May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 1

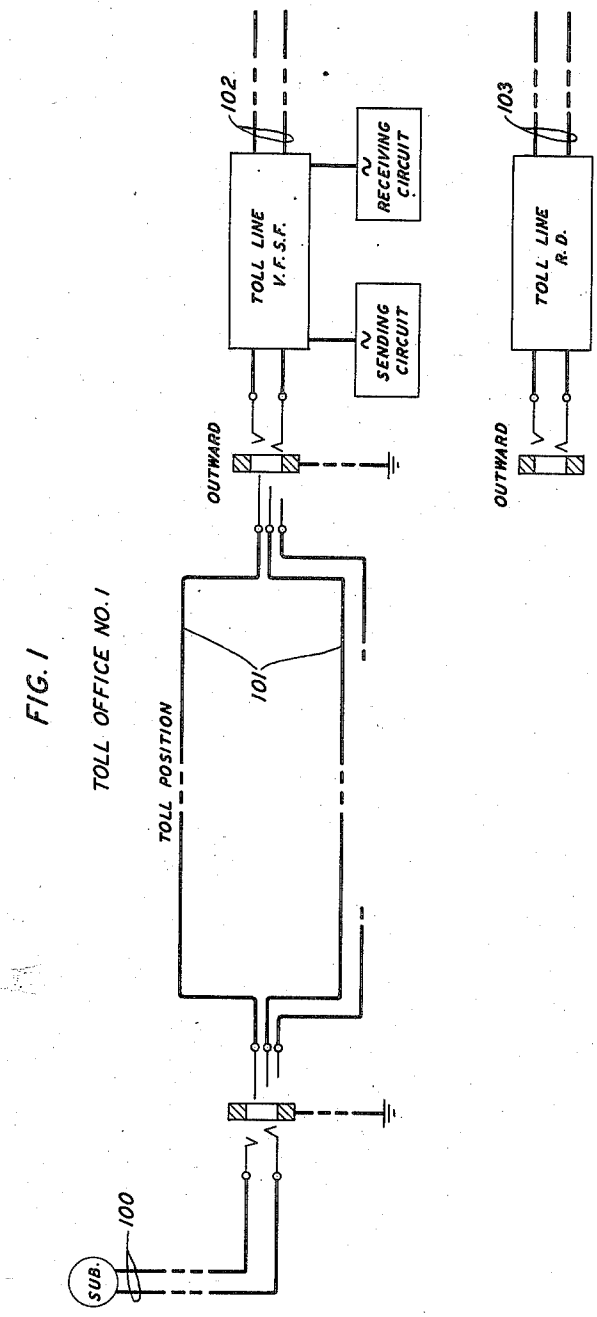
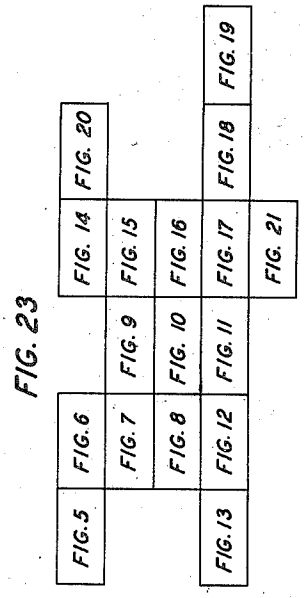
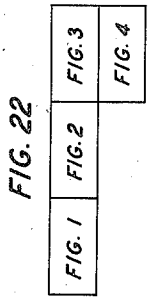


