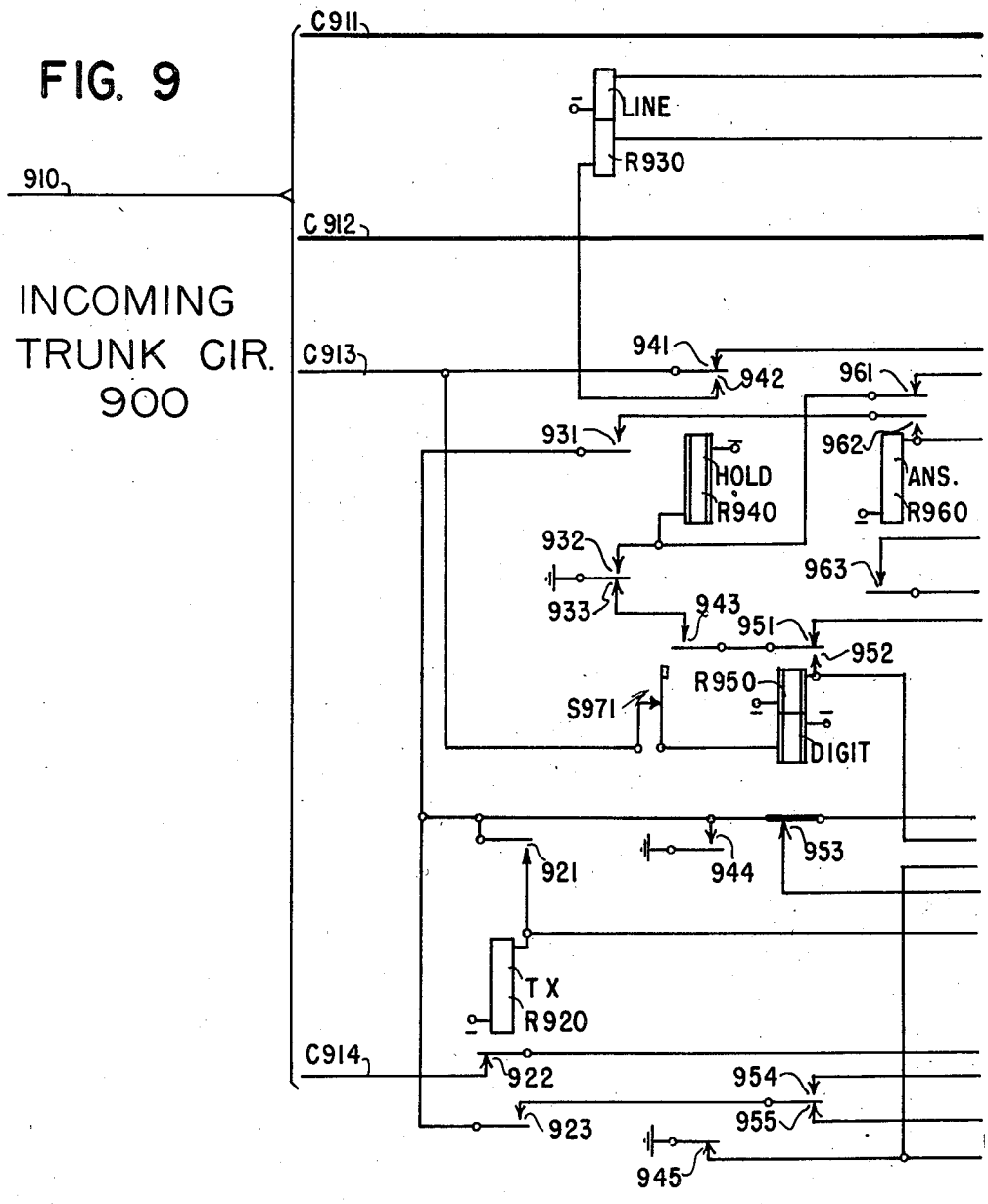
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TELEPHONE SYSTEM

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FIG. 9



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TELEPHONE SYSTEM

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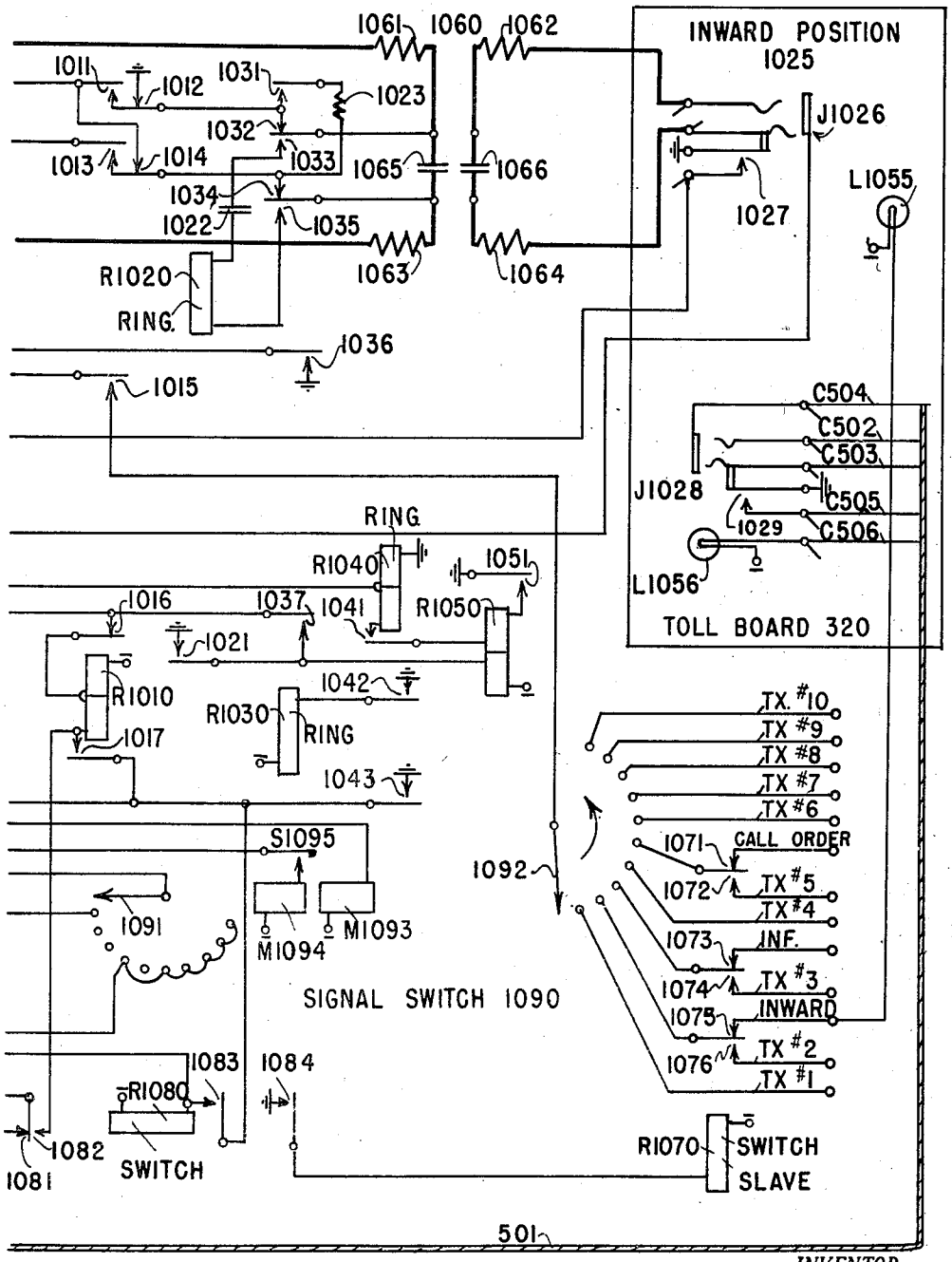


FIG.10

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Patented Jan. 16, 1945 2,367,635

UNITED STATES PATENT OFFICE

2,367,635

TELEPHONE SYSTEM

Harvey W. Balzer, Downers Grove, Ill., assignor to Automatic Electric Laboratories, Inc., a corporation of Delaware

Application December 17, 1942, Serial No. 469,297

22 Claims. (Cl. 179—27)

The present invention relates to telephone systems and more particularly to toll switching systems of the character of that disclosed in the copending application of Harvey W. Balzer, Serial No. 462,543, filed October 19, 1942, now Patent No. 2,353,212, granted July 11, 1944.

In a toll switching system of the type noted a plurality of exchanges are provided, each two exchanges being interconnected by a group of two-way toll trunks. Each exchange comprises a group of toll line circuits individually terminating the toll trunks extending thereto, associated automatic switching apparatus and an operator switchboard, whereby calls may be routed over the toll trunks to and from the various operator positions at the switchboard and calls may be routed over the toll trunks via the automatic switching apparatus independently of the switchboard.

It is an object of the present invention to provide in a toll switching system of the type noted an improved arrangement for determining the particular switching stage of an automatic switch train which encounters a busy condition during the operation thereof.

Another object of the invention is to provide in a toll switching system in conjunction with the determining arrangement noted, improved apparatus for translating the determination made into suitable supervisory signals which are returned over the trunk incoming to the switch train.

Another object of the invention is to provide in a telephone system a repeater arrangement between an incoming trunk and an associated switch train, which repeater arrangement embodies improved facilities for controlling supervision over the trunk from the switch train.

A further object of the invention is to provide in a telephone system comprising an incoming trunk and a switchboard including a plurality of operator positions, an improved arrangement for selectively indicating the presence of a call to be answered on the trunk to the different operator positions at the switchboard.

A still further object of the invention is to provide in a telephone system comprising a trunk, digit control switching apparatus operative to route a call over the trunk and a switchboard including a plurality of operator positions, an improved circuit arrangement for selectively releasing the switching apparatus in order to absorb digits transmitted thereto and for selectively indicating the presence of a call to be answered on the trunk to the different operator positions at the switchboard.

Further features of the invention pertain to the particular connection and arrangement of the circuit elements of the system, whereby the above-outlined and additional operating features are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which Figs. 1 to 3, inclusive, taken together, illustrate the general arrangement of a telephone system embodying the present invention; Fig. 11 illustrates the mode of combining Figs. 1 to 3, inclusive, to form a unified system; Figs. 4 to 10, inclusive, taken together, illustrate the details of a portion of the system having incorporated therein the features of the invention as briefly outlined above; and Fig. 12 illustrates the mode of combining Figs. 4 to 10, inclusive, to form the portion of the system.

Description of the apparatus incorporated in the system

Referring now more particularly to Figs. 1 to 3, inclusive, of the drawings, the telephone system there illustrated comprises a central office **10** of the fully automatic type, a remote toll office No. 1, a remote toll office No. 2, a remote manual office No. 1 provided with a switchboard **41**, a remote manual office No. 2 provided with a switchboard **42**, a remote automatic exchange **3** and a distant exchange **300**. The central office **10** is illustrated as serving a plurality of substations A, B, C, etc., which are connected with the automatic switching equipment of the office by means of lines **44**, **45**, etc. Each of the four remote offices and the two distant exchanges serve a plurality of subscriber substations, the distant exchange **300** serving a number of substations, including the substation X. It is noted in this regard that the two toll offices, the central office **10** and the distant exchange **300** are provided with automatic switching equipment for handling both local calls and interoffice toll calls. The four offices and the two exchanges remote from the central office **10** are trunk or toll line connected with the central office **10** by means of a number of toll trunks which are utilized exclusively in the handling of toll traffic. Thus, the toll office No. 1 is shown as being connected to the central office **10** by means of a trunk **5** which terminates in a trunk circuit **26** in the central office **10**. Similarly, the trunks **6**, **7**, **8**, **2** and **333** which respectively terminate in the

trunk or toll line circuits 27, 28, 29, 4 and 400 are provided for connecting the three other outlying offices and the two remote exchanges with the central office 10. It will be understood in this regard that the number of toll trunks provided to connect the central office 10 with any one of the four outlying offices and any one of the two remote exchanges is determined by the amount of toll traffic therebetween. For example, if the two illustrated toll offices are geographically situated to handle a large volume of toll traffic involving the central office 10, two or more groups of trunks, each including as many as ten trunks, may be required therebetween.

The trunks utilized to connect the central office 10 with the manual office No. 1 are of the ring-down type; while the trunks utilized to connect the central office 10 with the manual office No. 2 are of the combination dial and ring-down type. Accordingly, the trunk circuits 28 and 29 are, respectively, of the well-known ring-down and combination dial and ring-down types and are used to terminate these trunks in the central office 10. The trunk circuit 4 which terminates the one-way trunk 2 in the central office 10 is of the automatic-to-automatic type, being provided with facilities for repeating received dial impulses to the trunk 2 on an outgoing call to the exchange 3. The trunks utilized to connect the central office 10 with the two toll offices and with the distant exchange 300 are of the toll dial type. Accordingly, the trunk circuits 26, 27, and 400 may be substantially identical and are of the toll dial type.

The automatic switching equipment provided in the central office 10 is of two different types requiring two corresponding different forms of directive control. More specifically, the local automatic switching equipment comprising the switch trains 31, 33 and 41 includes selector and connector switches requiring the well-known revertive type of directive control. This form of directive control is commonly used in the two-motion selector and connector switches of the rotary-vertical type conventionally employed in auto-manual systems. The toll switching equipment provided in the central office 10 is of the well-known Strowger type employing straightforward impulsing or directive control in the setting of the selected switches of a train. Accordingly, provisions are made at certain switching stages of the toll switching equipment for converting straightforward directive control into revertive control for the purpose of permitting the toll operators to obtain access to the substations served by the central office 10.

In general, the facilities for handling toll calls in the central office 10 and each of the two illustrated toll offices may be identical. It will be understood, therefore, that the following description relative to the toll switching equipment provided in the central office 10 may be considered as applying also to the toll switching equipment provided in the toll office No. 1 and the toll office No. 2. This equipment provided in the central office 10 includes an 8-position toll operator switchboard 11 which is capable of handling toll calls of all types. It is contemplated that each position of this switchboard will function as a universal position, whereby both C. L. R. or outward toll calls requiring ticketing and inward toll calls requiring no ticketing may be handled at any operator position thereat. Facilities are also provided in conjunction with each of the eight operator positions for permitting the operator to initiate delayed calls in the handling of point-to-point traffic. The trunking plan of the system also contemplates that all interposition or T. X calls shall be routed to either the first position or the second position at the switchboard 11. To this end, the illustrated T. X position distributor 14 is limited in its operation to the distribution of calls to the first and second positions of the switchboard 11.

The call handling facilities provided at and in association with each of the eight positions of the switchboard 11 are identical. Briefly considered, these facilities as provided at the No. 1 position of the switchboard comprise an operator position circuit 18, a plurality of links, including the link 15, for routing calls to and from the position circuit 18 and a link distributor 19 for selecting idle ones of the links individual to the No. 1 position of the switchboard 11 for use in a predetermined order. Each of the links provided at the switchboard 11 includes an answer or line finder switch and a call or selector switch, the illustrated link 15 comprising an answer switch 16 and a call switch 17. For the purpose of directing the extension of a connection from the No. 1 position from the switchboard 11 either through the front end or the rear end of a link selected by the distributor 19, impulse sending equipment is provided which comprises a key set 22, a sender control circuit 20 and a register sender 21, including the impulse sender 21A and the digit registers 21B.

Incoming calls appearing before the various links of the switchboard 11 for answering are received in trunks which differ slightly in arrangement in accordance with the particular character of the cells. For example, inward toll calls originating in the toll office No. 1, the toll office No. 2 or in the distant exchange 300 may be extended to the switchboard 11 for answering through a group of inward trunk circuits, including the trunk circuit 25, or a group of interposition trunk circuits, including the trunk circuit 24. Outward toll calls, on the other hand, may be extended to the switchboard 11 for answering through a group of C. L. R. trunk circuits, including the trunk circuit 23. In order to preselect the different positions of the switchboard 11 for use in a predetermined order as calls are extended to the trunk circuits appearing before the rear ends of the links provided at the different positions of the switchboard, a position distributor 13 is provided for the purpose of allotting inward and outward toll calls alternately to the switchboard 11. For the additional purpose of controlling the position and link start relays of the position and link circuits provided at the different positions of the switchboard 11, a start circuit 12 common to the inward and outward trunk circuits is provided. This start circuit is also utilized in the extension of calls to the switchboard 11 from the ring-down trunks extending to the manual office No. 1, calls on these trunks being classified in the same category as outward or C. L. R. calls originating in the area served by the central office 10.