FIG. 1





INVENTORS: J. MESZAR
F. M. WIESE

BY

ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 2

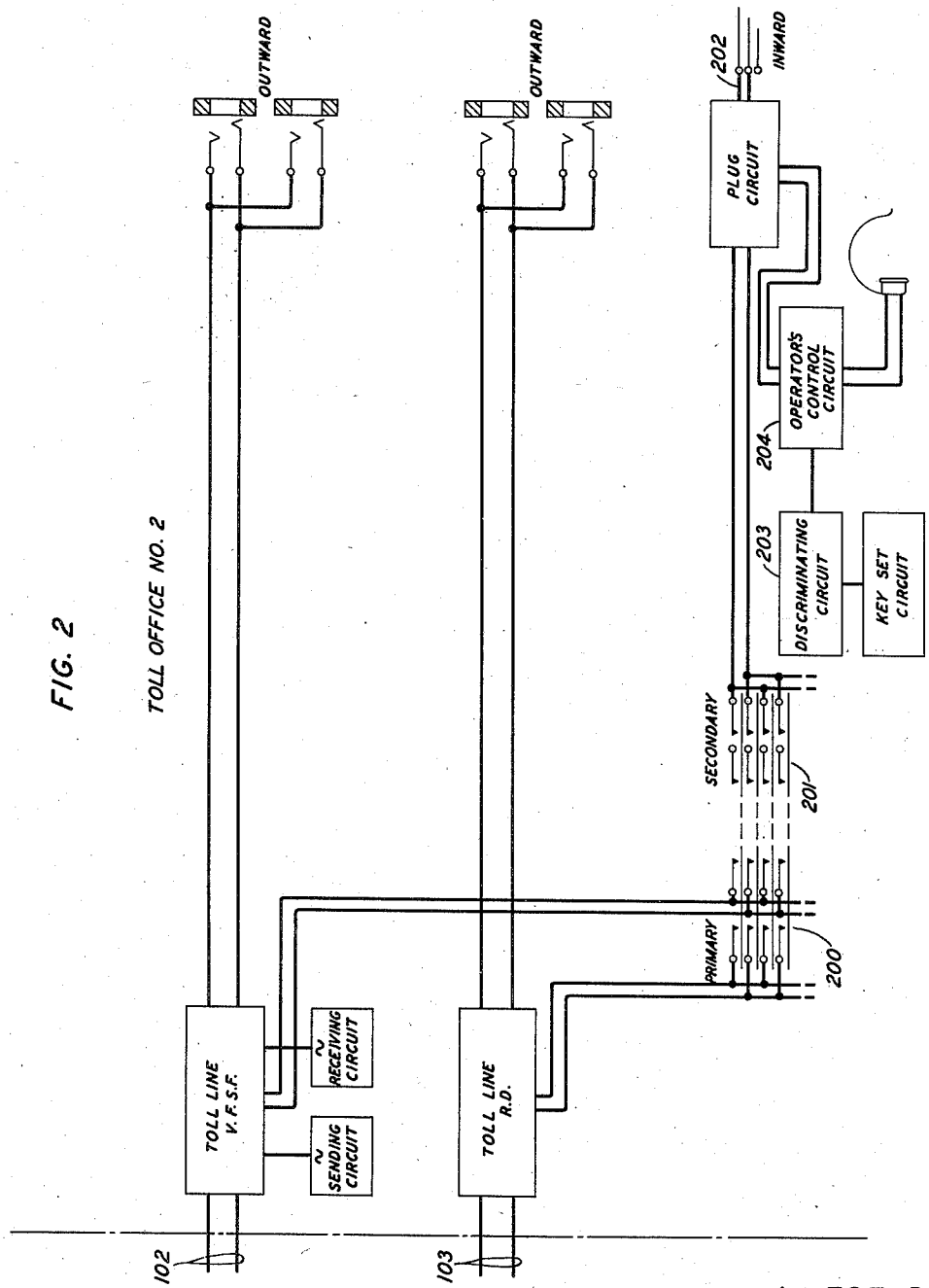


FIG. 2

INVENTORS: J. MESZAR
F. M. WIESE

BY

ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 3

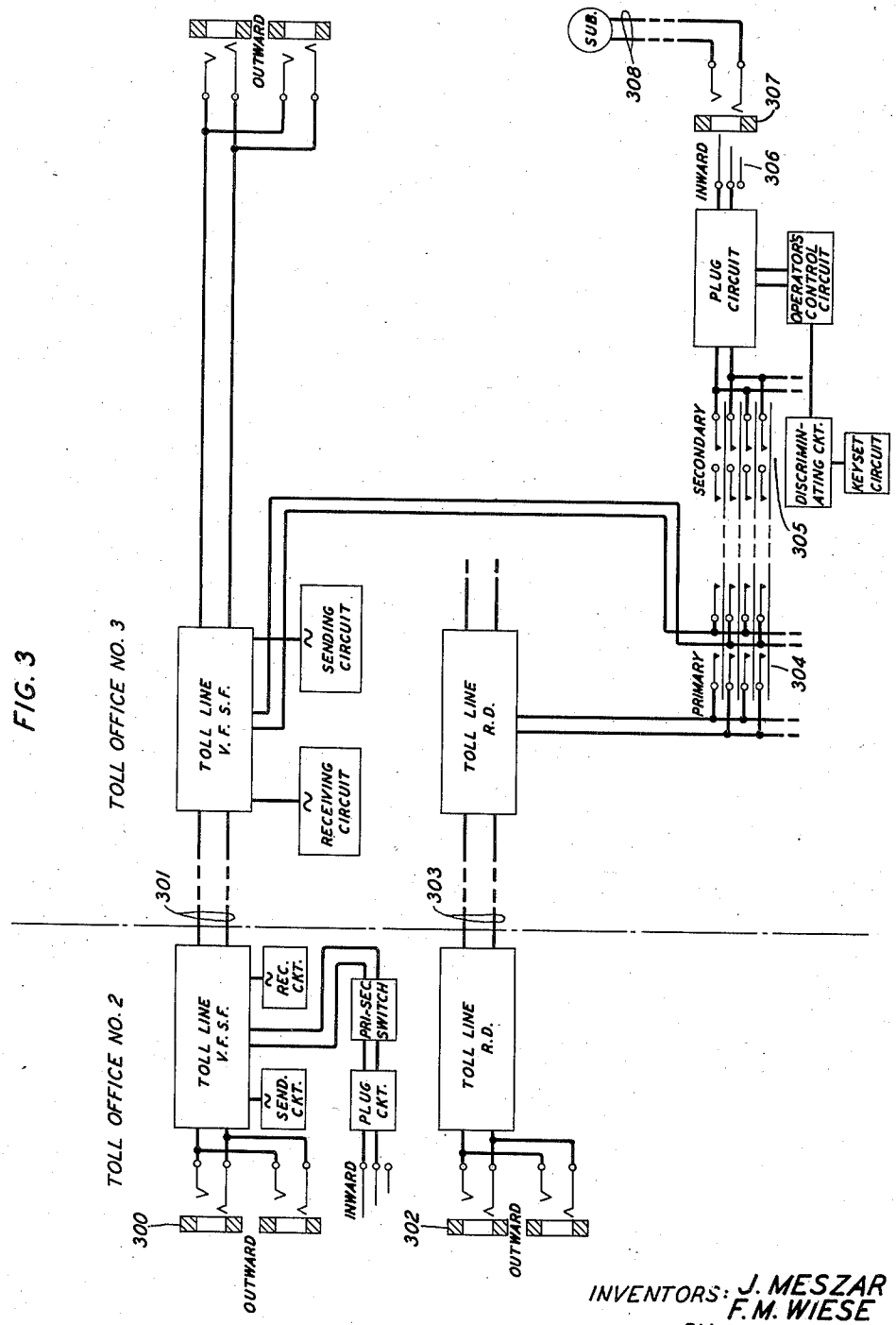


FIG. 3

INVENTORS: J. MESZAR
F. M. WIESE

BY

ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 4

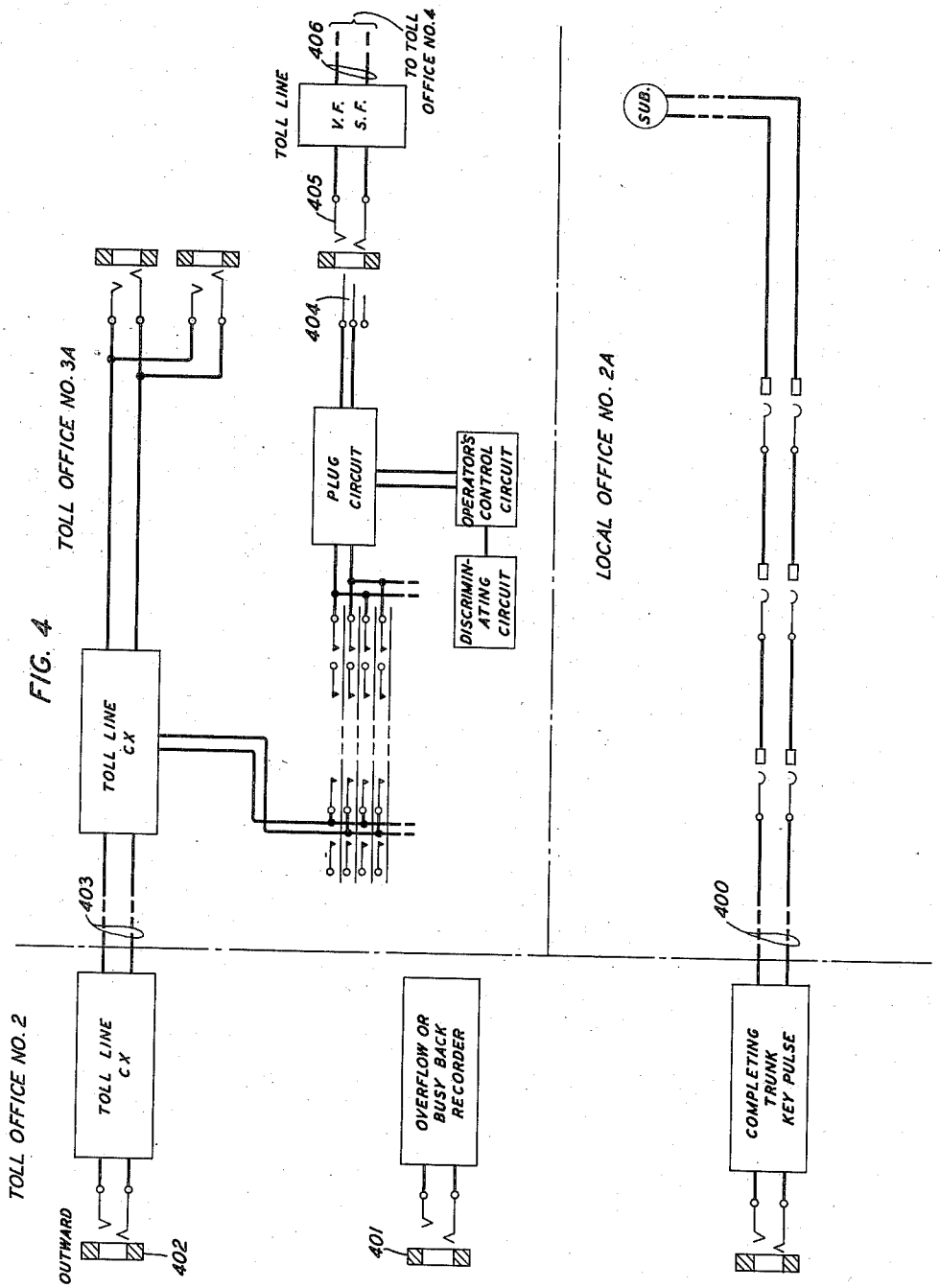


FIG. 4

INVENTORS: J. MESZAR
F.M. WIESE

BY

ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 5

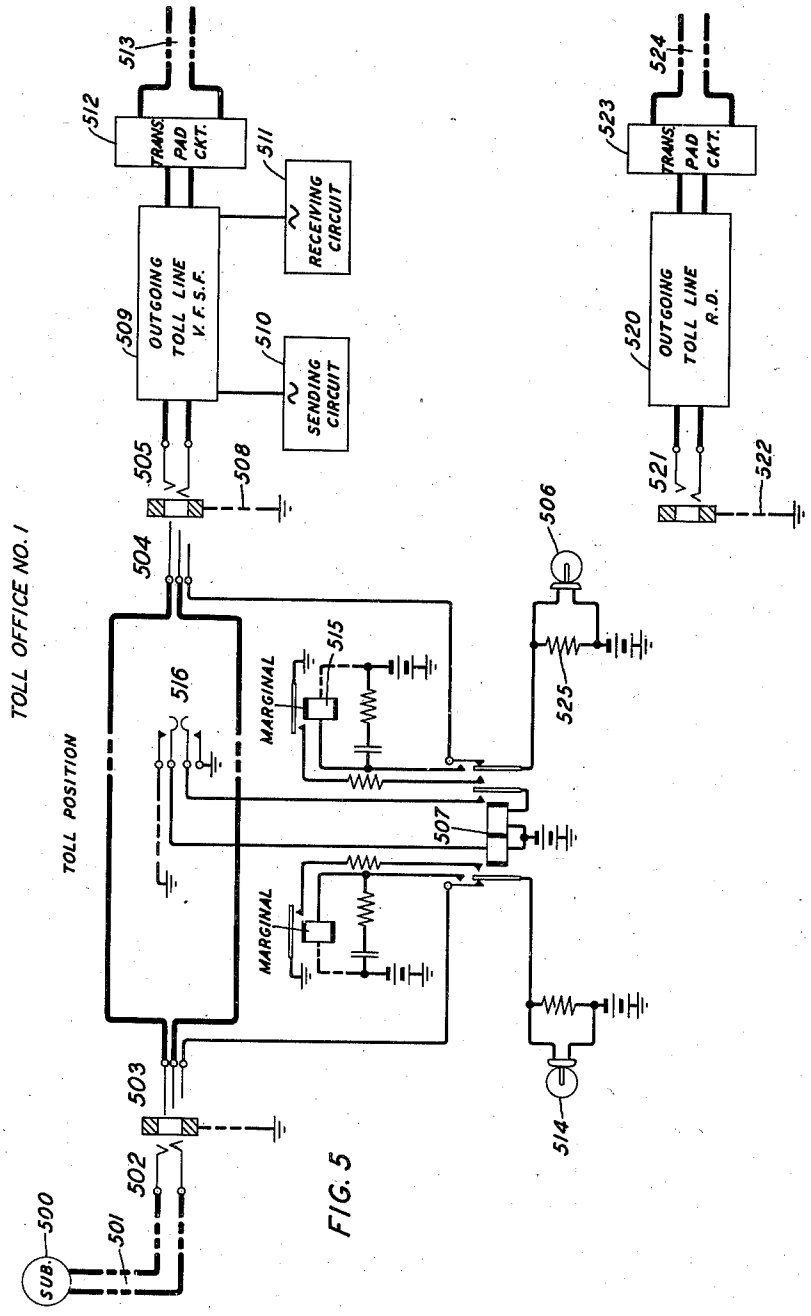


FIG. 5

INVENTORS: J. MESZAR
F. M. WIESE

BY

ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 6

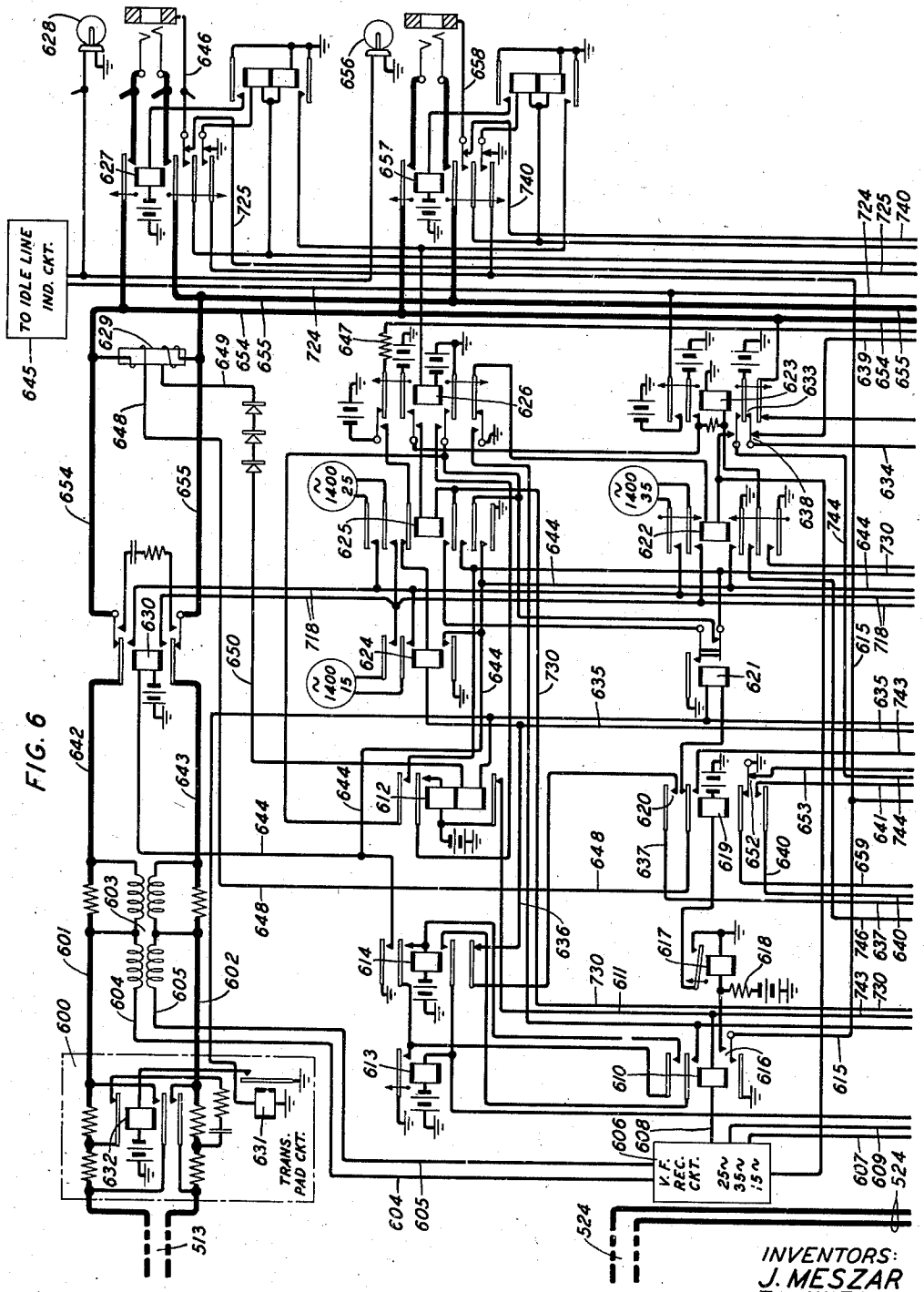


FIG. 6

INVENTORS:
J. MESZAR
F.M. WIESE

BY
ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 7

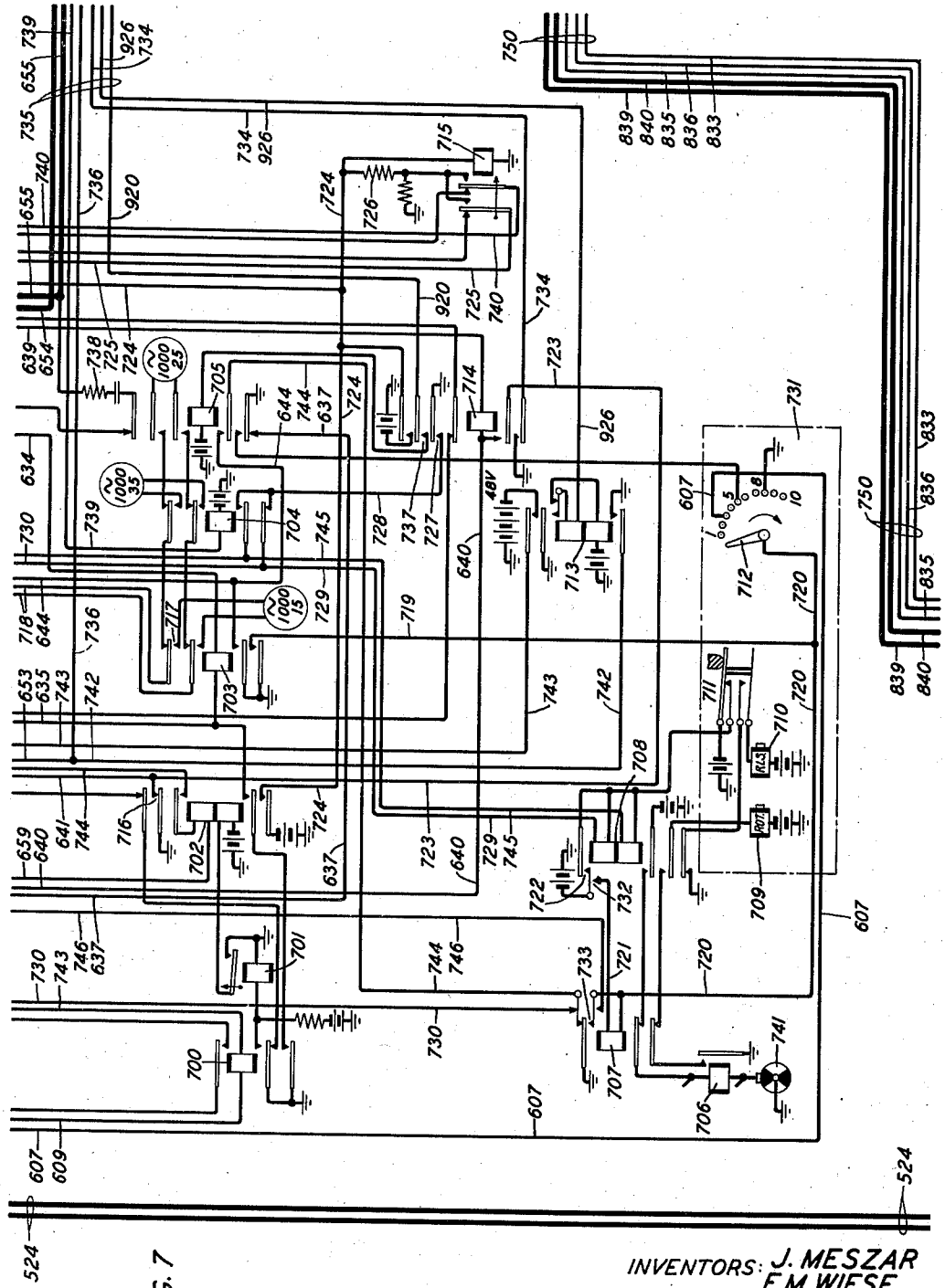


FIG. 7

INVENTORS: J. MESZAR
F. M. WIESE
BY
ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 8