In the illustrated trunking plan, three selective or directively controlled switching stages are provided in the toll switching equipment of the central office 10. More specifically, calls incoming from the toll office No. 1, the toll office No. 2, the manual office No. 2 and the distant exchange 300 are first handled at a primary switching stage which includes a group of finder-selector links, one of which is indicated at 35 as comprising a

finder 36 and a selector 37. For the purpose of allotting these links for use in a predetermined order, a link distributor 39 is provided for these links. Calls incoming from the indicated remote offices and exchange may either be extended through the local automatic switching equipment comprising the switch train 31 to the substations served by the central office 10, to the toll operator switchboard 11 or to other of the toll and manual offices and the exchanges remote from the central office 10. In the last-mentioned case, the second switching stage, comprising the toll second selector 32, or the second and third toll switching stages, comprising both the toll second selector 32 and the toll third selector 34, may be required to handle the calls.

If a call extended to the link 35, for example, is to be routed through the automatic local switching equipment to a substation served by the central office 10, the switch directing signals received in the link 35 from the calling point must be converted to the form required to control the local switching equipment of the central office before the call can be routed through this equipment to the desired substation. To this end, a group of register senders is provided in association with the links forming the first switching stage of the toll switching equipment. More specifically, the illustrated register sender 40 of this group has the function of converting received switch directing impulses into the revertive type of switch directing signals which are required for control of the local automatic switching equipment in the central office 10. These senders are common to the links provided at the primary switching stage of the toll switching equipment and may be seized through register selectors individual to the links. Thus, the illustrated link 35 is shown as having associated therewith a register selector 38 through which the register sender 40 may be seized.

In the routing of calls from the toll operator switchboard 11 to the remote offices and exchanges through the front ends of the links provided thereat, the primary and secondary switching stages of the toll switching equipment are not required. It will be noted in this regard that a straight multiple is provided between the contact levels of the toll second selectors 32 etc. and the call switches of the links 15 etc. associated with the different positions of the switchboard 11. Depending upon the destination of such calls, however, the toll third selectors 34 etc. may be required in order to gain access to the desired group of interoffice trunks. For the purpose of permitting calls to be extended through the rear ends of the links associated with the switchboard 11, a group of delayed call selectors, including the selector 47, is provided. These delayed call selectors 47 etc. are commonly accessible to all positions of the switchboard 11 through the first level of the bank contacts of the answer switch of each link 15 etc., and a straight multiple is provided between the bank contacts of the delayed call selectors 47 etc., the toll second selectors 32 etc., and the call switches of the links 15 etc. Thus, each position of the switchboard 11 is permitted to have access to the same routes over the front and rear ends of the links provided thereat.

In the handling of inward calls appearing at the switchboard 11, it is necessary to extend the calls to the desired substations through the local automatic switching equipment of the central office 10. To gain access to this equipment, a group of second selectors, including the selector 55, is provided; which selectors are directly accessible to the call switches of the links 15 etc. and to the delayed call selectors 47 etc. Each of the second selectors 55 etc. is similar to the selectors 37 etc. in that provisions are made therein for transmitting received switch directing signals through an associated register selector to a register sender. More particularly, the second selector 55 is provided with an associated register selector 56 having access to a register sender 57; the register sender 57 having the function of converting the received signals into the form required to control the switches of the local automatic switching equipment.

The trunking plan of the system is such that certain outward or C. L. R. toll calls which require ticketing in the central office 10 and which originate in the central office area are handled at a toll switchboard 30 of the manual type. In order to permit the operators attending the manual switchboard 30 to gain access to the trunks extending to the two toll offices, to the two manual offices, and to the distant exchange 300, this switchboard is trunk connected to the trunk circuits terminating the interoffice toll trunks mentioned in the central office 10; and provisions are made in the trunk circuits for guarding them against seizure from more than one access point at a time.

The toll trunks interconnecting the central office 10 and the distant exchange 300 terminate in toll line circuits respectively provided in the central office 10 and in the distant exchange 300. For example, the toll trunk 333 terminates in the toll line circuit 400 provided in the central office 10 and in the toll line circuit 500 provided in the distant exchange 300. Also each of these toll trunks comprises a plurality of repeaters of the vacuum tube type; the toll trunk 333 comprising the repeaters 331 and 332 illustrated, respectively disposed in the central office 10 and in the distant exchange 300. The toll line circuit 500 is provided with an incoming selector 315 and a tone detector 800 individual thereto in the distant exchange 300. Also the distant exchange 300 comprises toll switching equipment including not only the incoming selectors 315 etc. but also a group of toll transmission selectors and a number of groups of toll connectors. The group of toll transmission selectors includes the selector 311 which is accessible via the trunk 310 to the incoming selector 315; and one of the groups of toll connectors includes the connector 312 which is accessible via the trunk 313 to the toll selector 311. It is noted that the toll connector 312 has access via the subscriber line 322 to the substation X illustrated.

Further the distant exchange 300 comprises local switching apparatus including a number of local links 301 etc.; the local link 301 including a local finder 302 and a local connector 303. Also line circuits 321 etc. are individually associated with the lines 322 etc. extending to the substations X etc. Further a local link distributor 304 is associated with the group of local links for the purpose of allotting idle ones of these links to the various line circuits 321 etc. Finally the distant exchange 300 comprises a toll switchboard 320 including a number of operator positions. More particularly, the toll board 320 is of the manual type and includes an inward position, an information position, a call order position, and ten interposition or T. X positions. The toll switchboard 320 is accessible to the incoming

selector 315 etc. by way of a group of incoming trunk circuits, including the trunk circuit 900. Further the toll board 320 has access to a number of trunks 501 etc. individually extending to the toll line circuits 500 etc., whereby the toll trunks 333 extending between the distant exchange 300 and the central office 10 may be utilized for the purpose of extending outgoing calls from the toll board 320.

The elements of the system illustrated in Figs. 1 and 2 are either disclosed or properly identified in the previously mentioned copending Balzer application; the toll line circuit 400 is substantially identical to the trunk circuits 26 and 27; the repeaters 331 and 332 are of any suitable type; and the line circuits 321 etc. are of any suitable type. Also the incoming selectors 315 etc. are of the conventional Strowger drop-back type; the toll transmission selectors 311 etc. and the toll connectors 312 etc. are of the conventional Strowger types; the local finders 302 etc. and the local connectors 303 etc. are of the conventional Strowger type; and the local link distributor 304 is of any suitable type.

In the distant exchange 300, preferably, each of the toll line circuits is identical to the toll line circuit 500 which comprises, as best shown in Figs. 4 to 7, inclusive, a repeating coil 510, a relay group including a switch relay R510, three supervisory relays R540, R610 and R770, a seizure relay R520, a siezure slave relay R530, two rering relays R550 and R560, a control relay R570, a supervisory slave relay R580, a line relay R620, three hold relays R630, R670 and R710, a digit relay R640, a digit slave relay R650, a pulse relay R660, a simplex relay R680, a pulse slave relay R720, a select relay R730, an answer relay R740, two ring relays R750 and R760, and a busy relay R780; and a control network connected and arranged in a manner more fully described hereinafter.

Preferably, each of the tone detectors is identical to the tone detector 800 individually associated with the toll line circuit 500 which comprises, as shown in Fig. 8, a tone detecting unit 815 of the vacuum tube type and of any suitable form. Also the tone detector 800 comprises a digit switch 870 of the minor type, including a single wiper 871 provided with an associated contact bank, a magnet M872 for driving the wiper noted step by step in the clockwise direction, a magnet M873 for releasing the wiper noted and for causing it to be returned to its normal rotary position, and two sets of switch springs S874 and S875 which are actuated when the wiper noted is moved away from its normal rotary position. Further the tone detector 800 comprises a relay group, including a start relay R820, a flash relay R830, two control relays R835 and R850, a tone switch relay R840 and a tone relay R860; and a control network connected and arranged in a manner more fully described hereinafter.

Preferably, each of the incoming trunk circuits is identical to the incoming trunk circuit 900 which comprises, as shown in Figs. 9 and 10, a repeating coil 1060 and a signal switch 1090 of the minor type, including two wipers 1091 and 1092 provided with individually associated contact banks, a magnet M1093 for driving the wipers noted step by step in the counterclockwise direction, a magnet M1094 for releasing the wipers noted and for causing them to be returned to their normal rotary positions, and two sets of switch springs S971 and S1095 which are actuated when the wipers noted are moved away from their normal rotary positions. Also the incoming selector 900 comprises a relay group, including a T. X relay R920, a line relay R930, a hold relay R940, a digit relay R950, an answer relay R960, a reverse battery relay R1010, three ring relays R1020, R1030 and R1040, a supervisory relay R1050, a switch relay R1080 and a switch slave relay R1070; and a control network connected and arranged in a manner more fully described hereinafter.

As previously noted, the toll board 320 is of the manual type and comprises a plurality of operator positions, including the inward position 1025 illustrated which is provided with a signal lamp L1055 individual thereto. Each operator position at the switchboard comprises a jack upon which an incoming call on the incoming trunk circuit 900 may be answered; the inward position 1025 being provided with the jack J1026 illustrated. Also each operator position at the toll board 320 is provided with a jack and an associated signal lamp associated with the trunk 501 extending to the toll line circuit 500; the inward position 1025 being provided with the jack J1028 and the signal lamp L1056 associated with the trunk 501 extending to the toll line circuit 500.

A better understanding of the connection and arrangement of the system will be facilitated from a consideration of the detailed operation of the various pieces of apparatus incorporated therein incident to the completion of the various calls between the central office 10 and the distant exchange 300, as will appear hereinafter.

Initiation of a call from the central office to the distant exchange

Considering now the initiation of a call to the distanct exchange 300 from the central office 10, it is noted that the call may be initiated in the central office 10 either at the toll switchboard 11 or at the toll board 30, or the call may be initiated at one of the two remote toll offices or at the manual office No. 2 and extended via the central office 10. In any case, the toll switching apparatus in the central office 10 is controlled, whereby the toll third selector 34 seizes the trunk 400*f* extending to the toll line circuit 400 or the trunk 400*n* extending to the toll line circuit 400 is seized directly at the toll board 30, assuming that the call is to be routed via the toll line circuit 400 individual to the toll trunk 333 extending between the central office 10 and the distant exchange 300. More particularly, either the trunk 400*f* or 400*n* extending to the toll line circuit 400 is seized, whereby the toll line circuit 400 controls the toll line circuit 500 over the toll trunk 333 and the repeaters 331 and 332 illustrated. More specifically, when the toll line circuit 400 in the central office 10 is thus seized it operates in order to cause resistance battery potential to be applied by way of the two line conductors in parallel of the toll trunk 333 and the windings 411 and 413 of the repeating coil 410 to the simplex conductor C416. This application of resistance battery potential in the toll line circuit 400 in the central office 10 to the simplex conductor C416 completes a circuit, including the contacts 513', 783 and 775, for energizing the winding of the simplex relay R680 in the toll line circuit 500 in the distant exchange 300, whereby the last-mentioned relay operates. Upon operating, the simplex relay R680 completes, at the contacts 681, an obvious circuit for energizing the winding of the hold relay R670, thereby to cause the latter relay to operate.

Upon operating, the hold relay R670 interrupts, at the contacts 671, a normally completed path, including the contacts 631, for applying battery potential by way of the winding of the busy relay R780 to the control conductor C793 of the trunk 790 extending to the incoming selector 315 individually associated with the toll line circuit 500; and completes, at the contacts 672, an obvious path for applying ground potential to the control conductor C793 of the trunk 790, whereby the incoming selector 315 is seized preparatory to the reception of a digit to be transmitted over the trunk 790. Also the hold relay R670 completes, at the contacts 677, an obvious path for applying ground potential to the control conductor C506 of the trunk 501, thereby to complete obvious multiple circuits for illuminating the signal lamps L1056 etc. disposed at the various positions at the toll board 320 in order to indicate to the operators thereat that the toll line circuit 500 to which the trunk 501 extends and consequently the toll trunk 333 are busy at this time. Further the hold relay R670 completes, at the contacts 673, an obvious circuit, including the contacts 724, and the resistor 697, for energizing the upper winding of the pulse relay R660, and completes, at the contacts 674 and 675, a circuit, including the resistor 695 and the contacts 775, 783 and 513', for energizing the lower winding of the pulse relay R660 via the simplex conductor C416. When both the upper and the lower windings of the pulse relay R660 are thus energized this relay operates exceedingly fast as it is of the polarized type. Also the hold relay R670 completes, at the contacts 675 and 676, a local high resistance battery circuit including the resistors 695 and 696, the resistor 696 being of relatively high resistance with respect to the resistance of the resistor 695; which local battery circuit is without effect at this time. Further the hold relay R670 completes, at the contacts 675, an obvious circuit, including the resistors 693 and 695, for charging the condenser 694, and completes, at the contacts 674, an obvious multiple circuit, including the resistor 693 and the lower winding of the pulse relay R660, for charging the condenser 694.

Upon operating, the pulse relay R660 completes, at the contacts 661, an obvious circuit for energizing the winding of the pulse slave relay R720 and an obvious multiple circuit, including the resistor 796, for charging the condenser 797, whereby the latter relay operates. Upon operating, the pulse slave relay R720 interrupts, at the contacts 724, the previously traced circuit for energizing the upper winding of the pulse relay R660; however, the latter relay remains in its operated position due to the completed holding circuit for energizing the lower winding thereof. Also the pulse slave relay R720 completes, at the contacts 722, an obvious circuit for energizing the winding of the hold relay R710, thereby to cause the latter relay to operate. Upon operating, the hold relay R710 completes, at the contacts 711, an obvious circuit, including the resistor 798, for energizing the upper winding of the select relay R730, thereby to render the latter relay exceedingly fast to operate when the lower winding thereof is subsequently energized, the select relay R730 being of the polarized type. Also the hold relay R710 completes, at the contacts 713, an obvious multiple circuit for energizing the winding of the hold relay R670. Further the hold relay R710 completes, at the contacts 712, a loop circuit between the toll line circuit 500 and the incoming selector 315 via the trunk 790. The above-mentioned circuit extends from the line conductor C791 of the trunk 790 by way of the contacts 761, 721 and 511, the winding 412 of the repeating coil 410, the contacts 513, the upper winding of the answer relay R740, the lower winding of the select relay R730, the contacts 515, the winding 414 of the repeating coil 410, the contacts 517, 712 and 764 to the line conductor C792 of the trunk 790. When the above-mentioned loop circuit is completed the upper winding of the answer relay R740 is energized, whereby this relay operates; also the lower winding of the select relay R730 is energized, but the latter relay does not operate as it is of the polarized type and the direction of current flow in the lower winding thereof is in opposition to the direction of current flow in the upper winding thereof. Also, upon operating, the hold relay R710 completes, at the contacts 711, a circuit, including the contacts 732, for energizing the winding of the ring relay R750 in order to cause the latter relay to operate. Upon operating, the ring relay R750 completes, at the contacts 753, a circuit, including the contacts 732 and 711 and C804, for energizing the winding of the start relay R820 in the tone detector 800, thereby to cause the latter relay to operate.

Upon operating, the start relay R820 in the tone detector 800 completes, at the contacts 824, an obvious path for applying ground potential to the start conductor C813 extending to the tone detecting unit 815, whereby operation of the tone detecting unit 815 is initiated. Also the start relay R820 completes, at the contacts 821, an obvious connection between the conductor C801 extending to the toll line circuit 500 and the conductor C811 extending to the tone detecting unit 815, the last-mentioned connection including the condenser 818. Further the start relay R820 completes, at the contacts 822, an obvious path for applying ground potential to the conductor C812 extending to the tone detecting unit 815 and completes, at the contacts 825, an obvious path for applying battery potential by way of the winding of the flash relay R830 to the conductor C814 extending to the tone detecting unit 815. Also the start relay R820 completes, at the contacts 827, a connection including the contacts 856 and 846 between the rotary magnet M872 of the digit switch 870 and the conductor C805 extending to the toll line circuit 500, for a purpose more fully explained hereinafter. When operation of the tone detecting unit 815 is thus initiated, ground potential is returned over the conductor C814, thereby to complete an obvious circuit, including the contacts 825, for energizing the winding of the flash relay R830, whereby the latter relay operates. Upon operating, the flash relay R830 completes, at the contacts 831, an obvious circuit for energizing the winding of the control relay R835, thereby to cause the latter relay to operate. Also the flash relay R830 rompletes, at the contacts 833, an obvious path, including the contacts 873, for applying ground potential to the wiper 871 of the digit switch 870, for a purpose more fully explained hereinafter. Upon operating, the control relay R835 completes, at the contacts 836, an obvious multiple holding circuit, including the contacts 826, for energizing the winding thereof. At this time the toll line circuit 500 and the associated tone detector 800 occupy their seized conditions; and the toll line circoit 500 is in readi-

ness to receive the first digit transmitted over the toll trunk 333 from the central office 10.

At this time the first digit is transmitted from the central office 10 over the toll trunk 333, ground and battery potentials being alternately applied to the line conductors in multiple of the toll trunk 333 and consequently to the simplex conductor C416 in accordance with the number of impulses of the first digit. The first time battery potential is removed from and ground potential is applied to the simplex conductor C416 a path, including the contacts 513', 783 and 775, is completed for short-circuiting the winding of the simplex relay R680, thereby to cause the latter relay to restore. Also this application of ground potential to the simplex conductor C416 completes a circuit, including the contacts 513', 783, 775, 674 and 676 and the resistor 696, for energizing the lower winding of the pulse relay R660 in the opposite direction, whereby the latter relay restores exceedingly fast in view of the fact that it is of the polarized type. At this point it is noted that the above-traced circuit for energizing the lower winding of the pulse relay R660 in the opposite direction includes the resistor 696 having a high resistance value; whereby there is no tendency for the pulse relay R660 to reoperate. Also reoperation of the pulse relay R660 at this time is positively prevented due to interruption of the previously traced circuit for energizing the upper winding thereof. Upon restoring, the pulse relay R660 interrupts, at the contacts 661, the previously mentioned circuit for energizing the winding of the pulse slave relay R720 and the previously mentioned multiple circuit for charging the condenser 797, whereby the latter relay restores. Upon restoring, the pulse relay R720 recompletes, at the contacts 724, the previously traced circuit for energizing the upper winding of the pulse relay R660; however, the latter relay does not reoperate at this time as it is of the polarized type. Also when ground potential is applied to the simplex conductor C416 the condenser 694 is charged to a slightly higher potential, for a purpose more fully explained hereinafter.

At the conclusion of the first impulse of the digit transmitted over the toll trunk 333, ground potential is removed from and battery potential is reapplied to the simplex conductor C416, thereby to recomplete the previously traced circuit for energizing the winding of the simplex relay R680 and to recomplete the previously traced original multiple circuit for energizing the lower winding of the pulse relay R660, whereby the latter relay reoperates exceedingly fast as it is of the polarized type, as previously noted. Also when battery potential is reapplied to the simplex conductor C416 the condenser 694 is discharged partially through the lower winding of the pulse relay R660 in order further to enhance the time response of the latter relay. Upon reoperating, the pulse relay R660 completes, at the contacts 661, the previously mentioned circuit for energizing the winding of the pulse slave relay R720 and the previously mentioned multiple circuit for charging the condenser 797, whereby the latter relay reoperates. Accordingly, it will be understood that the simplex relay R680 and the pulse relay R660 follow the impulses of the digit transmitted over the toll trunk 333 and consequently over the simplex conductor C416. Also the pulse relay R660 repeats the impulses of the digit mentioned, at the contacts 661, to the pulse slave relay R720, whereby the latter relay follows the impulses of the digit mentioned. The condenser 797 and the associated resistor 796 connected in multiple with the winding of the pulse slave relay R720 constitute a pulse correcting network; whereby the pulse slave relay R720 remains restored and reoperated the appropriate portions of each impulse of the digit, in a manner well understood.

Also each time the pulse slave relay R720 restores and then reoperates it completes and then interrupts, at the contacts 723, an obvious circuit, including the contacts 714, for energizing the winding of the digit relay R640, thereby to cause the latter relay to operate. Further, each time the pulse slave relay R720 restores and then reoperates it interrupts and then recompletes, at the contacts 722, the previously mentioned circuit for energizing the winding of the hold relay R710. The hold relay R710 and the digit relay R740 are of the slow-to-release type; accordingly, these relays do not restore during impulsing. Moreover, the hold relay R710 retains operated the hold relay R670, the latter relay being of the slow-to-release type also. Upon operating, the digit relay R640 completes, at the contacts 641, an obvious circuit for energizing the winding of the digit slave relay R650, thereby to cause the latter relay to operate. Upon operating, the digit slave relay R650 interrupts, at the contacts 651, a normally completed path, including the contacts 771 and 571, the condenser 595 and the resistor 594, across the terminals of the windings 412 and 414 of the repeating coil 410; and interrupts, at the contacts 653, a normally completed connection between the toll line circuit 500 and the conductor C811 extending to the tone detecting unit 815, for a purpose more fully explained hereinafter. Also the digit slave relay R650 completes, at the contacts 652, an impulsing bridge between the line conductors C791 and C792 of the trunk 790 short-circuiting the windings 412 and 414 of the repeating coil 410, the lower winding of the select relay R730 and the upper winding of the answer relay R740. The above-mentioned bridge circuit extends, when completed, from the line conductor C791 of the trunk 790 by way of the contacts 761, 721, 652, 712 and 764 to the line conductor C792 of the trunk 790. Accordingly, the pulse slave relay R720 repeats the impulses of the digit mentioned, at the contacts 721, over the trunk 790 to the incoming selector 315, whereby the latter selector is operated in the vertical direction in accordance with the number of impulses of the digit mentioned, in a well-known manner. Further the digit slave relay R650 completes, at the contacts 656, an obvious path for applying ground potential to the conductor C805, thereby to complete a circuit, including the contacts 827, 846 and 856, for energizing the rotary magnet M872 of the digit switch 870 in the tone detector 800, whereby the latter magnet operates in order to drive the wiper 871 of the digit switch 870 one step in the clockwise direction. When the wiper 871 of the digit switch 870 is driven one step in the clockwise direction away from its normal rotary position, the sets of switch springs S874 and S875 are actuated for a purpose more fully explained hereinafter.

Also when the above-traced bridge circuit is completed at the contacts 652, incident to the operation of the digit slave relay R650, the windings 412 and 414 of the repeating coil 410, the lower winding of the select relay R730 and the upper winding of the answer relay R740 are short-

circuited, as previously noted; whereby the answer relay R740 restores.

At the conclusion of the first digit, battery potential is reapplied in the central office 10 to the line conductors of the toll trunk 333 and consequently to the simplex conductor C416, whereby the simplex relay R680, the pulse relay R660, the pulse slave relay R720, the hold relay R710, the hold relay R670, and the ring relay R750 in the toll line circuit 500 in the distant exchange 300 are retained in their operated positions. Shortly thereafter, the digit relay R640 restores, thereby to interrupt, at the contacts 641, the previously mentioned circuit for energizing the winding of the digit slave relay R650, whereby the latter relay restores. Upon restoring, the digit slave relay R650 recompletes, at the contacts 651, the previously traced path for connecting the condenser 595 and the resistor 594 across the terminals of the windings 412 and 414 of the repeating coil 410; recompletes, at the contacts 653, the previously traced connection between the terminal of the winding 414 of the repeating coil 410 and the conductor C801 extending to the tone detector 800; and interrupts, at the contacts 652, the previously traced bridge circuit between the line conductors C791 and C792 of the trunk 790. Also, upon restoring, the digit slave relay R650 interrupts, at the contacts 656, the previously traced circuit, including the conductor C805, for energizing the rotary magnet M872 of the digit switch 870, whereby the latter magnet restores. When the above-traced bridge circuit between the line conductors C791 and C792 is interrupted, at the contacts 652, incident to the restoration of the digit slave relay R650, the windings 412 and 414 of the repeating coil 410, the lower winding of the select relay R730 and the upper winding of the answer relay R740 are again connected in series across the line conductors C791 and C792 of the trunk 790 extending to the incoming selector 315.

In view of the foregoing explanation of the mode of operation of the toll line circuit 500, it will be understood that the first digit received thereby over the toll trunk 333 is repeated over the trunk 790 to the incoming selector 315 and the tone detector 800 is operated to register in the digit switch 870 the reception of the first digit. The incoming selector 315 responds to the first digit repeated over the trunk 790 so select a corresponding group of trunks accessible thereto and then operates automatically in order to select an idle trunk in the previously selected group, all in accordance with conventional practice.

Extension of the call to a substation in the distant exchange

Now assuming that the call initiated in the central office 10 and routed via the toll line circuit 400 and the toll trunk 333 to the toll line circuit 500, in the manner described above, is to be extended to a subscriber substation in the distant exchange 300, such, for example, as the substation X, four digits are required. The four digits are transmitted over the toll trunk 333 to the toll line circuit 500 and repeated in the manner explained above over the trunk 790. The first digit effects operation of the incoming selector 315, in the manner described above, whereby the incoming selector 315 seizes a trunk in the designated group extending to one of the groups of selectors, such, for example, as the trunk 310, extending to the toll transmission selector 311. The toll transmission selector 311 responds to the second digit and seizes a trunk in the designated group extending to one of the groups of toll connectors, such, for example, as the trunk 313, extending to the toll connector 312. The toll connector 312 responds to the third and fourth digits to select the subscriber line 322 extending to the called substation X, whereupon the toll connector 312 tests the idle or busy condition of the called substation X in accordance with conventional practice. As each of the four digits is received by the toll line circuit 500, the digit switch 870 is sequentially operated to register the reception of the digits mentioned. Accordingly, the wiper 871 of the digit switch 870 occupies its respective first, second, third and fourth positions at the beginning and, consequently, at the conclusion of the respective first, second, third and fourth digits received by the toll line circuit 500 over the toll trunk 333 from the central office 10.

Also it will be understood that, in the event the incoming selector 315 encounters an all-trunks-busy condition at the conclusion of its operation in response to the first digit, busy tone current will be returned over the trunk 790 in accordance with conventional practice. In a similar manner, in the event the toll transmission selector 311 encounters an all-trunks-busy condition at the conclusion of its operation in response to the second digit, busy tone current will be returned over the trunk 790 in accordance with conventional practice. Finally, in the event the toll connector 312 tests the subscriber line 322 extending to the called substation X as busy at the conclusion of its operation in response to the fourth digit, busy tone current will be returned over the trunk 790 in accordance with conventional practice.

Now assuming that an all-trunks-busy condition is encountered either by the incoming selector 315 or by the toll transmission selector 311, busy tone current is returned over the trunk 790, as explained above, at the conclusion of the respective first or second digit, whereby the busy tone current returned over the trunk 790 is returned over the conductor C801 to the tone detector 800 when the conductor C801 is connected, at the contacts 653, to the terminal of the winding 414 of the repeating coil 410 incident to the restoration of the digit slave relay R650, as explained above. At this time the conductor C801 is connected by way of the condenser 818 and the contacts 821 to the conductor C811 extending to the tone detecting unit 815, whereby the tone detecting unit 815 operates to detect the busy tone current impressed upon the trunk 790. More particularly, the tone detecting unit 815 operates in order to cause flashes of ground potential to be returned over the conductor C814, whereby the flash relay R830 operates and restores intermittently. At this time the wiper 871 of the digit switch 870 occupies either its first or its second position in view of the fact that only the first digit or only the first and the second digits have been received by the toll line circuit 500 over the toll trunk 333 and repeated over the trunk 790 to the incoming selector 315 or to the incoming selector 315 and the toll transmission selector 311.

The first time the flash relay R830 restores it interrupts, at the contacts 831, the previously traced original circuit for energizing the winding of the control relay R835; however, the latter relay remains in its operated position due to

the completed holding circuit for energizing the winding thereof. Also the first time the flash relay R830 restores it interrupts, at the contacts 833, the previously mentioned path for applying ground potential to the wiper 871 of the digit switch 870, and completes, at the contacts 832, a circuit, including the contacts 837 and 854, for energizing the lower winding of the control relay R850. When thus energized the control relay R850 operates to complete, at the contacts 853, an obvious holding circuit, including the contacts 826, for energizing the upper winding thereof, and to interrupt, at the contacts 854, the previously traced circuit for energizing the lower winding thereof. Also the control relay R850 interrupts, at the contacts 852, a point in a circuit traced hereinafter for energizing the winding of the tone switch relay R840, interrupts, at the contacts 856, a further point in the previously traced original circuit for energizing the rotary magnet M872, and completes, at the contacts 855, an obvious alternative circuit, including the contacts 837 and 832, for energizing the rotary magnet M872. When thus energized the rotary magnet M872 operates, thereby to drive the wiper 871 of the digit switch 870 an additional step in the clockwise direction. The first time the flash relay R830 reoperates it interrupts, at the contacts 832, the previously traced alternative circuit for energizing the rotary magnet M872, thereby to cause the latter magnet to restore. Also the first time the flash relay R830 reoperates it completes, at the contacts 833, the previously mentioned path for applying ground potential to the wiper 871 of the digit switch 870.

In view of the above description of the mode of operation of the rotary magnet M872 of the digit switch 870 in conjunction with the flash relay R830, it will be understood that the intermittent operation of the flash relay R830 causes intermittent operation of the rotary magnet M872, whereby the wiper 871 of the digit switch 870 is driven either three or four additional steps in the clockwise direction in order to engage the fifth contact in the associated contact bank terminating the conductor C877 extending to the tone relay R860. At this time, when the flash relay R830 reoperates and the rotary magnet M872 restores, the previously traced path for applying ground potential to the wiper 871 of the digit switch 870 is recompleted, whereby the ground potential is applied to the fifth contact in the contact bank engaged by the wiper 871 and consequently to the conductor C877 in order to complete an obvious circuit for energizing the winding of the tone relay R860. When thus energized the tone relay R860 operates to complete, at the contacts 863, an obvious holding circuit, including the contacts 826, for energizing the winding thereof, interrupts, at the contacts 861, the connection between the conductor C803 and the conductor C802, and completes, at the contacts 862, an obvious connection, including the contacts 841, between the 120 impulse-per-minute conductor C816 and the conductor C803, whereby the supervisory relay R770 operates and restores 120 times per minute.

Each time the supervisory relay R770 operates it interrupts, at the contacts 775, the previously traced path for applying ground potential by way of the winding of the simplex relay R680 to the simplex conductor C416, and completes, at the contacts 774, a path, including the contacts 783 and 513', for applying battery potential by way of the lower winding of the supervisory relay R810 to the simplex conductor C416. Also each time the supervisory relay R770 operates it completes, at the contacts 776, an obvious alternative circuit, including the contacts 583 and the resistor 593, for energizing in multiple the winding of the simplex relay R680 and the lower winding of the pulse relay R660, thereby to retain the latter relays in their operated positions. Each time the supervisory relay R770 restores it interrupts, at the contacts 774, the previously traced path for applying battery potential by way of the lower winding of the supervisory relay R610 to the simplex conductor C416, and recompletes, at the contacts 775, the previously traced path for applying ground potential by way of the winding of the simplex relay R680 to the simplex conductor C416. Also each time the supervisory relay R770 restores it recompletes, at the contacts 775, the previously traced original circuit for energizing in multiple the winding of the simplex relay R680 and the lower winding of the pulse relay R660, thereby to retain the latter relays in their operated positions. Accordingly, intermittent operation of the supervisory relay R770 causes alternate ground and battery potentials to be returned over the simplex conductor C416 at a rate of 120 complete impulses per minute; which 120 complete impulses per minute correspond to all-trunks-busy tone and is returned over the toll trunk 333 to the central office 10 and consequently over the calling connection in order to indicate the all-trunks-busy condition mentioned in the distant exchange 300.

Now assuming that no all-trunks-busy condition is encountered either by the incoming selector 315 or by the toll transmission selector 311, no busy tone current is returned over the trunk 790 at the conclusion of the first or second digit. Subsequently, the toll line circuit 500 operates to repeat the third digit over the trunk 790 to the toll connector 312, as previously noted, and the wiper 871 of the digit switch 870 in the tone detector 800 is driven to engage the third contact in the associated contact bank. At the conclusion of the third digit the rotary magnet M872 restores, thereby to complete, at the contacts 873, the previously mentioned circuit for applying ground potential to the wiper 871 of the digit switch 870 and consequently to the engaged third contact in the associated contact bank, whereby a circuit, including the conductor C876 and the contacts 852, is completed for energizing the winding of the tone switch relay R840. When thus energized the tone switch relay R840 operates to complete, at the contacts 845, a holding circuit, including the contacts 826, for energizing the winding thereof; and interrupts, at the contacts 846, a further point in the previously traced circuit for energizing the rotary magnet M872 of the digit switch 870. Also the tone switch relay R840 completes, at the contacts 843, a circuit, including the contacts 826 and 851 and the set of switch springs S874, for energizing the release magnet M873, whereby the latter magnet operates to release the wiper 871 of the digit switch 870 in order to cause the wiper noted to be returned to its normal rotary position. When the digit switch 870 is thus released the set of switch springs S874 is actuated into disengagement, thereby to interrupt the previously traced circuit for energizing the release magnet M873 in order to cause this latter magnet to restore. Also the set of switch springs S875 is actuated into engagement, thereby to complete a circuit, including the contacts 844 and 826, for energizing the upper winding of the control relay R850. When thus ener-

gized the control relay R850 operates to complete, at the contacts 853, a multiple holding circuit, including the contacts 826, for energizing the upper winding thereof. Also the control relay R850 interrupts, at the contacts 851, a further point in the previously traced circuit for energizing the release magnet M873 of the digit switch 870; interrupts, at the contacts 854, a further point in the previously traced circuit for energizing the lower winding thereof; and prepares, at the contacts 855, the previously traced alternative circuit for energizing the rotary magnet M872.