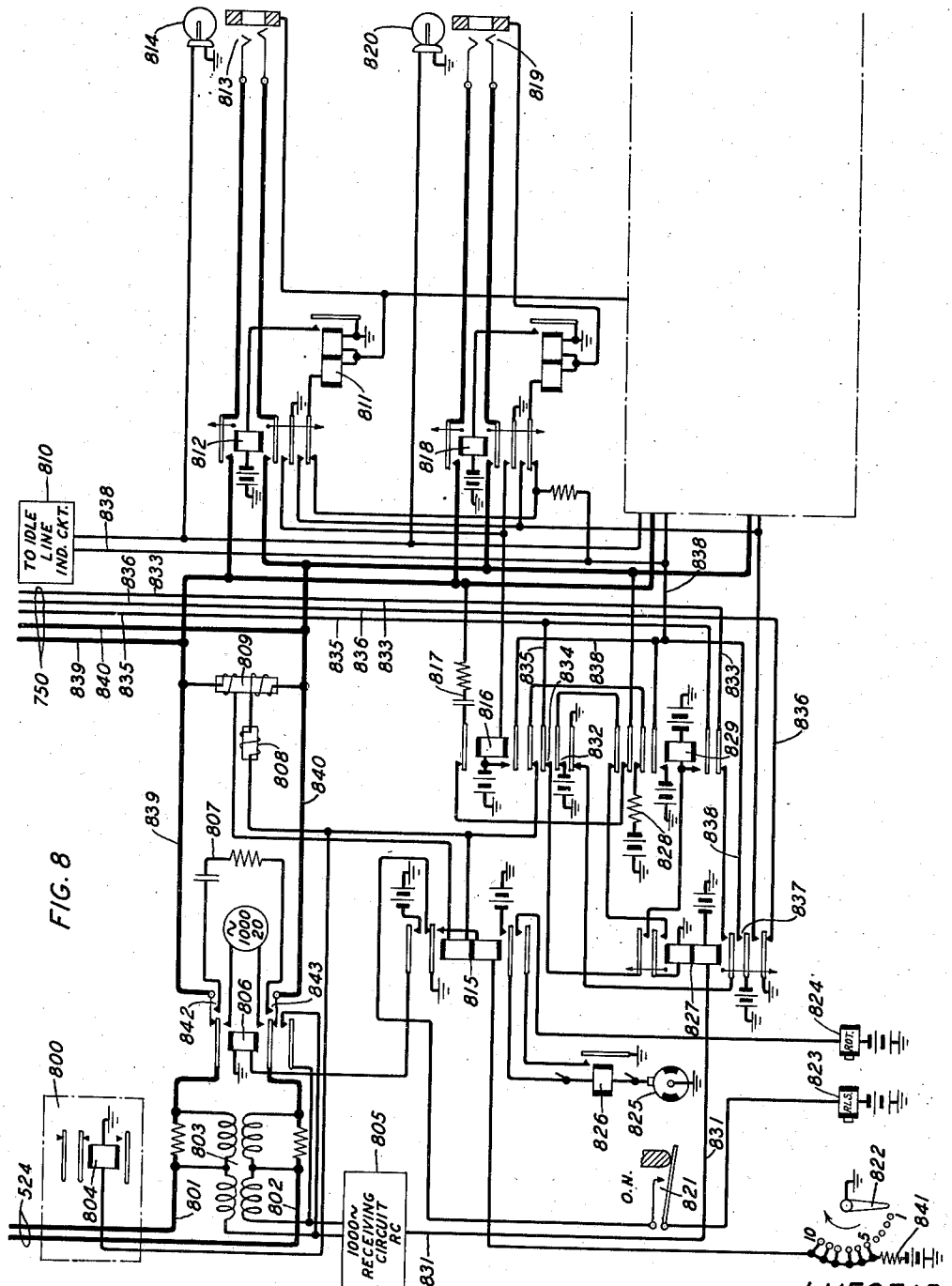


FIG. 8

INVENTORS: J. MESZAR
F. M. WIESE

BY

ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 9

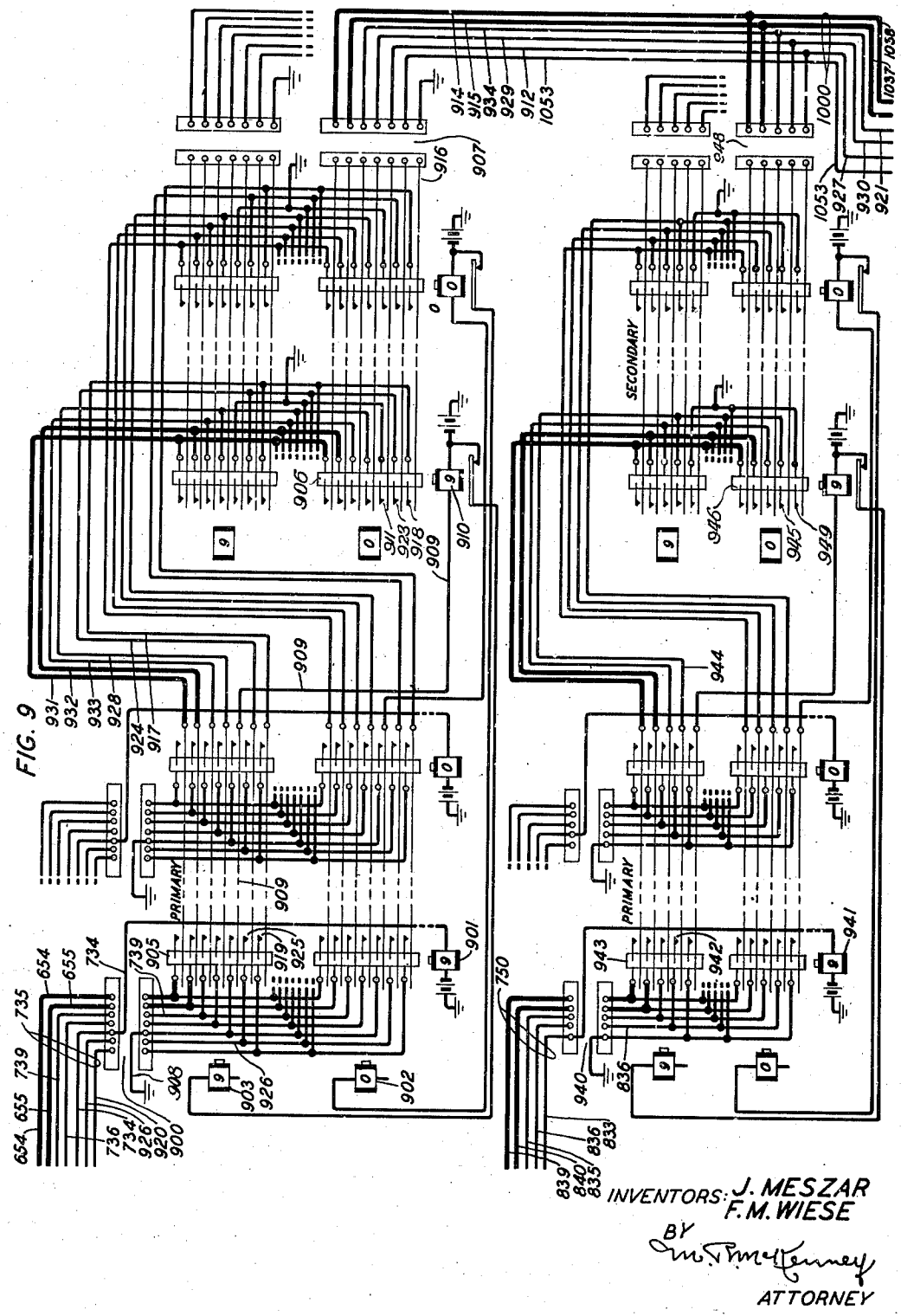


FIG. 9

INVENTORS: J. MESZAR
F. M. WIESE

BY

ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 10