The toll line circuit 500 then receives the fourth digit over the toll trunk 333 from the central office 10 and repeats the digit mentioned over the trunk 790 to the toll connector 312, whereby the toll connector 312 operates to select the subscriber line 322 extending to the called substation X, as previously explained. At this time the toll connector 312 tests the idle or busy condition of the subscriber line 322 extending to the called substation X as previously noted; whereupon busy tone current is returned therefrom over the trunk 790 in the event the subscriber line 322 is tested as busy, as previously explained.

Now assuming that the subscriber line 322 extending to the called substation X is tested as busy by the toll connector 312, busy tone current is returned over the trunk 790, as explained above, at the conclusion of the fourth digit, whereby the busy tone current returned over the trunk 790 is detected by the tone detecting unit 815 and the flash relay R830 is operated intermittently, all in the manner previously explained. The intermittent operation of the flash relay R830 causes intermittent operation of the rotary magnet M872, as previously explained, whereby the wiper 871 is driven five steps in the clockwise direction into engagement with the fifth contact in the associated contact bank. When the rotary magnet M872 next restores it completes, at the contacts 873, the previously traced circuit for energizing the winding of the tone relay R860, thereby to cause the latter relay to operate. Upon operating, the tone relay R860 completes, at the contacts 863, the previously traced holding circuit, including the contacts 826, for energizing the winding thereof, and completes, at the contacts 862, an obvious connection, including the contacts 842, between the 60 impulse-per-minute conductor C817 and the conductor C803, whereby a circuit substantially identical to that previously traced is completed for energizing the winding of the supervisory relay R770. The last-mentioned circuit includes the 60 impulse-per-minute conductor C817, whereby the supervisory relay R770 operates and restores at a rate of 60 times per minute. The operation of the supervisory relay R770 is substantially the same as that previously described. However, in the present example, 60 alternate ground and battery impulses per minute are returned over the simplex conductor C416 and consequently over the toll trunk 333 to the central office 10 and consequently over the calling connection in order to indicate the busy condition mentioned of the subscriber line 322 extending to the called substation X in the distant exchange 300.

In view of the foregoing explanation of the tone detector 800, it will be understood that the digit switch 870 therein is controlled in conjunction with the toll line circuit 500 to register the number of digits which have been received by the toll line circuit 500 over the toll trunk 333 and repeated over the trunk 790 and to make a busy tone detection test at the conclusion of each digit; whereby the tone detector 800 may discriminate between an all-trunks-busy condition and a busy condition of a subscriber line extending to a called substation in the distant exchange 300. Further the tone detector 800 selectively controls the toll line circuit 500 in response to the discriminating busy test mentioned, whereby two different types of busy signals respectively corresponding to the two busy conditions mentioned are selectively returned over the toll trunk 333 to the central office 10 and consequently to the calling circuit.

Now assuming that the toll connector 312 tests the subscriber line 322 extending to the called substation X as idle at the conclusion of the operation thereof in response to the fourth digit, the toll connector 312 controls the toll transmission selector 311, whereby the toll transmission selector 311 operates to cause battery potential to be reversed over the loop circuit which now extends between the toll line circuit 500 and the toll transmission selector 311. The above-mentioned loop circuit extends between the toll line circuit 500 and the toll transmission selector 311 and includes the trunk 310, the incoming selector 315 and the trunk 790, as previously explained. Also this loop circuit includes the lower winding of the select relay F730 and the upper winding of the answer relay R740. Accordingly, the answer relay R740 occupies its operated position and the select relay R730 operates due to the reversal of the direction of current flow in the lower winding thereof, the select relay R730 being of the polarized type.

Upon operating, the select relay R730 completes, at the contacts 734, an obvious path for short-circuiting the resistor 798, thereby to complete an obvious holding circuit, including the contacts 711, for energizing the upper winding thereof. Also the select relay R730 interrupts, at the contacts 732, the previously traced circuit for energizing the winding of the ring relay R750 and the previously traced multiple circuit for energizing the winding of the start relay R820 in the tone detector 800; whereby the ring relay R750 restores shortly thereafter, the latter relay being of the slow-to-release type, and the start relay R820 restores immediately. Also the select relay R730 completes, at the contacts 731, a circuit, including the contacts 711 and 752, for energizing the winding of the ring relay R760, thereby to cause the latter relay to operate. Upon restoring, the start relay R820 in the tone detector 800 completes, the the contacts 823, an obvious alternative circuit, including the set of switch springs S874, for energizing the release magnet M873, whereby the latter magnet operates in order to release the wiper 871 of the digit switch 870 and to cause it to be returned to its normal rotary position. When the digit switch 870 is thus released the set of switch springs S874 is actuated into disengagement, thereby to interrupt the previously traced circuit for energizing the release magnet M873, whereby the latter magnet restores. Also, upon restoring, the start relay R820 interrupts, at the contacts 821, the previously traced connection between the conductor C801 and the conductor C811; interrupts, at the contacts 822 and 824, the previously mentioned paths for applying ground potential to the conductors C812 and C813; and interrupts, at the contacts 825, the previously traced circuit for energizing the winding of the flash relay R830, thereby to cause the latter relay to restore. Further the

start relay R820 interrupts, at the contacts 826, the previously traced holding circuits for energizing the windings of the control relay R835, the tone switch relay R840 and the control relay R850, thereby to cause the relays mentioned to restore. At this time the tone detector 800 is completely released.

Upon operating, the ring relay R760 completes, at the contacts 763, an obvious holding circuit, including the contacts 772, for energizing the lower winding of the answer relay R740, and interrupts, at the contacts 761 and 764, the previously traced loop circuit for energizing in series the lower winding of the select relay R730 and the upper winding of the answer relay R740; however, the select relay R730 remains operated due to the completion of the previously traced holding circuit for energizing the upper winding thereof and the answer relay R740 remains operated due to the completion of the previously traced holding circuit for energizing the lower winding thereof. Further the ring relay R760 completes, at the contacts 762 and 765, obvious paths for connecting generator potential by way of the generator conductor C794 and the ballast lamp L795 and ground potential, respectively, to the conductors C791 and C792 of the trunk 790. The application of generator potential and ground potential to the line conductors C791 and C792, respectively, of the trunk 790 controls the toll transmission selector 311, whereby the toll connector 312 is operated to project ringing current therefrom over the subscriber line 322 extending to the called substation X. The ring relay R750 then restores to interrupt, at the contacts 752, the previously traced circuit for energizing the winding of the ring relay R760, thereby to cause the latter relay to restore shortly thereafter, the ring relay R760 being of the slow-to-release type.

Upon restoring, the ring relay R760 interrupts, at the contacts 763, the previously mentioned holding circuit for energizing the lower winding of the answer relay R740, and recompletes, at the contacts 761 and 764, the previously traced loop circuit, including the trunk 790, for energizing in series the lower winding of the select relay R730 and the upper winding of the answer relay R740. Also the ring relay R760 interrupts, at the contacts 762 and 765, the previously traced path for projecting generator and ground potentials, respectively, over the line conductors C791 and C792 of the trunk 790. The toll connector 312 continues to project ringing current over the subscriber line 322 to the called substation X until the subscriber at the called substation X answers the call. At this time the toll connector 312 switches through, whereby the projection of ringing current over the subscriber line 322 to the called substation X is interrupted and the toll transmission selector 311 is controlled. More particularly, the toll transmission selector 311 is controlled to dry of ground and battery potentials the loop circuit extending between the toll transmission selector 311 and the toll line circuit 500. When the loop circuit mentioned is thus dried of ground and battery potentials the previously traced circuit for energizing in series the lower winding of the select relay R730 and the upper winding of the answer relay R740 is interrupted, whereby the select relay R730 remains in its operated position due to the completed holding circuit for energizing the upper winding thereof and the answer relay R740 restores. Upon restoring, the answer relay R740 completes, at the contacts 741, a circuit, including the contacts 711, 731, 751 and 861, for energizing the winding of the supervisory relay R770, whereby the latter relay operates. Upon operating, the supervisory relay R770 interrupts, at the contacts 771, the previously traced path for connecting the resistor 594 and the condenser 595 across the terminals of the windings 412 and 414 of the repeating coil 410; interrupts, at the contacts 775, the previously traced path for applying ground potential by way of the winding of the simplex relay R680 to the simplex conductor C416; and completes, at the contacts 774, the previously traced path for applying battery potential by way of the lower winding of the supervisory relay R610 to the simplex conductor C416. Also the supervisory relay R770 completes, at the contacts 776, the previously traced alternative holding circuit for energizing in multiple the winding of the simplex relay R680 and the lower winding of the pulse relay R660, thereby to retain the relays mentioned in their operated positions.

The removal of resistance ground potential and the application of resistance battery potential to the simplex conductor C416 effect the transmission of answer supervision over the toll trunk 333 to the central office 10 and the calling circuit. At this time the calling circuit is connected by way of the apparatus in the central office 10 to the toll line circuit 400; while the toll line circuit 400 is connected by way of the repeaters 331 and 332 and the toll trunk 333 to the windings 411 and 413 of the repeating coil 410; the windings 412 and 414 of the repeating coil 410 are connected by way of the condenser 415, the contacts 511, 517, 712, 721, 761 and 764, the line conductors C791 and C792 of the trunk 790, the incoming selector 315 and the trunk 310 to the toll transmission selector 311; and a loop circuit is completed between the called substation X and the toll transmission selector 311, including the toll connector 312, the trunk 313 and the subscriber line 322.

When the subscriber at the called substation X initiates the release of the established connection by replacing the receiver of the telephone instrument thereat upon its associated switchhook, interrupting the loop circuit between the called substation X and the toll transmission selector 311, the toll transmission selector 311 operates in order again to supply ground and battery potentials over the previously traced loop circuit, including the trunk 790, whereby the lower winding of the select relay R730 and the upper winding of the answer relay R740 are again energized in series. When thus energized the answer relay R740 operates to interrupt, at the contacts 741, the previously traced circuit for energizing the winding of the supervisory relay R770, thereby to cause the latter relay to restore. Upon restoring, the supervisory relay R770 again completes, at the contacts 771, the previously traced path for connecting the resistor 594 and the condenser 595 across the terminals of the windings 412 and 414 of the repeating coil 410; and interrupts, at the contacts 774, the previously traced path for applying battery potential by way of the lower winding of the supervisory relay R610 to the simplex conductor C416. Also the supervisory relay R770 interrupts, at the contacts 776, the previously traced alternative holding circuit for energizing in multiple the winding of the simplex relay R680 and the lower winding of the pulse relay R660; and recompletes, at the contacts 775, the previously traced path for applying ground poten-

tial by way of the winding of the simplex relay R680 and the lower winding of the pulse relay R660 to the simplex conductor C416, whereby the simplex relay R680 and the pulse relay R660 are retained in their operated positions. The removal of resistance battery potential from and the application of resistance ground potential to the simplex conductor C416 effect the transmission of release supervision over the toll trunk 333 to the central office 10 and the calling circuit.

The apparatus in the central office 10 is then released, whereby the toll line circuit 400 operates in order to cause battery potential to be removed from the line conductors of the toll trunk 333 and consequently from the simplex conductor C416 extending to the toll line circuit 500. When battery potential is thus removed from the simplex conductor C416 the previously traced circuit for energizing in multiple the winding of the simplex relay R680 and the lower winding of the pulse relay R660 is interrupted, thereby to cause these relays to restore. Upon restoring, the simplex relay R680 interrupts, at the contacts 681, one of the multiple holding circuits for energizing the winding of the hold relay R670. Upon restoring, the pulse relay R660 interrupts, at the contacts 661, the previously mentioned circuit for energizing the winding of the pulse slave relay R720, thereby to cause the latter relay to restore. Upon restoring, the pulse slave relay R720 completes, at the contacts 723, the previously traced circuit for energizing the winding of the digit relay R640, thereby to cause the latter relay to operate and effect the operation of the digit slave relay R650. Also, upon restoring, the pulse slave relay R720 interrupts, at the contacts 721, the previously traced loop circuit extending between the toll line circuit 500 and the incoming selector 315, thereby to effect the restoration of the answer relay R740. Upon restoring, the answer relay R740 recompletes, at the contacts 741, the previously traced circuit for energizing the winding of the supervisory relay R770, thereby to cause the latter relay to reoperate. Upon reoperating, the supervisory relay R770 recompletes, at the contacts 776, the previously traced alternative holding circuit for energizing in multiple the winding of the simplex relay R680 and the lower winding of the pulse relay R660, thereby to cause the relays mentioned to reoperate. Upon reoperating, the pulse relay R660 recompletes, at the contacts 661, the previously mentioned circuit for energizing the winding of the pulse slave relay R720, thereby to cause the latter relay to reoperate. Upon reoperating, the pulse slave relay R720 recompletes, at the contacts 721, the previously traced loop circuit, including the trunk 790, between the toll line circuit 500 and the toll transmission selector 311, whereby the answer relay R740 reoperates. Also, upon reoperating, the pulse slave relay R720 interrupts, at the contacts 723, the previously traced circuit for energizing the winding of the digit relay R640, thereby to cause the latter relay to restore shortly thereafter and effect the restoration of the digit slave relay R650.

Also, upon operating, the supervisory relay R770 completes, at the contacts 774, the previously traced path for applying battery potential by way of the lower winding of the supervisory relay R610 to the simplex conductor C416. At this time ground potential is applied in the toll line circuit 400 to the line conductors of the toll trunk 333 and consequently to the simplex conductor C416, whereby an obvious circuit is completed for energizing the lower winding of the supervisory relay R610 in order to cause the latter relay to operate. Upon operating, the supervisory relay R610 completes, at the contacts 611, an obvious circuit for energizing the winding of the supervisory slave relay R580, thereby to cause the latter relay to operate. Upon operating, the supervisory slave relay R580 interrupts, at the contacts 583, the previously traced holding circuit for energizing in multiple the winding of the simplex relay R680 and the lower winding of the pulse relay R660, thereby to cause the relays mentioned to restore. Upon restoring, the pulse relay R660 effects the restoration of the pulse slave relay R720. Upon restoring, the pulse slave relay R720 effects the restoration of the answer relay R740 and the hold relay R710 shortly thereafter. Upon restoring, the hold relay R710 interrupts, at the contacts 713, the previously mentioned holding circuit for energizing the winding of the hold relay R670, thereby to cause the latter relay to restore shortly thereafter, the hold relay R670 being of the slow-to-release type. Also, upon restoring, the hold relay R710 interrupts, at the contacts 714, the previously traced circuit for energizing the winding of the digit relay R640, thereby to cause the latter relay to restore shortly thereafter and effect the restoration of the digit slave relay R650. Upon restoring, the hold relay R710 interrupts, at the contacts 711, the previously traced circuit for energizing the winding of the supervisory relay R770, thereby to cause the latter relay to restore. Upon restoring, the supervisory relay R770 interrupts, at the contacts 774, the previously traced circuit for energizing the lower winding of the supervisory relay R610, thereby to cause the latter relay to restore. Also the supervisory relay R770 recompletes, at the contacts 775, the previously traced path for applying ground potential by way of the winding of the simplex relay R680 to the simplex conductor C416. Upon restoring, the supervisory relay R610 interrupts, at the contacts 611, the previously mentioned circuit for energizing the winding of the supervisory slave relay R580, thereby to cause the latter relay to restore. Upon restoring, the hold relay R670 interrupts, at the contacts 672, the previously mentioned path for applying ground potential to the control conductor C793 of the trunk 790, thereby to effect the release of the incoming selector 315 and the consequent release of the toll transmission selector 311 and the toll connector 312. At this time the toll line circuit 500 is completely released and the toll trunk 333 incoming thereto is marked as idle in the toll line circuit 400 by the application of ground potential by way of the winding of the simplex relay R680 in the toll line circuit 500 to the simplex conductor C416.