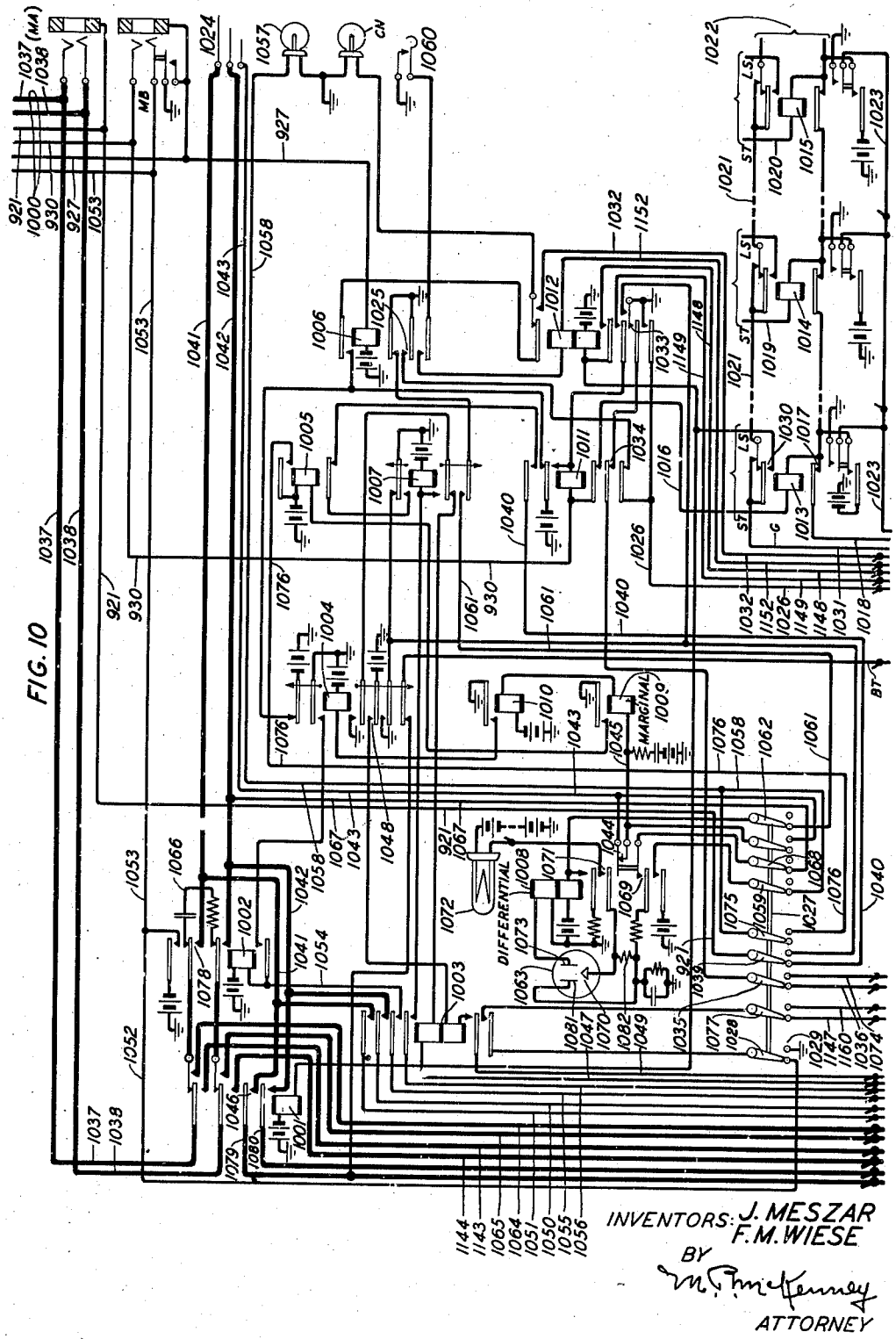


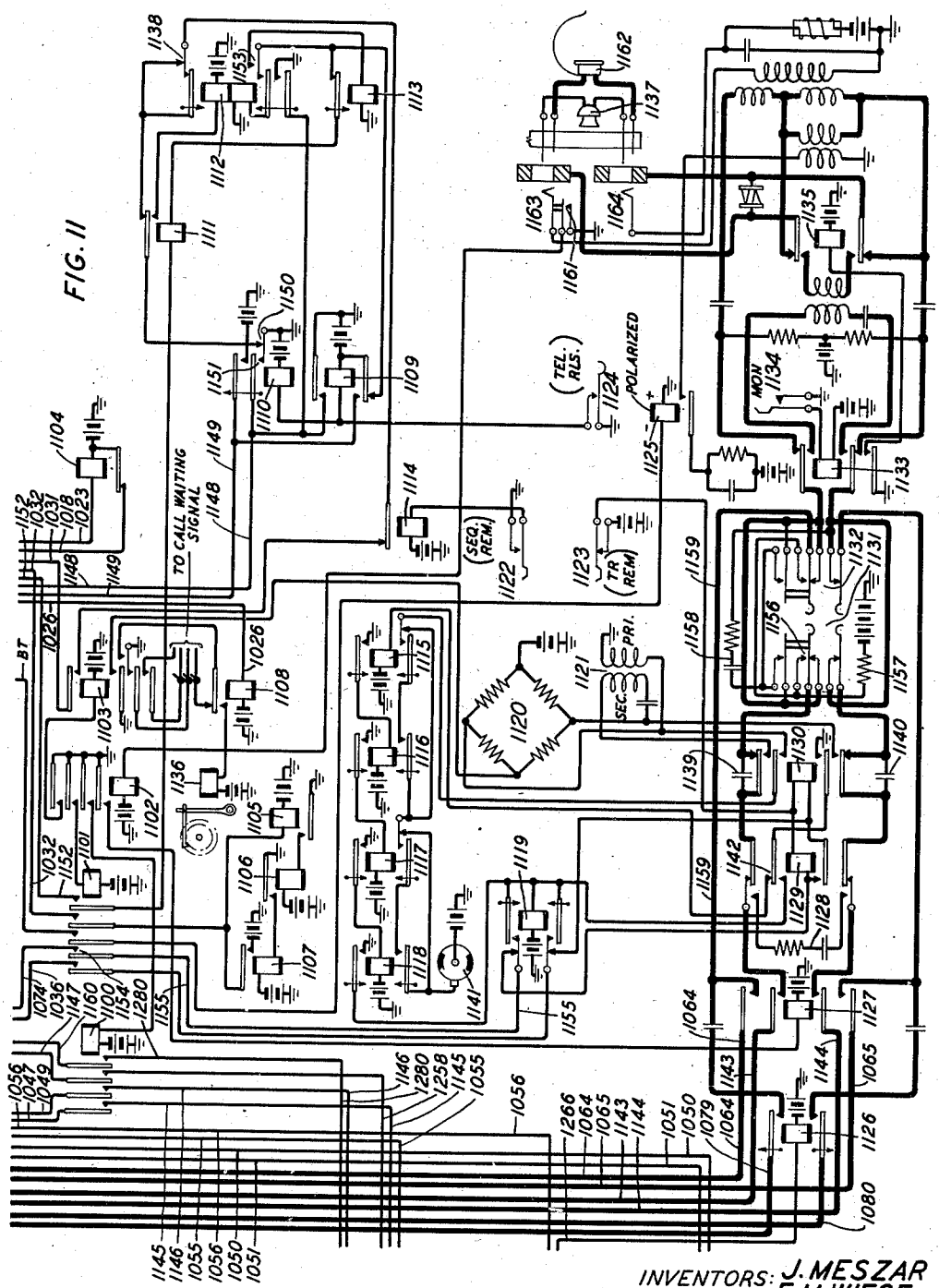
FIG. 10

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 11

FIG. 11



INVENTORS: J. MESZAR
F. M. WIESE

BY

M. P. McKenney

ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 12

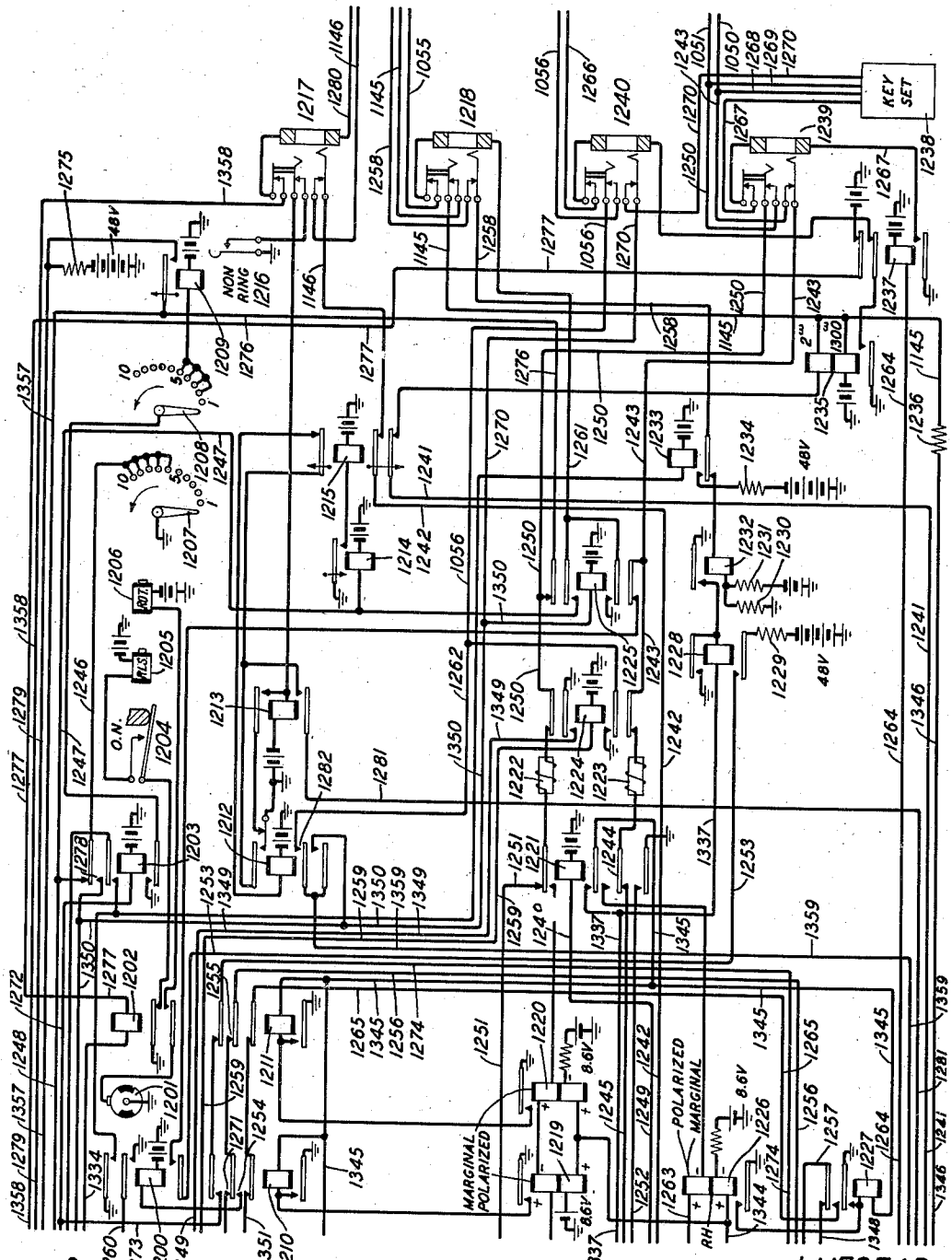


FIG. 12

INVENTORS: J. MESZAR
F. M. WIESE

BY

ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 13

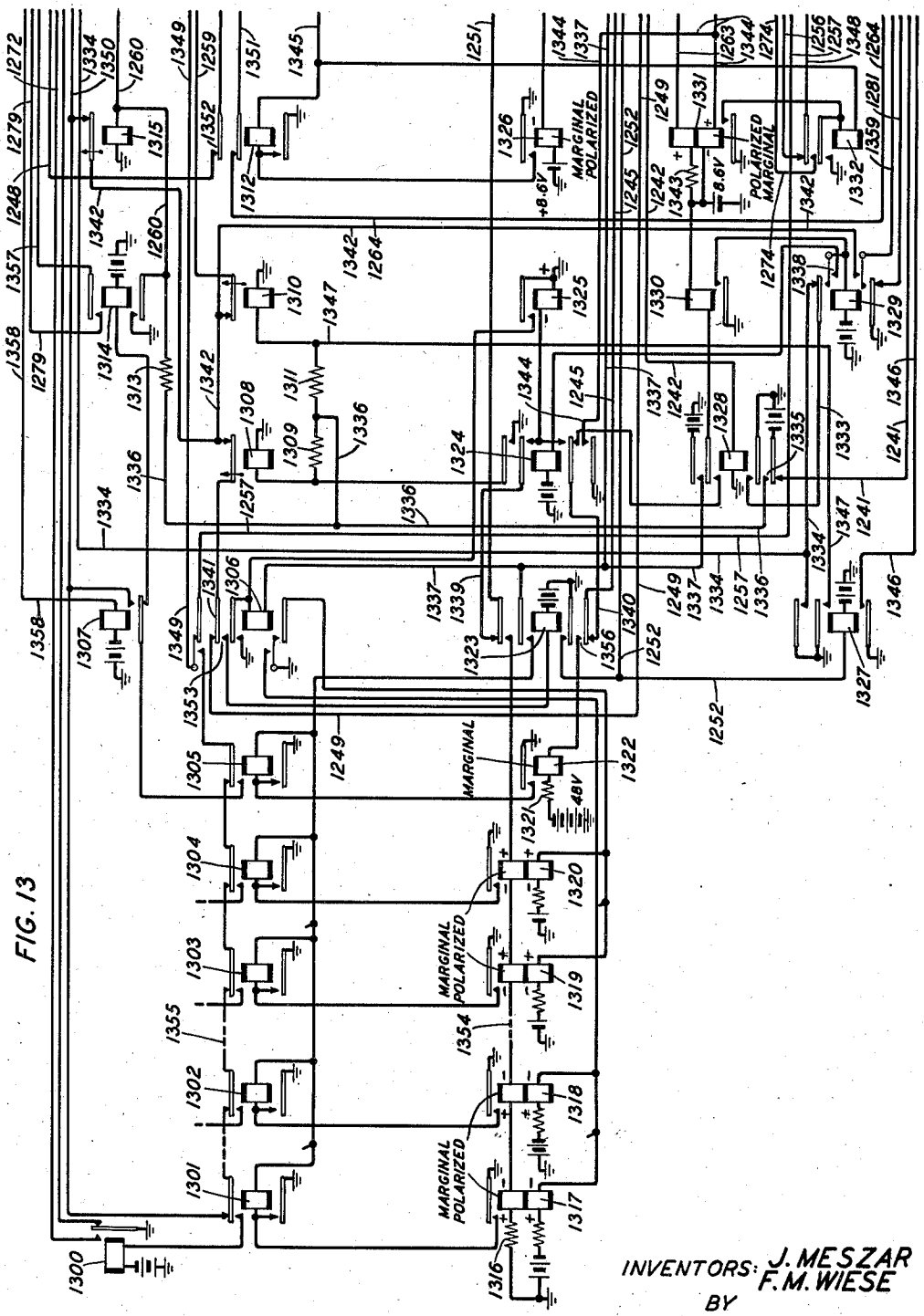


FIG. 13

INVENTORS: J. MESZAR
F. M. WIESE
BY
ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 14