Extension of the call to the toll board in the distant exchange

Now assuming that the call initiated in the central office 10 and routed via the toll line circuit 400 and the toll trunk 333 to the toll line circuit 500, in the manner described above, is to be extended to the toll board 320 in the distant exchange 300, three digits are required. The three digits are transmitted over the toll trunk 333 to the toll line circuit 500 and repeated in the manner explained above over the trunk 790. In this case, the first digit is 1 and effects operation of the incoming selector 315, in the manner described above, whereby the incoming selector

315 seizes a trunk in the designated group extending to one of the incoming trunk circuits, such, for example, as the trunk 910, extending to the incoming trunk circuit 900. The incoming trunk circuit 900 then registers the second and third digits in order to indicate the particular position at the toll board 320 at which it is desired that the call be answered, in a manner more fully explained hereinafter.

More particularly, when the incoming selector 315 seizes the trunk 910, a loop circuit is completed between the toll line circuit 500 and the incoming trunk circuit 900 for energizing the upper winding of the line relay R930, this circuit extending from ground by way of the contacts 1012 and 1032, the winding 1061 of the repeating coil 1060, the line conductor C911 of the trunk 910, the incoming selector 315 to the line conductor C791 of the trunk 790, and from battery by way of the upper winding of R930, the contacts 1014 and 1034, the winding 1063 of the repeating coil 1060, the line conductor C912 of the trunk 910 and the incoming selector 315 to the line conductor C792 of the trunk 790; the line conductors C791 and C792 being looped together in the toll line circuit 500 by way of the previously traced path, including the contacts 721 of the pulse slave relay R720, as previously explained. When this loop circuit is completed the line relay R930 in the incoming trunk circuit 900 operates. At this point it is noted that the trunk 910 extending to the incoming trunk circuit 900 was marked as idle to the incoming selector 315 by the presence of battery potential upon the control conductor C913 thereof, battery potential being applied by way of the lower winding of the digit relay R950 and the set of switch springs S971 to the control conductor C913 of the trunk 910. Also when the incoming selector 315 seizes the trunk 910, ground potential is applied to the control conductor C913 thereof, thereby to complete an obvious circuit for energizing the lower winding of the digit relay R950, whereupon the latter relay operates. Upon operating, the line relay R930 completes, at the contacts 932, an obvious circuit for energizing the winding of the hold relay R940, thereby to cause the latter relay to operate. At this time the incoming trunk circuit 900 has been seized and is in readiness to receive the second digit.

At this point it is noted that the present call to the toll board 320 via the incoming trunk circuit 900 may be answered at any one of the positions thereat. However, the desired answering position is designated by the second and third digits which are registered by the signal switch 1090 in the incoming trunk circuit 900. More particularly, in the event the call is to be answered at the inward position 1025 illustrated, at the information position or at the call order position, the second and third digits respectively comprise 21, 31 and 51. On the other hand, in the event the call is to be answered at one of the ten T. X positions, the second and third digits respectively comprise 11 to 10, inclusive.

Now assuming that the present call is to be answered at one of the T. X positions, such, for example, as the position T. X #10, the second and third digits are 1 and 0. The line relay R930 follows the single impulse of the second digit 1 in accordance with conventional practice. Upon restoring, the line relay R930 interrupts, at the contacts 932, the previously mentioned circuit for energizing the winding of the hold relay R940, and completes, at the contacts 933, an obvious circuit, including the contacts 943 and 952, for energizing the upper winding of the digit relay R950 in multiple with the rotary magnet M1093 of the signal switch 1090. Upon reoperating, the line relay R930 interrupts, at the contacts 933, the previously traced circuit for energizing the upper winding of the digit relay R950 in multiple with the rotary magnet M1093 of the signal switch 1090, and recompletes, at the contacts 932, the previously mentioned circuit for energizing the winding of the hold relay R940. When thus energized the digit relay R950 is retained operated; and when thus energized the rotary magnet M1093 operates, thereby to drive the wipers noted of the signal switch 1090 one step in the counterclockwise direction. The hold relay R940 and the digit relay R950 are of the slow-to-release type and remain operated during impulsing. The rotary magnet M1093 then restores incident to the reoperation of the line relay R930, as previously noted. When the wipers noted of the signal switch 1090 are driven one step in the counterclockwise direction away from their normal rotary positions, the sets of switch springs S971 and S1095 are actuated. More particularly, the set of switch springs S971 is actuated into disengagement, thereby to interrupt the previously traced circuit for energizing the lower winding of the digit relay R950; and the set of switch springs S1095 is actuated into engagement, thereby to prepare a circuit traced hereinafter for energizing the release magnet M1094 of the signal switch 1090.

Shortly following the reception of the second digit 1 the digit relay R950 restores as it is of the slow-to-release type; the circuits for energizing the upper and lower windings thereof are interrupted at this time due to the operation of the line relay R930 and the actuation of the set of switch springs S971. Upon restoring, the digit relay R950 completes, at the contacts 953, a circuit, including the contacts 944, the wiper 1091 of the signal switch 1090 and the engaged first contact in the associated contact bank for energizing the winding of the T. X relay R920, thereby to cause the latter relay to operate. Upon operating, the T. X relay R920 completes, at the contacts 921, an obvious holding circuit, including the contacts 944, for energizing the winding thereof, and completes, at the contacts 923, a circuit, including the contacts 944, 955, 1081 and the set of switch springs S1095, for energizing the release magnet M1094; thereby to cause the latter magnet to operate and release the wipers noted of the signal switch 1090, whereby the wipers thereof are returned to their normal rotary positions. When the signal switch 1090 is thus released the set of switch springs S971 is actuated into engagement, thereby to recomplete the previously traced circuit for energizing the lower winding of the digit relay R950 in order to cause the latter relay to reoperate. Also the set of switch springs S1095 is actuated into disengagement, thereby to interrupt the previously traced circuit for energizing the release magnet M1094, whereupon the latter magnet restores. Upon reoperating, the digit relay R950 completes, at the contacts 954, a circuit, including the contacts 923 and 944, for energizing the winding of the switch relay R1080, thereby to cause the latter relay to operate. Upon operating, the switch relay R1080 completes, at the contacts 1083, an obvious holding circuit, including the contacts 944, for energizing the winding thereof, and com-

pletes, at the contacts 1084, an obvious circuit for energizing the winding of the switch slave relay R1070, thereby to cause the latter relay to operate. Upon operating, the switch slave relay R1070 interrupts, at the contacts 1071, 1073 and 1075, the normally completed connections between the call order conductor, the information conductor and the inward conductor and the respective fifth, third and second contacts in the contact bank associated with the wiper 1092 of the signal switch 1090; and completes, at the contacts 1072, 1074 and 1076, obvious connections between the T. X conductor #5, the T. X conductor #3 and the T. X conductor #2 and the respective fifth, third and second contacts in the contact bank associated with the wiper 1092 of the signal switch 1090.

The line relay R930 then responds to the third digit 0, whereby the digit relay R950 reoperates and the rotary magnet M1093 is energized and deenergized ten times, all in the manner previously explained. At this time the wipers noted of the signal switch 1090 engage the tenth contacts in the associated contact banks and the two sets of switch springs S971 and S1095 are again actuated for the purpose previously explained. Also, at this time, the line relay R930 reoperates, thereby to retain the hold relay R940 in its operated position and to effect the restoration of the digit relay R950 shortly thereafter, all as previously explained. Upon restoring, the digit relay R950 completes, at the contacts 955, a circuit, including the contacts 944, 923 and 1082, for energizing in series the upper and lower windings of the reverse battery relay R1010, thereby to cause the latter relay to operate. Upon operating, the reverse battery relay R1010 completes, at the contacts 1017, an obvious holding circuit, including the contacts 944, for energizing in series the upper and lower windings thereof; interrupts, at the contacts 1012 and 1014, the previously traced loop circuit extending between the incoming trunk circuit 900 and the toll line circuit 500; and completes, at the contacts 1011 and 1013, an alternative loop circuit extending between the incoming trunk circuit 900 and the toll line circuit 500. The alternative loop circuit includes in series the upper and lower windings of the line relay R930 and effects the reversal of battery over the trunk 790, whereby the select relay R730 in the toll line circuit 500 is operated in the manner previously explained. The alternative loop circuit mentioned extends from the grounded control conductor C913 of the trunk 910 by way of the contacts 942, the lower winding of R930, the contacts 1013 and 1034 and the winding 1063 of the repeating coil 1060 to the line conductor C912 of the trunk 910, and from battery by way of the upper winding of R930, the contacts 1011 and 1032 and the winding 1061 of the repeating coil 1060 to the line conductor C911 of the trunk 910; the line conductors C911 and C912 of the trunk 910 being connected by way of the incoming selector 315 to the line conductors C791 and C792 of the trunk 790; and the last-mentioned conductors being connected together in the toll line circuit 500 via the lower winding of the select relay R730 and the upper winding of the answer relay R740, as previously explained. Also the reverse battery relay R1010 completes, at the contacts 1015, a path, including the contacts 932 and 961, the wiper 1092 of the signal switch 1090 and the engaged tenth contact in the associated contact bank, for applying ground potential to the conductor T. X #10, whereby a signal lamp individual to the T. X #10 position at the toll board 320 is illuminated in order to indicate to the operator thereat that there is a call on the incoming trunk circuit 900 waiting to be answered. The operator at the T. X #10 position answers the call by inserting the answer plug of the associated cord circuit into the jack thereat which is connected to the windings 1062 and 1064 of the repeating coil 1060, in a manner more fully explained hereinafter.

In view of the above description of the mode of operation of the incoming trunk circuit 900 to receive the second and third digits 1 and 0, in order to indicate that the present call should be answered at the T. X #10 position at the toll board 320, it will be understood that the incoming trunk circuit 900 will receive the second and third digits 11 to 19, inclusive, in order to indicate that the present call should be answered at the respective T. X #1 to T. X #9 positions at the toll board 320.

Now assuming that the present call is to be answered at the inward position 1025 illustrated at the toll board 320, the second and third digits are 2 and 1. The line relay R930 follows the second digit 2 in the manner explained above, causing operation of the digit relay R950 and the rotary magnet M1093, whereby the wipers noted of the signal switch 1090 are driven two steps in the counterclockwise direction into engagement with the second contacts in the associated contact banks. Shortly following the conclusion of the second digit 2, the digit relay R950 restores, as previously explained. However, in this case, the wipers noted of the signal switch 1090 are not released in view of the fact that the T. X relay R920, the switch relay R1080 and the switch slave relay R1070 are not operated in the present example.

The line relay R930 then follows the third digit 1. Upon restoring, the line relay R930 completes, at the contacts 933, a circuit, including the contacts 943, 951 and 1016, for energizing the upper winding of the reverse battery relay R1010, whereby the latter relay operates partially to complete, at the contacts 1017, an obvious path, including the contacts 944, for short-circuiting the lower winding thereof. Subsequently, when the line relay R930 operates it interrupts, at the contacts 933, the above-traced circuit for energizing the upper winding of the reverse battery relay R1010 and the above-traced path for short-circuiting the lower winding of the reverse battery relay R1010, whereupon the upper and lower windings of the reverse battery relay R1010 are energized in series by way of the previously traced circuit, including the contacts 944. When thus energized the reverse battery relay R1010 operates completely, thereby to interrupt, at the contacts 1012 and 1014, the previously traced original loop circuit extending between the incoming trunk circuit 900 and the toll line circuit 500, and to complete, at the contacts 1011 and 1013, the previously traced alternative loop circuit extending between the incoming trunk circuit 900 and the toll line circuit 500, whereby battery potential is reversed over the trunk 910, the incoming selector 315 and the trunk 790 in order to effect the operation of the select relay R730 in the toll line circuit 500, in the manner previously explained. Also the reverse battery relay R1010 completes, at the contacts 1015, the previously traced path for applying ground potential to the wiper 1092 of the signal switch 1090, whereby ground potential is forwarded by

way of the engaged second contact in the contact bank associated with the wiper 1092 of the signal switch 1090 and the contacts 1075 to the inward conductor extending to the inward position 1025 at the toll board 320 in order to complete an obvious circuit for illuminating the associated signal lamp L1055. The illumination of the signal lamp L1055 indicates to the operator at the inward position 1025 at the toll board 320 that a call is waiting on the incoming trunk circuit 900 terminated by the associated jack J1026, which call should be answered at the inward position 1025.

The operator at the inward position 1025 at the toll board 320 answers the call by inserting the plug of the associated cord circuit into the jack J1026, whereby there is completed, at the contacts 1027 thereof, an obvious circuit for energizing the winding of the answer relay R960. When thus energized the answer relay R960 operates to complete, at the contacts 962, a holding circuit, including the contacts 931 and 944, for energizing the winding thereof, and to interrupt, at the contacts 961, the previously traced path for applying ground potential to the inward conductor in order to extinguish the signal lamp L1055 at the inward position 1025. Also the answer relay R960 completes, at the contacts 963, an obvious path for applying ground potential by way of the upper winding of the ring relay R1040 to the sleeve of the jack J1026, whereby a circuit is completed in the associated cord circuit for energizing the upper winding of the ring relay R1040 in order to cause the latter relay to operate. Upon operating, the ring relay R1040 completes, at the contacts 1042, an obvious circuit for energizing the winding of the ring relay R1030. When thus energized the ring relay R1030 operates to interrupt, at the contacts 1032 and 1034, the previously traced alternative loop circuit extending between the incoming trunk circuit 900 and the toll line circuit 500, thereby to cause the answer relay R740 in the toll line circuit 500 to restore in order to effect the return of answer supervision over the toll trunk 333 to the central office 10 and the calling circuit, in the manner previously explained. Also the ring relay R1030 completes, at the contacts 1031, an alternative local circuit for energizing in series the upper and lower windings of the line relay R930, this circuit extending from the grounded control conductor C913 of the trunk 910 by way of the contacts 942, the lower windings of R930, the contacts 1013, the resistor 1023, the contacts 1031 and 1011 and the upper winding of R930 to battery. When this local circuit is completed the line relay R930 is retained in its operated position. Further, the ring relay R1030 completes, at the contacts 1033 and 1035, an obvious path, including the condenser 1022 and the windings 1061 and 1063, for bridging the winding of the ring relay R1020 across the line conductors C911 and C912 of the trunk 910. At this time an operative connection is completed between the toll line circuit 500 and the incoming trunk circuit 900; this connection including the windings 412 and 414 of the repeating coil 410, the lower winding of the select relay R730 and the upper winding of the answer relay R740 in the toll line circuit 500, the trunk 790, the incoming selector 315, the trunk 910, the windings 1061 and 1063 of the repeating coil 1060 and the winding of the ring relay R1020 in the incoming trunk circuit 900. Also the windings 1062 and 1064 of the repeating coil 1060 are operatively connected by way of the condenser 1066, the jack J1026 and the associated cord circuit to the telephone set at the inward position 1025 at the toll switchboard 320.

In the event the operator at the inward position 1025 at the toll switchboard 320 in the distant exchange 300 desires to signal over the toll trunk 333 to the calling circuit in the central office 10, this may be accomplished by momentarily operating the ring key, thereby momentarily to interrupt the previously traced circuit for energizing the upper winding of the ring relay R1040, whereby the latter relay restores and then reoperates. Upon restoring, the ring relay R1040 interrupts, at the contacts 1042, the previously mentioned circuit for energizing the winding of the ring relay R1030, thereby to cause the latter relay to restore. Upon restoring, the ring relay R1030 interrupts, at the contacts 1031, the previously traced local circuit for energizing in series the upper and lower windings of the line relay R930, and recompletes, at the contacts 1032 and 1034, the previously traced alternative loop circuit between the incoming trunk circuit 900 and the toll line circuit 500, thereby to effect reoperation of the answer relay R740 in the toll line circuit 500; whereby a supervisory signal is transmitted over the toll trunk 333 to the calling circuit in the central office 10, in the manner previously explained. Upon reoperating, the ring relay R1040 effects reoperation of the ring relay R1030. Upon reoperating, the ring relay R1030 again interrupts, at the contacts 1032 and 1034, the previously traced alternative loop circuit extending between the incoming trunk circuit 900 and the toll line circuit 500, whereby the answer relay R740 in the toll line circuit 500 again restores in order to arrest the transmission of the supervisory signal over the toll trunk 333 to the calling circuit in the central office 10. Also the ring relay R1030 recompletes, at the contacts 1031, the previously traced local circuit for energizing in series the upper and lower windings of the line relay R930, and reconnects, at the contacts 1033 and 1035, the winding of the ring relay R1020 across the line conductors C911 and C912 of the trunk 910.