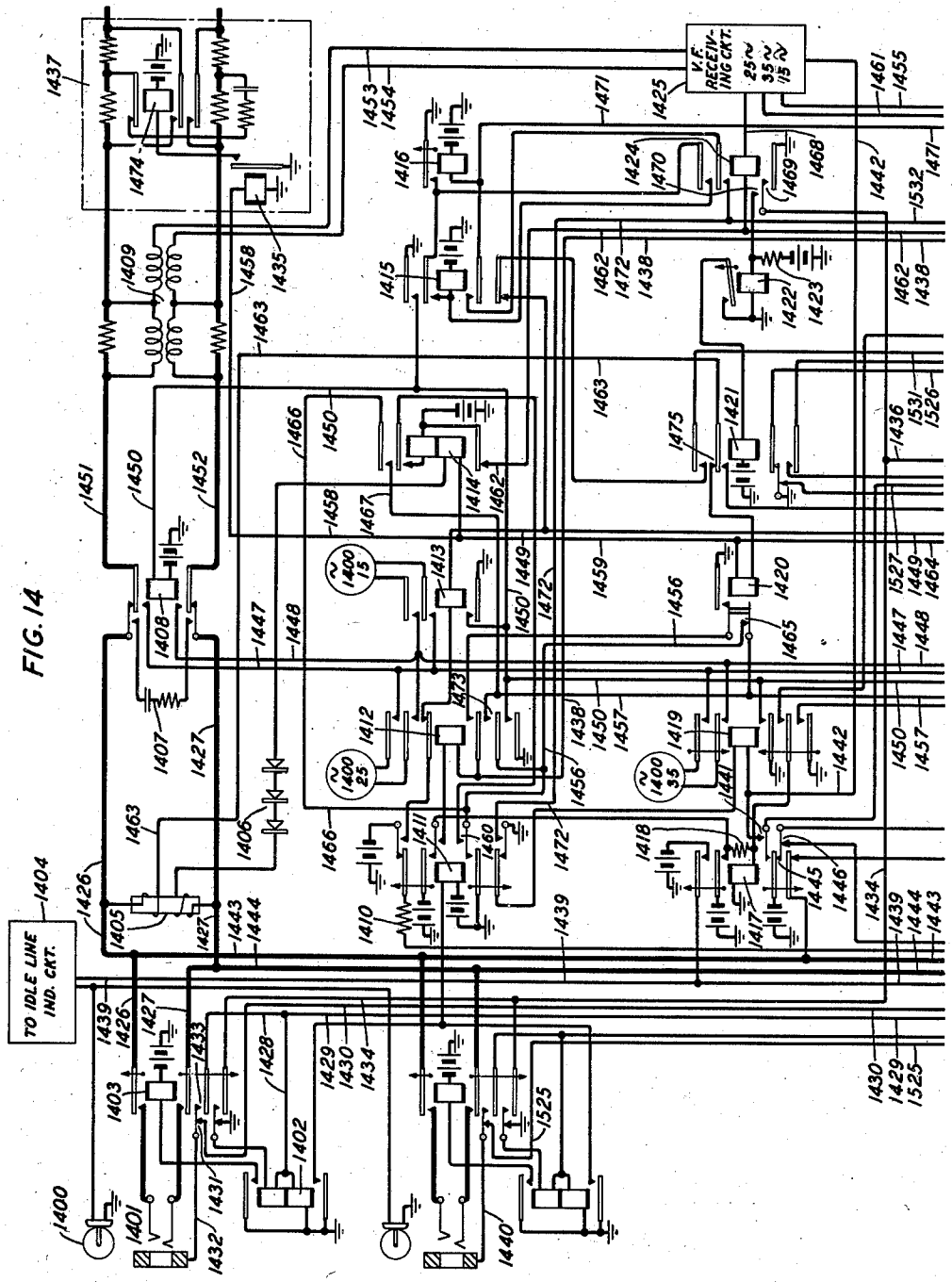


FIG. 14

INVENTORS: J. MESZAR
F. M. WIESE

BY

ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 15

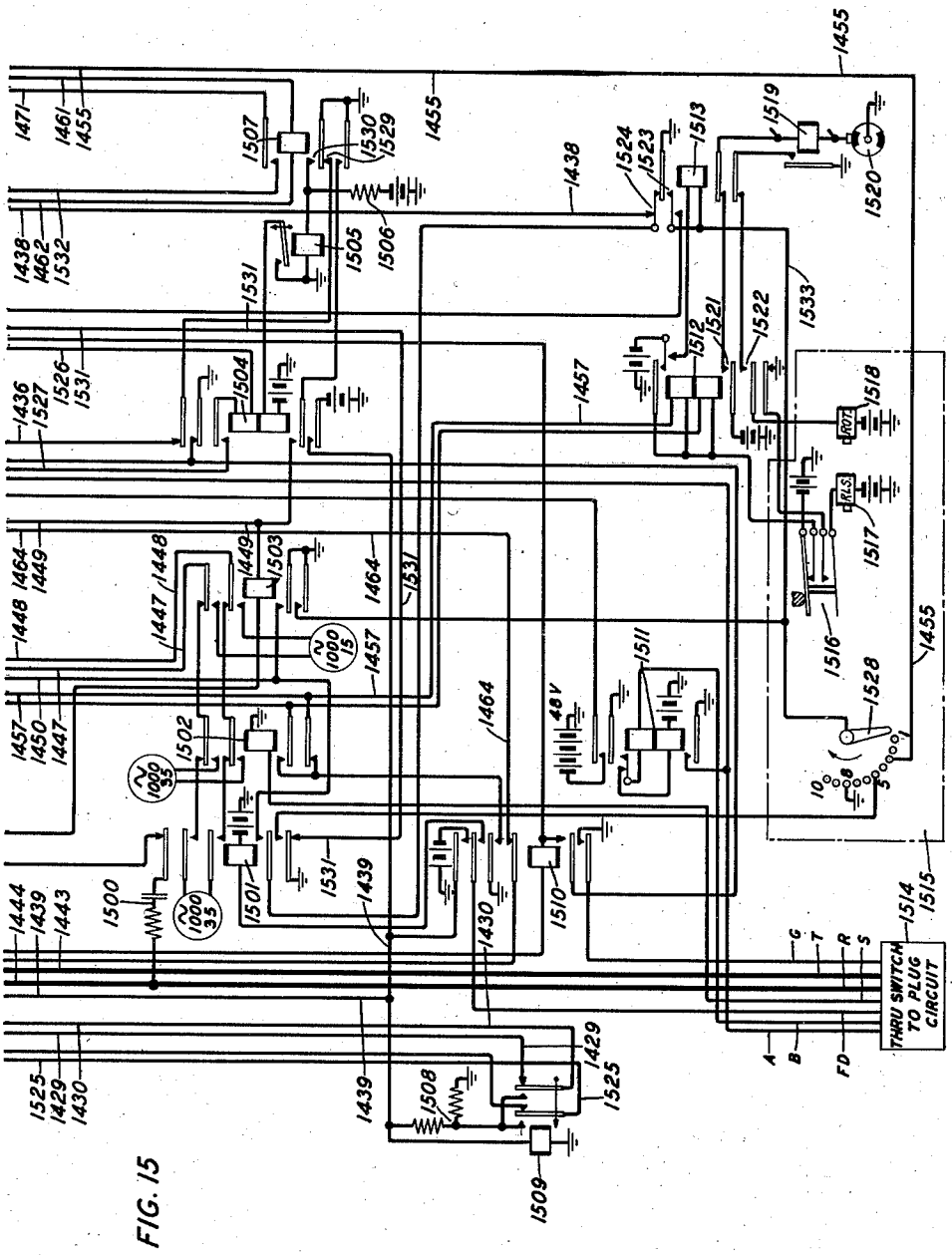


FIG. 15

INVENTORS: J. MESZAR
F. M. WIESE

BY

ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 16

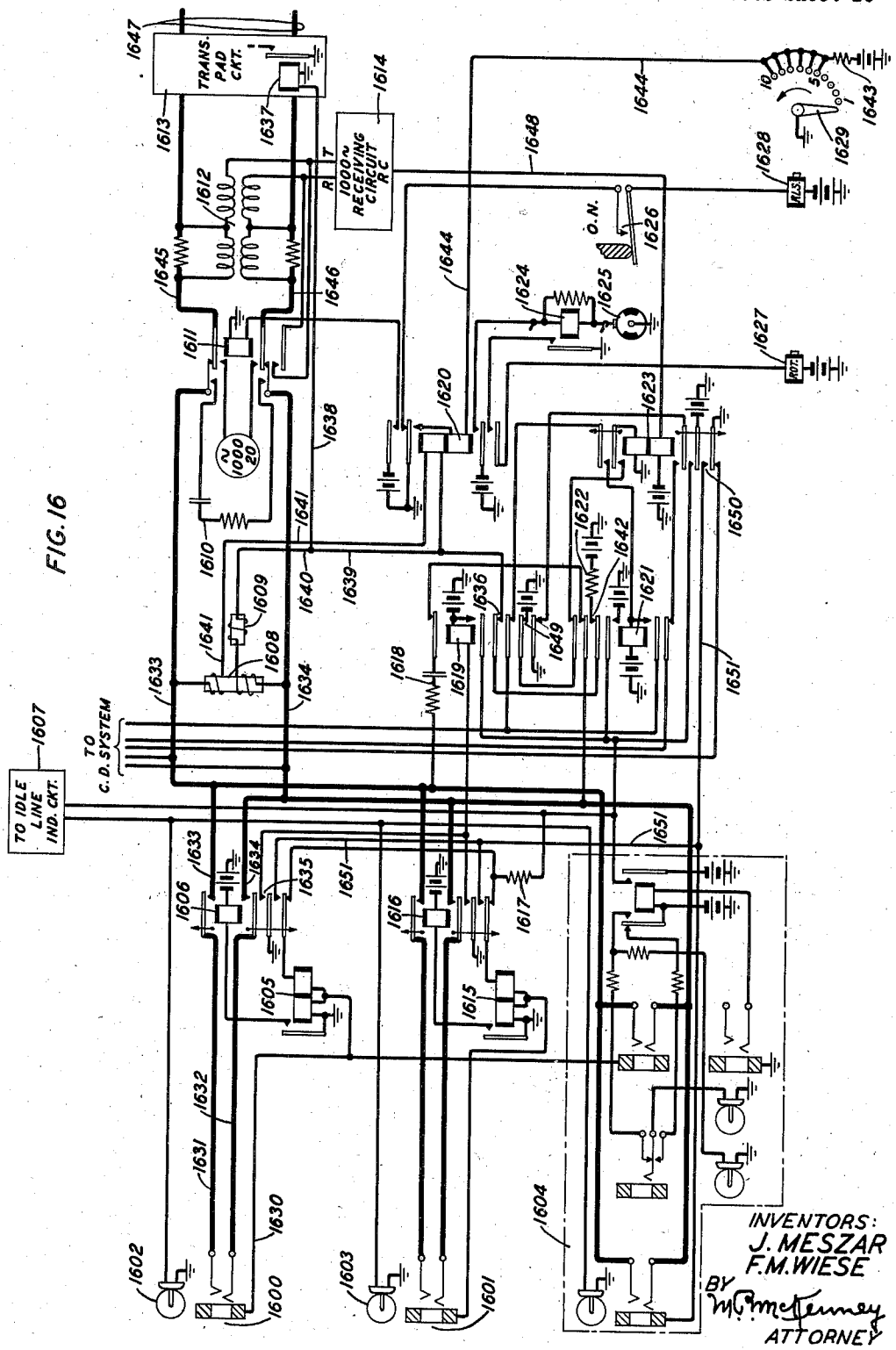


FIG. 16

INVENTORS:
J. MESZAR
F. M. WIESE
BY
ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 17