In the event it is necessary to resignal the operator at the inward position 1025 at the toll board 320 in the distant exchange 300 from the calling circuit in the central office 10, the apparatus in the central office 10 is controlled, whereby ringing current is momentarily projected over the toll trunk 333 through the windings 411 and 413 of the repeating coil 410, whereby a corresponding ringing voltage is induced in the windings 412 and 414 of the repeating coil 410 in order to cause a corresponding ringing current to traverse the previously traced connection extending between the toll line circuit 500 and the incoming trunk circuit 900. This ringing current traversing the connection mentioned effects the momentary operation of the ring relay R1020. Upon operating, the ring relay R1020 completes, at the contacts 1021, an obvious circuit for energizing the lower winding of the supervisory relay R1050, whereby the latter relay operates to complete, at the contacts 1051, an obvious path for applying ground potential by way of the upper winding of the supervisory relay R1050 and the lower winding of the ring relay R1040 to the sleeve of the jack J1026, this path including the contacts 963 and 1041. Accordingly, at this time, the upper winding of the ring relay R1040 is energized in multiple with the series connected lower wind-

ing of the ring relay R1040 and the upper winding of the supervisory relay R1050, whereby the supervisory relay R1050 remains in its operated position subsequent to the restoration of the ring relay R1020 to interrupt, at the contacts 1021, the previously mentioned circuit for energizing the lower winding of the supervisory relay R1050. Accordingly, low resistance ground potential is applied to the sleeve of the jack J1026 which is effective to illuminate a signal lamp associated with the cord circuit at the inward position 1025, thereby to indicate the supervision mentioned to the operator at the inward position 1025.

When the operator at the inward position 1025 reenters the connection, battery potential is momentarily removed from the sleeve of the jack J1026, thereby to effect the restoration of the ring relay R1040 and the supervisory relay R1050. Upon restoring, the ring relay R1040 effects the restoration of the ring relay R1030 and the consequent operation of the answer relay R740 in the toll line circuit 500, whereby an answer supervision is transmitted over the toll trunk 333 to the calling circuit in the central office 10, in the manner previously explained. The ring relay R1040 then reoperates in order to effect reoperation of the ring relay R1030 and the consequent restoration of the answer relay R740 in the toll line circuit 500, whereby the transmission of the answer signal over the toll trunk 333 to the calling circuit in the central office 10 is arrested, in the manner previously explained. Upon restoring, the supervisory relay R1050 interrupts, at the contacts 1051, the previously traced holding circuit for energizing the upper winding thereof in series with the lower winding of the ring relay R1040, whereby high resistance ground potential is again applied by way of the upper winding of the ring relay R1040 to the sleeve of the jack J1026 in order to extinguish the signal lamp associated with the cord circuit at the inward position 1025 at the toll board 320, in an obvious manner.

Considering now the release of the established connection, in the event the release is initiated at the calling circuit in the central office 10, the toll line circuit 500 and the incoming selector 315 are released in the manner previously explained, whereby ground potential is removed from the control conductor C913 of the trunk 910 in order to interrupt the previously traced circuit for energizing in series the upper and lower windings of the line relay R930. The line relay R930 then restores, thereby to interrupt, at the contacts 932, the previously mentioned circuit for energizing the winding of the hold relay R940 in order to cause the latter relay to restore shortly thereafter, the hold relay R940 being of the slow-to-release type. Also the line relay R930 completes, at the contacts 933, an alternative circuit, including the contacts 943, 951 and 1037, for energizing the lower winding of the suprevisory relay R1050, whereby the latter relay operates to complete, at the contacts 1051, the previously traced holding circuit for energizing the upper winding thereof in series with the lower winding of the ring relay R1040. When the supervisory relay R1050 is thus operated the signal lamp associated with the cord circuit at the inward position 1025 is again illuminated in order to indicate the release supervision. Upon restoring, the hold relay R940 completes, at the contacts 941, an obvious path, including the contacts 1036, for applying ground potential to the control conductor C913 of the trunk 910, thereby to mark the trunk 910 and consequently the incoming trunk circuit 900 as busy to the incoming selector 315 prior to the actual release of the incoming trunk circuit 900 by the operator at the inward position 1025 at the toll board 320.

When the operator at the inward position 1025 at the toll switchboard 320 effects the initiation of the release of the incoming trunk circuit 900 by withdrawing the plug of the associated cord circuit from the jack J1026, the previously traced multiple circuits for energizing the upper winding of the ring relay R1040 and the lower winding of the ring relay R1040 and the upper winding of the supervisory relay R1050 are interrupted, thereby to cause the relays mentioned to restore; the previously traced circuit for energizing the lower winding of the supervisory relay R1050 being interrupted at the contacts 943 incident to the restoration of the hold relay R940. Upon restoring, the ring relay R1040 effects the restoration of the ring relay R1030 and interrupts, at the contacts 1043, alternative holding circuits for energizing the windings of the T. X relay R920 and the switch relay R1080, whereby the latter relays restore in the event they are operated at this time. In the event the switch relay R1080 is operated, upon restoring, it interrupts, at the contacts 1084, the previously mentioned circuit for energizing the winding of the switch slave relay R1070, thereby to cause the latter relay to restore. Also when the plug of the cord circuit at the inward position 1025 is withdrawn from the jack J1026 the previously traced circuit for energizing the winding of the answer relay R960 is interrupted, thereby to cause the latter relay to restore. Also, upon restoring, the ring relay R1040 interrupts, at the contacts 1043, the previously traced holding circuit for energizing in series the upper and lower windings of the reverse battery relay R1010, thereby to cause the latter relay to restore. Also, upon restoring, the hold relay R940 completes, at the contacts 945, the previously mentioned alternative circuit, including the set of switch springs S1095, for energizing the release magnet M1094, whereby the latter magnet operates and releases the wipers noted of the signal switch 1090, whereupon the wipers mentioned are returned to their normal rotary positions. When the signal switch 1090 is thus released the set of switch springs S1095 is actuated into disengagement, thereby to effect the restoration of the release magnet M1094; and the set of switch springs C971 is actuated into engagement, thereby to recomplete the previously traced path for applying battery potential by way of the lower winding of the digit relay R950 to the control conductor C913 of the trunk 910; the previously traced path for applying ground potential to the control conductor C913 being interrupted at the contacts 1036 incident to the restoration of the ring relay R1030. At this time the incoming trunk circuit 900 is completely released and the trunk 910 extending thereto is marked as idle to the incoming selector 315 by the application of battery potential to the control conductor C913 thereof.

On the other hand, in the event the release of the established connection is initiated at the inward position 1025 at the toll board 320 in the distant exchange 300 by the withdrawal of the plug of the associated cord circuit from the jack J1026, the ring relay R1040 and the answer relay R960 restore in the manner explained above. Upon restoring, the ring relay R1040 effects the restoration of the ring relay R1030 and the latter

relay recompletes, at the contacts 1032 and 1034, the previously traced alternative loop circuit between the incoming trunk circuit 900 and the toll line circuit 500, whereby the answer relay R740 in the toll line circuit 500 operates in order to effect the transmission of release supervision over the toll trunk 333 to the calling circuit in the central office 10, in the manner previously explained. When the calling circuit in the central office 10 is then released the toll line circuit 500 and the incoming selector 315 are released in the manner previously explained, whereby ground potential is removed from the control conductor C913 of the trunk 910 in order to effect the restoration of the line relay R930 and the restoration of the hold relay R940 shortly thereafter. Upon restoring, the hold relay R940 interrupts, at the contacts 944, the previously traced holding circuit for energizing in series the upper and lower windings of the reverse battery relay R1010 in order to cause the latter relay to restore. Also the hold relay R940 effects the release of the signal switch 1090 and the restoration of the T. X relay R920, the switch relay R1080 and the switch slave relay R1070, in the event the latter relays occupy their operated positions, all in the manner previously explained. At this time the incoming trunk circuit 900 is completely released and is marked as idle to the incoming selector 315 by the application of battery potential upon the control conductor C913 of the trunk 910.

In view of the above description of the mode of operation of the incoming trunk circuit 900 to receive the second and third digits 2 and 1 in order to indicate that the present call should be answered at the inward position 1025 at the toll board 320, it will be understood that the incoming trunk circuit 900 will receive the second and third digits 31 and 51 in order, respectively, to indicate that the present call should be answered at the information and call order positions at the toll board 320.

Extension of the call to other local points in the distant exchange 300

Now assuming that the call initiated in the central office 10 and routed via the toll line circuit 400 and the toll trunk 333 to the toll line circuit 500, in the manner described above, is to be extended to a local point in the distant exchange 300, a number of digits is required, including a first digit 1 and a second digit 4, 6, 7, 8, 9 or 0. In this case, the first digit 1 received over the toll trunk 333 is repeated by the toll line circuit 500 over the trunk 790 to the incoming selector 315, whereupon the incoming selector 315 operates to seize a trunk in the designated group extending to an idle incoming trunk circuit, such, for example, as the trunk 910, extending to the incoming trunk circuit 900. The second digit 4, 6, 7, 8, 9 or 0 received over the toll trunk 333 is repeated by the toll line circuit 500 over the trunk 790, the incoming selector 315 and the trunk 910 to the incoming trunk circuit 900 and registered in the signal switch 1090, in the manner previously explained.

Shortly following the conclusion of the second digit mentioned, the digit relay R950 restores, thereby to complete, at the contacts 953, the previously mentioned path, including the contacts 944, for applying ground potential to the wiper 1091 of the signal switch 1090. The ground potential applied to the wiper 1091 of the signal switch 1090 is connected via the engaged fourth, sixth, seventh, eighth, ninth or tenth contact in the associated contact bank and the contacts 922 to the control conductor C914 of the trunk 910. This application of ground potential to the control conductor C914 of the trunk 910 effects the release of the incoming selector 315 as the incoming selector 315 is of the drop-back type, as previously noted. When the incoming selector 315 is thus released the incoming trunk circuit 900 is released in the manner previously explained. At this time the next digit transmitted over the toll trunk 333 is repeated by the toll line circuit 500 over the trunk 790 to the incoming selector 315, whereby the incoming selector 315 is reoperated in order to extend the routing of the present call to the local point mentioned.

In view of the above explanation of the mode of operation of the incoming trunk circuit 900 in response to the second digit 4, 6, 7, 8, 9 or 0, it will be understood that the arrangement including the incoming selector 315 and the incoming trunk circuit 900 is effective to absorb a first digit 1 and a second digit 4, 6, 7, 8, 9 or 0 in the routing of the connection to a local point in the distant exchange 300.

Call from the distant exchange to the central office

Considering now the extension of a call to the central office 10 from the distant exchange 300, it is noted that the call may be initiated at any position at the toll board 320 in the distant exchange 300. For example, the call may be initiated at the inward position 1025 illustrated at the toll board 320 by first selecting the jack terminating an idle trunk extending to an idle toll line circuit, such, for example, as the jack J1028 terminating the trunk 501 extending to the toll line circuit 500, the toll line circuit 500 and consequently the toll trunk 333 being marked as idle by the extinguished condition of the signal lamp L1056 at the inward position 1025 and individually associated with the jack J1028 terminating the trunk 501. The operator at the inward position 1025 first selects the idle jack J1028 and inserts the plug of the associated cord circuit therein. When the plug of the cord circuit is inserted into the jack J1028 the contacts 1029 are closed, thereby to apply ground potential to the conductor C505 of the trunk 501, whereby an obvious circuit, including the contacts 733, 754 and 781, is completed for energizing the winding of the switch relay R510 in the toll line circuit 500 in order to cause the latter relay to operate. Also when the plug of the cord circuit is inserted into the jack J1028, resistance battery potential therein is connected to the associated sleeve of the jack J1028 and consequently to the conductor C504 of the trunk 501, whereby an obvious circuit for energizing the upper winding of the seizure relay R520 in the toll line circuit 500 is completed in order to cause the latter relay to operate. Upon operating, the switch relay R510 interrupts, at the contacts 511, 513, 515 and 517, the normally completed connections between the windings 412 and 414 of the repeating coil 410 and the toll line circuit 500; and completes, at the contacts 512, 514, 516 and 518, a loop circuit between the inward position 1025 at the toll board 320 and the toll line circuit 500. The above-mentioned circuit extends from the tip of the jack J1028 by way of the line conductor C502 of the trunk 501 and from the ring of the jack J1028 to the line conductor C503 of the trunk 501; the line conductor C502 of the trunk 501 is con-

nected by way of the contacts 512, the winding 412 of the repeating coil 410, the contacts 514, 533 and 542 and the upper winding of the line relay R620 to battery potential; and the line conductor C503 of the trunk 501 is connected by way of the contacts 518, the winding 414 of the repeating coil 410, the contacts 516, 543 and 534 and the lower winding of the line relay R620 to ground potential. When the above-traced loop circuit is thus completed between the inward position 1025 at the toll board 320 and the toll line circuit 500 the line relay R620 operates.

Upon operating, the seizure relay R520 completes, at the contacts 521, an obvious circuit for energizing the winding of the seizure slave relay R530, thereby to cause the latter relay to operate. Upon operating, the line relay R620 completes, at the contacts 622, an obvious circuit for energizing the winding of the hold relay R630, thereby to cause the latter relay to operate. Also the line relay R620 completes, at the contacts 623, a path, including the contacts 561 and 512', for applying battery potential by way of the upper winding of the supervisory relay R610 to the simplex conductor C416. At this point it is noted that, upon operating, the switch relay R510 interrupts, at the contacts 513', the previously traced path for applying ground potential by way of the winding of the simplex relay R680 to the simplex conductor C416. The removal of resistance ground potential from the simplex conductor C416 marks the toll line circuit 500 and consequently the toll trunk 333 as busy to the switching apparatus in the central office 10; while the application of resistance battery potential to the simplex conductor C416 marks the toll trunk 333 as a calling toll trunk to the toll line circuit 400 and completes an obvious circuit for energizing the upper winding of the supervisory relay R610 in the toll line circuit 500 in order to cause the latter relay to operate. The toll line circuit 400 then operates in order to mark the trunk 400*d* as a calling trunk to the link distributor 39 in the central office 10, whereby the link distributor 39 assigns an idle link, such, for example, as the link 35. The finder 36 of the link 35 operates to seize the trunk 400*d* extending to the toll line circuit 400, whereby the selector 37 is operatively connected thereto and consequently to the toll line circuit 400 and to the toll line circuit 500 via the toll trunk 333.

Upon operating, the supervisory relay R610 completes, at the contacts 611, an obvious circuit for energizing the winding of the supervisory slave relay R580, thereby to cause the latter relay to operate. Upon operating, the seizure slave relay R530 interrupts, at the contacts 533 and 534, the previously traced loop circuit between the line relay R620 in the toll line circuit 500 and the inward position 1025 at the toll board 320; and completes, at the contacts 532, a local circuit, including the resistor 591 and the contacts 519 and 542, for energizing in series the upper and lower windings of the line relay R620, thereby to retain the latter relay in its operated position. Upon operating, the supervisory slave relay R580 completes, at the contacts 582, a circuit, including the contacts 511' and 782, for energizing the winding of the control relay R570, thereby to cause the latter relay to operate and complete, at the contacts 574, a holding circuit substantially identical to that traced above for energizing the winding thereof. Also, upon operating, the control relay R570 completes, at the contacts 575, an obvious path for applying ground potential to the conductor C506 of the trunk 501, thereby to illuminate the signal lamps L1056 etc. at the various positions at the toll board 320 in order to indicate that the trunk 501 and the toll line circuit 500, to which it extends, are busy at this time. Also the control relay R570 interrupts, at the contacts 571, the previously traced path for connecting the resistor 594 and the condenser 595 across the terminals of the windings 412 and 414 of the repeating coil 410; and completes, at the contacts 573, a holding circuit, including the contacts 545 and 522, for energizing the lower winding of the seizure relay R520 from the conductor C504 of the trunk 501, the latter conductor having battery potential thereon. The application of low resistance ground potential at the contacts 573 in the toll line circuit 500 to the conductor C504 of the trunk 501, incident to the operation of the control relay R570, causes a signal lamp associated with the cord circuit at the inward position 1025 to be illuminated in order to indicate to the operator thereat that the toll line circuit 500 is in readiness to receive the first digit.

At this time the operator at the inward position 1025 at the toll board 320 operates the dial in the associated cord circuit preparatory to transmission of the first digit over the trunk 501 to the toll line circuit 500, whereby resistance battery potential in the associated cord circuit is removed from the sleeve of the jack J1028 in order to effect the deenergization of the upper and lower windings of the seizure relay R520, whereupon the latter relay restores in order to effect the restoration of the seizure slave relay R530. Upon restoring, the seizure slave relay R530 interrupts, at the contacts 532, the previously traced local circuit for energizing in series the upper and lower windings of the line relay R620; and recompletes, at the contacts 533 and 534, the previously traced original loop circuit between the inward position 1025 and the toll line circuit 500, including the upper and lower windings of the line relay R620, whereby the line relay R620 may be controlled from the dial associated with the cord circuit at the inward position 1025. Also, upon restoring, the seizure slave relay R530 completes, at the contacts 531, a path, including the contacts 516 and 518, for short-circuiting the winding 414 of the repeating coil 410, thereby to improve impulsing over the previously traced loop circuit including the upper and lower windings of the line relay R620.

The line relay R620 then follows the impulses of the first digit in accordance with conventional practice. Each time the line relay R620 restores it completes, at the contacts 621, a circuit, including the contacts 632, for energizing the winding of the digit relay R640; and interrupts, at the contacts 622, the previously mentioned circuit for energizing the winding of the hold relay R630. Each time the line relay R620 operates it recompletes, at the contacts 622, the previously mentioned circuit for energizing the winding of the hold relay R630 and interrupts, at the contacts 621, the previously traced circuit for energizing the winding of the digit relay R640. When thus energized the digit relay R640 operates to complete, at the contacts 641, an obvious circuit for energizing the winding of the digit slave relay R650, thereby to cause the latter relay to operate. Also, upon operating, the digit relay R640 prepares, at the contacts 642, a path traced here-

inafter for applying battery potential by way of the resistor 691 to the simplex conductor C416; and prepares, at the contacts 643, a path traced hereinafter for applying ground potential by way of the resistor 692 to the simplex conductor C416. Also each time the line relay R620 operates it completes, at the contacts 623, an obvious path, including the contacts 512', 561 and 642, for connecting battery potential in multiple by way of the upper winding of the supervisory relay R610 and the resistor 691 to the simplex conductor C416. Also each time the line relay R620 restores it completes, at the contacts 624, a path, including the contacts 512', 561 and 643, for applying ground potential by way of the resistor 692 to the simplex conductor C416. Accordingly, as the line relay R620 follows the impulses of the first digit transmitted from the dial associated with the cord circuit at the inward position 1025 at the toll board 320, it repeats, at the contacts 623 and 624, alternate battery and ground impulses over the simplex conductor C416 and consequently over the toll trunk 333 to the toll line circuit 400, whereby the impulses of the digit mentioned are repeated by way of the trunk 400d and the finder 36 to the selector 37 in the central office 10.

At the conclusion of the first digit, resistance ground potential in the cord circuit at the inward position 1025 at the toll board 320 is again applied to the sleeve of the jack J1028 and consequently to the conductor C504 of the trunk 501, whereby the seizure relay R520 in the toll line circuit 500 reoperates in order to effect the reoperation of the seizure slave relay R530. Upon reoperating, the seizure slave relay R530 again interrupts, at the contacts 533 and 534, the previously traced loop circuit between the inward position 1025 and the line relay R620 in the toll line circuit 500; completes, at the contacts 532, the previously traced local circuit for energizing in series the upper and lower windings of the line relay R620; and interrupts, at the contacts 531, the previously traced path for short-circuiting the winding 414 of the repeating coil 410. Accordingly, following the transmission of the first digit, the line relay R620 is retained in its operated position, thereby to cause the digit relay R640 to restore shortly thereafter, the digit relay R640 being of the slow-to-release type. Upon restoring, the digit relay R640 effects the restoration of the digit slave relay R650. At this time the apparatus in the toll line circuit 500 again occupies its seized condition and the first digit has been repeated thereby over the toll trunk 333 to the called circuit in the central office 10. The operator at the inward position 1025 again operates the dial in the associated cord circuit, whereby one or more additional digits are transmitted over the trunk 501 to the toll line circuit 500 and repeated over the toll trunk 333 to the called circuit in the central office 10, in the manner explained above. At this point it is noted that the present call may be routed via the selector 37 and the revertive pulse switch train 31 to a called substation in the central office 10, such, for example, as the substation B. Similarly, the present call may be routed via the selector 37 to the toll second selector 32 and therefrom to the toll operator switchboard 11 in the central office 10, to the automatic exchange 3, to the manual office #1 or the manual office #2 or to the toll office #1 or the toll office #2.

The switching apparatus in the central office 10 is operative in the manner more particularly disclosed in the previously mentioned copending Balzer application and, in the event this switching apparatus encounters a busy condition, the toll line circuit 400 is controlled, whereby battery potential is removed from the toll trunk 333 and flashing ground potential is applied to the toll trunk 333. More particularly, in the event the switching apparatus in the central office 10 encounters an all-trunks-busy condition, 120 ground impulses per minute are applied to the toll trunk 333. On the other hand, if a subscriber line extending to a called substation is tested as busy, 60 ground impulses per minute are applied to the toll trunk 333. The ground impulses applied to the toll trunk 333 are connected to the simplex conductor C416, thereby to complete a circuit substantially identical to that previously traced for energizing the upper winding of the supervisory relay R610, whereby the latter relay operates and restores intermittently in accordance with the type of busy condition encountered, as noted above. More particularly, the supervisory relay R610 follows the impulses mentioned and repeats them, at the contacts 611, to the supervisory slave relay R580, whereby the latter relay follows the impulses mentioned. The supervisory slave relay R580 repeats, at the contacts 581, over a circuit including the contacts 622, 633, 655 and 572 and the winding of the supervisory relay R540, the impulses mentioned, whereby the supervisory relay R540 follows these impulses. Each time the supervisory relay R540 operates it interrupts, at the contacts 545, the previously traced path for applying low resistance ground potential to the conductor C504 of the trunk 501; and each time the supervisory relay R540 restores it recompletes, at the contacts 545, the previously mentioned path for applying low resistance ground potential to the conductor C504 of the trunk 501, whereby the signal lamp associated with the cord circuit at the inward position 1025 at the toll board 320 is flashed in accordance with the impulses received by the toll line circuit 500 in order selectively to indicate to the operator thereat the particular type of busy condition which has been encountered by the switching apparatus in the central office 10.

Now assuming that the call has been extended in the central office 10 without encountering either the all-trunks-busy condition or the busy substation condition mentioned above, when the call is answered on the called circuit the toll line circuit 400 is controlled, whereby ground potential is removed from and battery potentional is applied to the toll trunk 333, whereby the upper winding of the supervisory relay R610 in the toll line circuit 500 is short-circuited via the simplex conductor C416 in an obvious manner. The supervisory relay R610 then restores, thereby to effect the restoration of the supervisory slave relay R580. Upon restoring, the supervisory slave relay R580 effects operation of the supervisory relay R540, whereby the latter relay interrupts, at the contacts 545, the previously traced path for applying low resistance ground potential to the conductor C504 of the trunk 501 in order to extinguish the signal lamp associated with the cord circuit at the inward position 1025 at the toll board 320, giving the operator thereat answer supervision. At this time an established connection is completed between the calling inward position 1025 at the toll board 320 and the called circuit in the central office 10. More particularly, the telephone set at the inward position 1025 is operatively associated with the cord circuit, the plug of which is inserted into

the jack J1028 terminating the trunk 501; the line conductors C502 and C503 of the trunk 501 are connected by way of the contacts 512 and 518 and the condenser 415 to the windings 412 and 414 of the repeating coil 410; the windings 411 and 413 of the repeating coil 410 are operatively connected by way of the toll trunk 333, the toll line circuit 400 and the finder 36 to the selector 37; and the selector 37 is operatively connected to the called circuit.

In the extension of the above-described call from the inward position 1025 at the toll board 320 in the distant exchange 300 to the called circuit in the central office 10, the automatic switching apparatus in the central office 10 normally operates to ring the called circuit. However, in the event it is necessary for the operator at the inward position 1025 to rering the called circuit, this may be accomplished by operating the ring key in the associated cord circuit, whereby battery potential is removed from the sleeve of the jack J1028 and consequently from the conductor C504 of the trunk 501 in order to to effect the restoration of the seizure relay R520 and the seizure slave relay R530. Also ground potential is applied to the ring of the jack J1028 and consequently to the line conductor C503 of the trunk 501. Upon restoring, the seizure slave relay R530 completes, at the contacts 535, a circuit, including the contacts 544, 516 and 518, the winding 414 of the repeating coil 410 and the line conductor C503 of the trunk 501 having ground potential thereon, for energizing the winding of the rering relay R550. When thus energized the rering relay R550 operates shortly thereafter, as it is of the combination slow-to-operate and slow-to-release type, to complete, at the contacts 551, an obvious circuit for energizing the winding of the rering relay R560. When thus energized the rering relay R560 operates to interrupt, at the contacts 561, the previously traced path for applying battery potential by way of the upper winding of the supervisory relay R610 to the simplex conductor C416. The ring key at the inward position 1025 is operated only momentarily and, when it is returned to its normal position, resistance battery potential is again applied to the sleeve and ground potential is again removed from the ring of the jack J1028, whereby the seizure relay R520 and the seizure slave relay R530 reoperate and the rering relay R550 restores shortly thereafter. Upon restoring, the rering relay R550 completes, at the contacts 552, a path, including the contacts 563 and 512', for applying ground potential by way of the resistor 592 to the simplex conductor C416. Also the rering relay R550 interrupts, at the contacts 551, the previously mentioned circuit for energizing the winding of the rering relay R560, thereby to cause the latter relay to restore shortly thereafter, the rering relay R560 being of the slow-to-release type. Upon restoring, the rering relay R560 interrupts, at the contacts 563, the previously traced path for applying ground potential by way of the resistor 592 to the simplex conductor C416; and recompletes, at the contacts 561, the previously traced path for applying battery potential by way of the upper winding of the supervisory relay R610 to the simplex conductor C416. Accordingly, resistance battery potential is removed from the simplex conductor C416 and then again applied thereto after a short time interval, resistance ground potential being applied to the simplex conductor C416 during the time interval mentioned. This application of resistance ground potential between the applications of resistance battery potential to the simplex conductor C416 controls the toll line circuit 400 over the toll trunk 333, whereby the switching apparatus in the central office 10 is controlled in order to effect rering of the called circuit.

When the called circuit in the central office 10 is released the toll line circuit 400 is controlled, whereby ground potential is returned over the toll trunk 333 and consequently over the simplex conductor C416, whereby the previously traced circuit for energizing the upper winding of the supervisory relay R610 is recompleted in order to cause the latter relay to reoperate. Upon reoperating, the supervisory relay R610 effects reoperation of the supervisory slave relay R580; and the latter relay effects the restoration of the supervisory relay R540, whereby low resistance ground potential is again applied to the conductor C504 of the trunk 501 in order to illuminate the signal lamp associated with the cord circuit at the inward position 1025 at the toll board 320, all in the manner previously explained. When the operator at the inward position 1025 at the toll board 320 receives the disconnect supervision mentioned, she withdraws the plug of the associated cord circuit from the jack J1028, thereby to interrupt the previously traced circuit for energizing the winding of the switch relay R510 and the previously traced circuit for energizing the upper winding of the seizure relay R520 in the toll line circuit 500, whereby the relays mentioned restore. Upon restoring, the seizure relay R520 effects the restoration of the seizure slave relay R530; and, upon restoring, the switch relay R510 interrupts, at the contacts 519, the previously traced local circuit for energizing in series the upper and lower windings of the line relay R620, thereby to cause the latter relay to restore. Also, upon restoring, the switch relay R510 interrupts, at the contacts 512', the previously traced circuit for energizing the upper winding of the supervisory relay R610, thereby to cause the latter relay to restore and effect the restoration of the supervisory slave relay R580. Further the switch relay R510 recompletes, at the contacts 513', the previously traced path for applying ground potential by way of the winding of the simplex relay R680 to the simplex conductor C416, whereby the toll line circuit 400 is controlled in order to effect the release of the finder 36, the selector 37 and the remainder of the switching apparatus in the central office 10. Upon restoring, the line relay R620 interrupts, at the contacts 622, the previously traced circuit for energizing the winding of the supervisory relay R540, thereby to cause the latter relay to restore. Also the line relay R620 completes, at the contacts 621, the previously mentioned circuit for energizing the winding of the digit relay R640, thereby to cause the latter relay to operate and effect the operation of the digit slave relay R650. Further the line relay R620 interrupts, at the contacts 622, the previously mentioned circuit for energizing the winding of the hold relay R630, thereby to cause the latter relay to restore shortly thereafter, the hold relay R630 being of the slow-to-release type. Upon restoring, the hold relay R630 interrupts, at the contacts 632, the previously traced circuit for energizing the winding of the digit relay R640, thereby to cause the latter relay to restore

shortly thereafter, the digit relay R640 being of the slow-to-release type. Upon restoring, the digit relay R640 effects the restoration of the digit slave relay R650. Also, upon restoring, the switch relay R510 interrupts, at the contacts 511', the previously traced circuit for energizing the winding of the control relay R570, thereby to cause the latter relay to restore. Upon restoring, the control relay R570 interrupts, at the contacts 575, the previously mentioned path for applying ground potential to the conductor C506 of the trunk 501, thereby to extinguish the signal lamps L1056 etc. at the various positions at the toll board 320 in order to indicate that the trunk 501 and consequently the toll line circuit 500 are idle at this time to the operators at the various positions at the toll board 320. Finally, upon restoring, the digit slave relay R650 recompletes, at the contacts 651, the previously traced path for connecting the resistor 594 and the condenser 595 across the terminals of the windings 412 and 414 of the repeating coil 410. This arrangement maintains balanced the impedance of the circuits connected to the vacuum tube repeaters 331 and 332, thereby positively to prevent singing of the repeaters mentioned both when the toll trunk 333 is idle and busy. At this time the toll line circuit 500 is completely released and both the toll trunk 333 and the trunk 501 extending thereto are available for further use.

Busying the toll line circuit in the distant exchange

In the distant exchange 300, any one of the toll line circuits may be busied at the associated incoming selector. For example, the toll line circuit 500 may be busied at the associated incoming selector 315 by causing ground potential in the incoming selector 315 to be connected to the control conductor C793 of the trunk 790, thereby to complete an obvious circuit, including the contacts 671 and 631, for energizing the winding of the busy relay R780 in the toll line circuit 500. When thus energized the busy relay R780 operates to interrupt, at the contacts 783, the previously traced path for applying ground potential by way of the winding of the simplex relay R680 to the simplex conductor C416; and to complete, at the contacts 784, an obvious path for applying battery potential by way of the lower winding of the supervisory relay R610 to the simplex conductor C416. The removal of resistance ground potential from and the application of resistance battery potential to the simplex conductor C416 marks the toll trunk 333 as a calling toll trunk to the toll line circuit 400 and, consequently, as busy to the automatic switching equipment in the central office 10. A separate connection is set up from the toll board 320 in the distant exchange 300 over an idle one of the toll trunks to the toll operator switchboard 11 in the central office 10 and the operator at the answering operator position at the toll operator switchboard 11 is advised that the toll trunk 333 and consequently the toll line circuit 400 have been rendered busy. The operator at the answering operator position at the toll operator switchboard 11 then advises the exchange attendant, whereby the exchange attendant interrupts the normally completed connection between the toll line circuit 400 and the finder of one of the links via the trunk 400*d* in order to prevent useless holding of the link in the central office 10.

Also, upon operating, the busy relay R780 in the toll line circuit 500 interrupts, at the contacts 781, the normally completed path for applying battery potential by way of the winding of the switch relay R510 to the conductor C505 of the trunk 501, thereby positively to prevent seizure of the toll line circuit 500 via the trunk 501 at any one of the positions at the toll board 320. Finally, the busy relay R780 completes, at the contacts 785, an obvious alternative path for applying ground potential to the conductor C506 of the trunk 501, thereby to illuminate the signal lamps L1056 etc. at the various positions at the toll board 320 in order to indicate to the operators thereat that the trunk 501 and consequently the toll line circuit 500 are busy at this time.

Subsequently the toll line circuit 500 may again be placed in service by effecting the removal of ground potential in the incoming selector 305 from the control conductor C793 of the trunk 790, whereby the busy relay R780 in the toll line circuit 500 restores, again placing the toll line circuit 500 in service, in an obvious manner.

Conclusions

From the foregoing it is apparent that a telephone system is provided which comprises an improved arrangement for setting up and supervising connections in either direction over a two-way toll trunk extending between two exchanges; whereby a call from an operator position in either exchange may be extended either to an operator position or a telephone substation in the other exchange.

While one embodiment of the invention has been disclosed, it will be understood that various modifications may be made therein which are within the true spirit and scope of the invention.

What is claimed is:

1. In a telephone system, a trunk, switching apparatus including a plurality of switching stages selectively operative sequentially in response to the transmission of a plurality of switch directing signals over said trunk, thereby progressively to extend a connection from said trunk, register apparatus operative to register the sequential operation of the switching stages of said switching apparatus, a busy tone source, busy apparatus operative in response to the encounter of said busy tone source by any switching stage of said switching apparatus, and means controlled jointly by said register apparatus and said busy apparatus for determining the particular switching stage of said switching apparatus which encounters said busy tone source.

2. In a telephone system, a trunk, switching apparatus including a plurality of switching stages selectively operative sequentially in response to the transmission of a plurality of switch directing signals over said trunk, thereby progressively to extend a connection from said trunk, counting apparatus operative to count the switch directing signals transmitted over said trunk, a busy tone source, busy apparatus operative in response to the encounter of said busy tone source by any switching stage of said switching apparatus, and means controlled jointly by said counting apparatus and said busy apparatus for determining the particular switching stage of said switching apparatus which encounters said busy tone source.

3. In a telephone system, a trunk, a plurality of lines, switching apparatus including a plurality of switching stages selectively operative

sequentially in response to the transmission of a plurality of switch directing signals over said trunk, thereby progressively to extend a connection from said trunk to one of said lines, counting apparatus operative to count the switch directing signals transmitted over said trunk, a busy tone source, busy apparatus operative in response to the encounter of said busy tone source by an intermediate switching stage of said switching apparatus or to the encounter of said busy tone source by the final switching stage of said switching apparatus, and means controlled jointly by said counting apparatus and said busy apparatus for determining whether an intermediate switching stage or the final switching stage of said switching apparatus encounters said busy tone source.

4. In a telephone system, a trunk, a plurality of lines, switching apparatus including a selector and a connector selectively operative sequentially in response to the transmission of a plurality of switch directing signals over said trunk, thereby progressively to extend a connection from said trunk to one of said lines, counting apparatus operative to count the switch directing signals transmitted over said trunk, a busy tone source, busy apparatus operative in response to the encounter of said busy tone source by said selector or to the encounter of said busy tone source by said connector, and means controlled jointly by said counting apparatus and said busy apparatus for determining whether said selector or said connector encounters said busy tone source.

5. In a telephone system, a trunk, switching apparatus including a plurality of switching stages selectively operative sequentially in response to the transmission of a plurality of switch directing signals over said trunk, thereby progressively to extend a connection from said trunk, register apparatus operative to register the sequential operation of the switching stages of said switching apparatus, a busy tone source, busy apparatus operative in response to the transmission of a busy tone thereto, means responsive to the encounter of a busy condition by any switching stage of said switching apparatus for connecting to said busy tone source and for transmitting a busy tone to said busy apparatus, and means controlled jointly by said register apparatus and said busy apparatus for determining the particular switching stage of said switching apparatus which encounters a busy condition.

6. In a telephone system, a trunk, switching apparatus including a plurality of switching stages selectively operative sequentially in response to the transmission of a plurality of switch directing signals over said trunk, thereby progressively to extend a connection from said trunk, register apparatus operative to register the sequential operation of the switching stages of said switching apparatus, a busy tone source, busy apparatus operative in response to the encounter of said busy tone source by any switching stage of said switching apparatus, means controlled jointly by said register apparatus and said busy apparatus for determining the particular switching stage of said switching apparatus which encounters said busy tone source, and means controlled by said determining means for returning over said trunk a busy signal corresponding to said particular switching stage of said switching apparatus.

7. In a telephone system, a trunk, switching apparatus including a plurality of switching stages selectively operative sequentially in response to the transmission of a plurality of switch directing signals over said trunk, thereby progressively to extend a connection from said trunk, counting apparatus operative to count the switch directing signals transmitted over said trunk, a busy tone source, busy apparatus operative in response to the encounter of said busy tone source by any switching stage of said switching apparatus, means controlled jointly by said counting apparatus and said busy apparatus for determining the particular switching stage of said switching apparatus which encounters said busy tone source, and means controlled by said determining means for returning over said trunk a busy signal corresponding to said particular switching stage of said switching apparatus.

8. In a telephone system, a trunk, a plurality of lines, switching apparatus including a plurality of switching stages selectively operative sequentially in response to the transmission of a plurality of switch directing signals over said trunk, thereby progressively to extend a connection from said trunk to one of said lines, counting apparatus operative to count the switch direction signals transmitted over said trunk, a busy tone source, busy apparatus operative in response to the encounter of said busy tone source on a trunk busy condition by an intermediate switching stage of said switching apparatus or to the encounter of said busy tone source on a line busy condition by the final switching stage of said switching apparatus, means controlled jointly by said counting apparatus and said busy apparatus for determining whether an intermediate switching stage or the final switching stage of said switching apparatus encounters said busy tone source, and means controlled by said determining means for correspondingly returning over said trunk a trunk busy signal or a line busy signal.

9. In a telephone system, a trunk, a plurality of lines, switching apparatus including a selector and a connector selectively operative sequentially in response to the transmission of a plurality of switch directing signals over said trunk, thereby progressively to extend a connection from said trunk to one of said lines, counting apparatus operative to count the switch directing signals transmitted over said trunk, a busy tone source, busy apparatus operative in response to the encounter of said busy tone source on a trunk busy condition by said selector or to the encounter of said busy tone source on a line busy condition by said connector, means controlled jointly by said counting apparatus and said busy apparatus for determining whether said selector or said connector encounters said busy tone source, and means controlled by said determining means for correspondingly returning over said trunk a trunk busy signal or a line busy signal.

10. In a telephone system, a trunk, switching apparatus including a plurality of switching stages selectively operative sequentially in response to the transmission of a plurality of switch directing signals over said trunk, thereby progressively to extend a connection from said trunk, register apparatus operative to register the sequential operation of the switching stages of said switching apparatus, a busy tone source, busy apparatus operative in response to the transmission of a busy tone thereto, means responsive to the encounter of said

busy tone source by any switching stage of said switching apparatus for transmitting a busy tone from said source to said busy apparatus, means controlled jointly by said register apparatus and said busy apparatus for determining the particular switching stage of said switching apparatus which encounters said busy tone source, and means controlled by said determining means for returning over said trunk a busy signal corresponding to said particular switching stage of said switching apparatus.

11. In a telephone system, an incoming trunk, an outgoing trunk, a repeater operative to receive switch directing signals over said incoming trunk and to repeat the switch directing signals over said outgoing trunk, switching apparatus including a plurality of switching stages selectively operative sequentially in response to the transmission of a plurality of switch directing signals over said outgoing trunk, thereby progressively to extend a connection from said incoming trunk, register apparatus operative to register the sequential operation of the switching stages of said switching apparatus, a busy tone source, busy apparatus operative in response to the encounter of said busy tone source by any switching stage of said switching apparatus, means controlled jointly by said register apparatus and said busy apparatus for determining the particular switching stage of said switching apparatus which encounters said busy tone source, and means controlled by said determining means for returning over said incoming trunk a busy signal corresponding to said particular switching stage of said switching apparatus.

12. In a telephone system, an incoming trunk, an outgoing trunk, a repeater operative to receive switch directing signals over said incoming trunk and to repeat the switch directing signals over said outgoing trunk, switching apparatus including a plurality of switching stages selectively operative sequentially in response to the transmission of a plurality of switch directing signals over said outgoing trunk, thereby progressively to extend a connection from said incoming trunk, counting apparatus operative to count the switch directing signals transmitted over said outgoing trunk, a busy tone source, busy apparatus operative in response to the transmission of a busy tone over said outgoing trunk, means responsive to the encounter of said busy tone source by any switching stage of said switching apparatus for transmitting a busy tone over said outgoing trunk, means controlled jointly by said counting apparatus and said busy apparatus for determining the particular switching stage of said switching apparatus which encounters said busy tone source, and means controlled by said determining means for returning over said incoming trunk a busy signal corresponding to said particular switching stage of said switching apparatus.

13. In a telephone system, an incoming trunk, an outgoing trunk, a repeater operative to receive switch directing signals over said incoming trunk and to repeat the switch directing signals over said outgoing trunk, a plurality of lines, switching apparatus including a plurality of switching stages selectively operative sequentially in response to the transmission of a plurality of switch directing signals over said outgoing trunk, thereby progressively to extend a connection from said incoming trunk to one of said lines, counting apparatus operative to count the switch directing signals transmitted over said outgoing trunk, a busy tone source, busy apparatus operative in response to the encounter of said busy tone source on a trunk busy condition by an intermediate stage of said switching apparatus or to the encounter of said busy tone source on a line busy condition by the final switching stage of said switching apparatus, means controlled jointly by said counting apparatus and said busy apparatus for determining whether an intermediate switching stage or the final switching stage of said switching apparatus encounters a busy condition, and means controlled by said determining means for correspondingly returning over said incoming trunk a trunk busy signal or a line busy signal.

14. In a telephone system, an incoming trunk, an outgoing trunk, a repeater operative to receive switch directing signals over said incoming trunk and to repeat the switch directing signals over said outgoing trunk, switching apparatus including a plurality of switching stages selectively operative sequentially in response to the transmission of a plurality of switch directing signals over said outgoing trunk, thereby progressively to extend a connection from said incoming trunk, register apparatus operative to register the sequential operation of the switching stages of said switching apparatus, means responsive to the encounter of a busy condition by any switching stage of said switching apparatus for impressing a busy tone voltage upon said outgoing trunk, detector apparatus operative in response to a busy tone voltage impressed upon said outgoing trunk, and means controlled jointly by said register apparatus and said detector apparatus for returning over said incoming trunk a trunk busy signal or a line busy signal depending respectively upon whether said detector apparatus is operated following the operation of an intermediate switching stage or the final switching stage of said switching apparatus.

15. In a telephone system, a first trunk, a second trunk including two line conductors, a repeater operative to receive switch directing signals over said first trunk and to repeat loop switch directing signals over the line conductors of said second trunk, switching apparatus associated with said second trunk and operative in response to the loop switch directing signals repeated over the line conductors of said second trunk, said switching apparatus being normally arranged to supply battery potentials in one direction over the line conductors of said second trunk, a plurality of lines accessible to said switching apparatus, said switching apparatus being operative to select any called one of said lines and to test the idle or busy condition thereof, means included in said switching apparatus and responsive to the testing of a selected called line as idle for supplying battery potentials in the opposite direction over the line conductors of said second trunk, means included in said repeater and responsive to the reversal of battery potentials over the line conductors of said second trunk for momentarily superimposing a ring start signal in said repeater upon the line conductors of said second trunk, and means included in said switching apparatus and responsive to the momentary superimposition of the ring start signal upon the line conductors of said second trunk for applying a ringing voltage in said switching apparatus to the selected called line.

16. In a telephone system, a first trunk, a second trunk including two line conductors, a repeater operative to receive switch directing signals over said first trunk and to repeat loop switch

directing signals over the line conductors of said second trunk, switching apparatus associated with said second trunk and operative in response to the loop switch directing signals repeated over the line conductors of said second trunk, said switching apparatus being normally arranged to supply battery potentials over the line conductors of said second trunk, a plurality of lines accessible to said switching apparatus, said switching apparatus being operative to select any called one of said lines and to test the idle or busy condition thereof, means included in said switching apparatus and responsive to the testing of a selected called line as busy for superimposing a busy tone voltage upon the line conductors of said second trunk, a detector associated with said repeater and operative in response to the superimposition of the busy tone voltage upon the line conductors of said second trunk, and means included in said repeater and controlled by said detector for returning a busy signal over said first trunk.

17. In a telephone system, a first trunk, a second trunk including two line conductors, a repeater operative to receive switch directing signals over said first trunk and to repeat loop switch directing signals over the line conductors of said second trunk, switching apparatus associated with said second trunk and operative in response to the loop switch directing signals repeated over the line conductors of said second trunk, said switching apparatus being normally arranged to supply battery potentials in one direction over the line conductors of said second trunk, a plurality of lines accessible to said switching apparatus, said switching apparatus being operative to select any called one of said lines and to test the idle or busy condition thereof, means included in said switching apparatus and responsive to the testing of a selected called line as idle for supplying battery potentials in the opposite direction over the line conductors of said second trunk, said repeater including a first relay controlled in response to the reversal of battery potentials over the line conductors of said second trunk, means included in said switching apparatus and responsive to the answering of the call on the selected called line for interrupting the supply of battery potentials over the line conductors of said second trunk, said repeater including a second relay controlled in response to the drying of battery potentials from the line conductors of said second trunk, and means included in said repeater and governed jointly by the control of said first and second relays for returning an answer signal over said first trunk.

18. In a telephone system, a first trunk, a second trunk including two line conductors, a repeater operative to receive switch directing signals over said first trunk and to repeat loop switch directing signals over the line conductors of said second trunk, switching apparatus associated with said second trunk and operative in response to the loop switch directing signals reepated over the line conductors of said second trunk, said switching apparatus being normally arranged to supply battery potentials in one direction over the line conductors of said second trunk, a plurality of lines accessible to said switching apparatus, said switching apparatus being operative to select any called one of said lines and to test the idle or busy condition thereof, means included in said switching apparatus and responsive to the testing of a selected called line as idle for supplying battery potentials in the opposite direction over the line conductors of said second trunk, means included in said repeater and responsive to the reversal of battery potentials over the line conductors of said second trunk for momentarily superimposing a ring start signal in said repeater upon the line conductors of said second trunk, means included in said switching apparatus and responsive to the momentary superimposition of the ring start signal upon the line conductors of said second trunk for applying a ringing voltage in said switching apparatus to the selected called line, means included in said switching apparatus and responsive to the answering of the call on the selected called line for interrupting the application of ringing voltage thereto and for interrupting the supply of battery potentials over the line conductors of said second trunk, and means included in said repeater and controlled in response to the drying of battery potentials from the line conductors of said second trunk for returning an answer signal over said first trunk.

19. In a telephone system, an operator position, a first trunk, means controllable from said operator position for seizing said first trunk and for transmitting a plurality of switch directing signals thereover, a second trunk, switching apparatus responsive to the transmission of one or more switch directing signals over said first trunk for seizing said second trunk, whereby a subsequent switch directing signal transmitted over said first trunk is transmitted over said second trunk, a switchboard including a plurality of operator positions each comprising facilities for answering a call on said second trunk, a register apparatus directively operated to select a desired one of said operator's positions in response to the transmission of one or more switch directing signals over said second trunk dependent upon the value of the switch directing signals transmitted, and means controlled by the operation of said register apparatus for selectively indicating the presence of a call to be answered on said second trunk to the different operator positions at said switchboard.

20. In a telephone system, a first trunk, a second trunk, switching apparatus responsive to the transmission of one or more switch directing signals over said first trunk for seizing said second trunk, whereby a subsequent switch directing signal transmitted over said first trunk is transmitted over said second trunk, a switchboard including a plurality of operator positions each comprising facilities for answering a call on said second trunk, a register apparatus directively operated to select a desired one of said operator's positions in response to the transmission of one or more switch directing signals over said second trunk dependent upon the value of the switch directing signals transmitted, and means controlled by the operation of said register apparatus for selectively indicating the presence of a call to be answered on said second trunk to the different operator positions at said switchboard.

21. In a telephone system, a first trunk, a second trunk, switching apparatus responsive to the transmission of one or more switch directing signals over said first trunk for seizing said second trunk, whereby a subsequent switch directing signal transmitted over said first trunk is transmitted over said second trunk, a switchboard including a plurality of operator positions each comprising facilities for answering a call on said second trunk, a plurality of signals individually associated with said operator positions, each of

said signals being operative to indicate to the associated operator position the presence of a call to be answered thereat on said second trunk, and a register apparatus directively operated to select and operate a desired one of said signals in response to the transmission of one or more switch directing signals over said second trunk dependent upon the value of the transmitted switch directing signals.

22. In a telephone system, a first trunk, a second trunk, switching apparatus responsive to the transmission of one or more switch directing signals over said first trunk for seizing said second trunk, whereby a subsequent switch directing signal transmitted over said first trunk is transmitted over said second trunk, register apparatus selectively operative to register one or more switch directing signals transmitted over said second trunk, means controlled by a first operation of said register apparatus for releasing said switching apparatus, whereby the one or more switch directing signals registered in said register apparatus are absorbed, a switchboard including a plurality of operator positions each comprising facilities for answering a call on said second trunk, and means controlled by a second operation of said register apparatus for selectively indicating the presence of a call to be answered on said second trunk to the different operator positions at said switchboard.

HARVEY W. BALZER.

CERTIFICATE OF CORRECTION.

Patent No. 2,367,635. January 16, 1945.

HARVEY W. BALZER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 21, second column, line 26-27, claim 8, for "direction" read --directing--; page 23, first column, line 64, claim 18, for "reepated" read --repeated--; and second column, line 63, claim 20, strike out the syllable and hyphen "dif-"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 15th day of May, A. D. 1945.

Leslie Frazer

(Seal) Acting Commissioner of Patents.