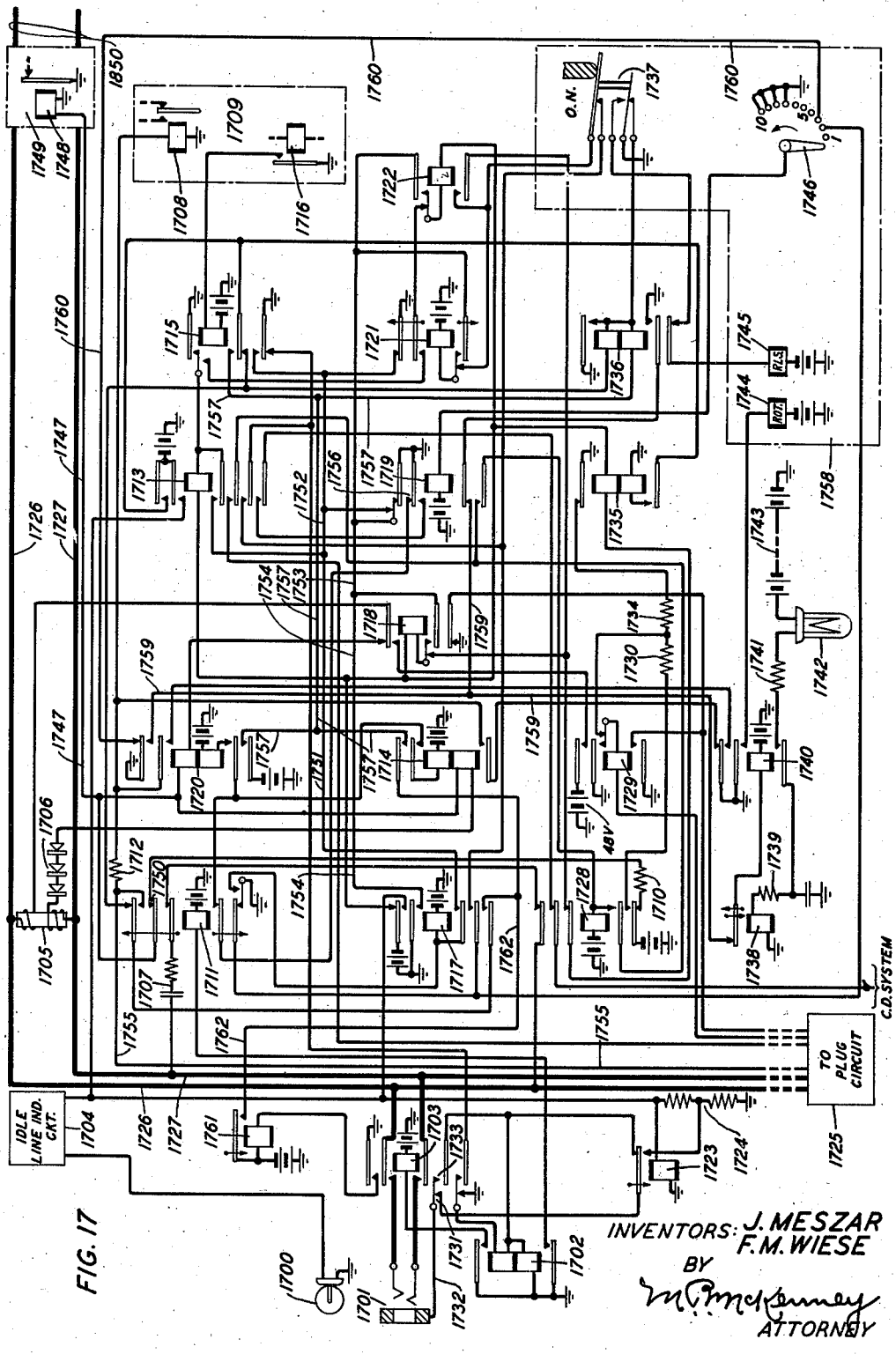


FIG. 17

INVENTORS: J. MESZAR
F. M. WIESE

BY

ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 18

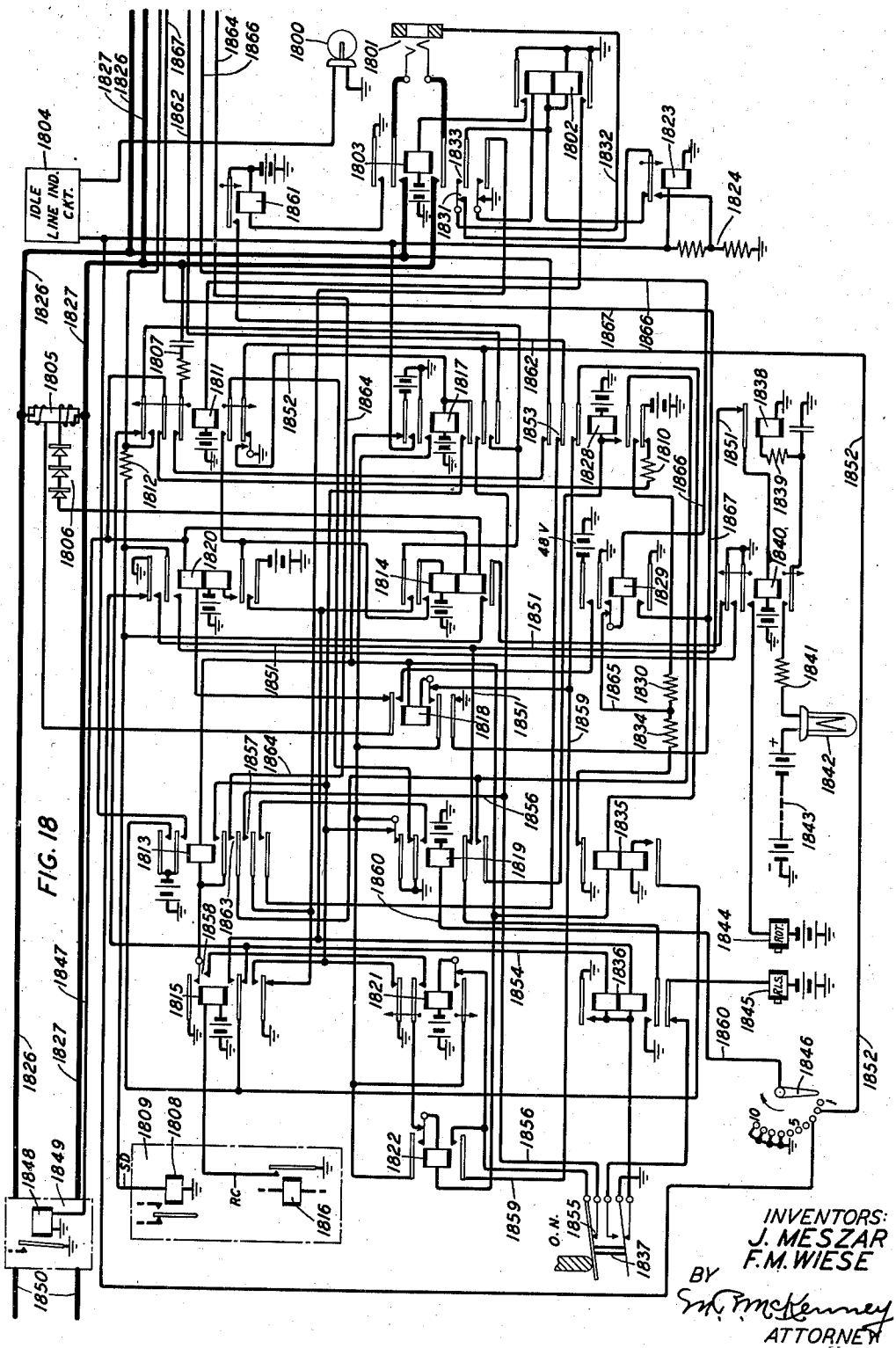


FIG. 18

INVENTORS:
J. MESZAR
F. M. WIESE
BY
ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 19

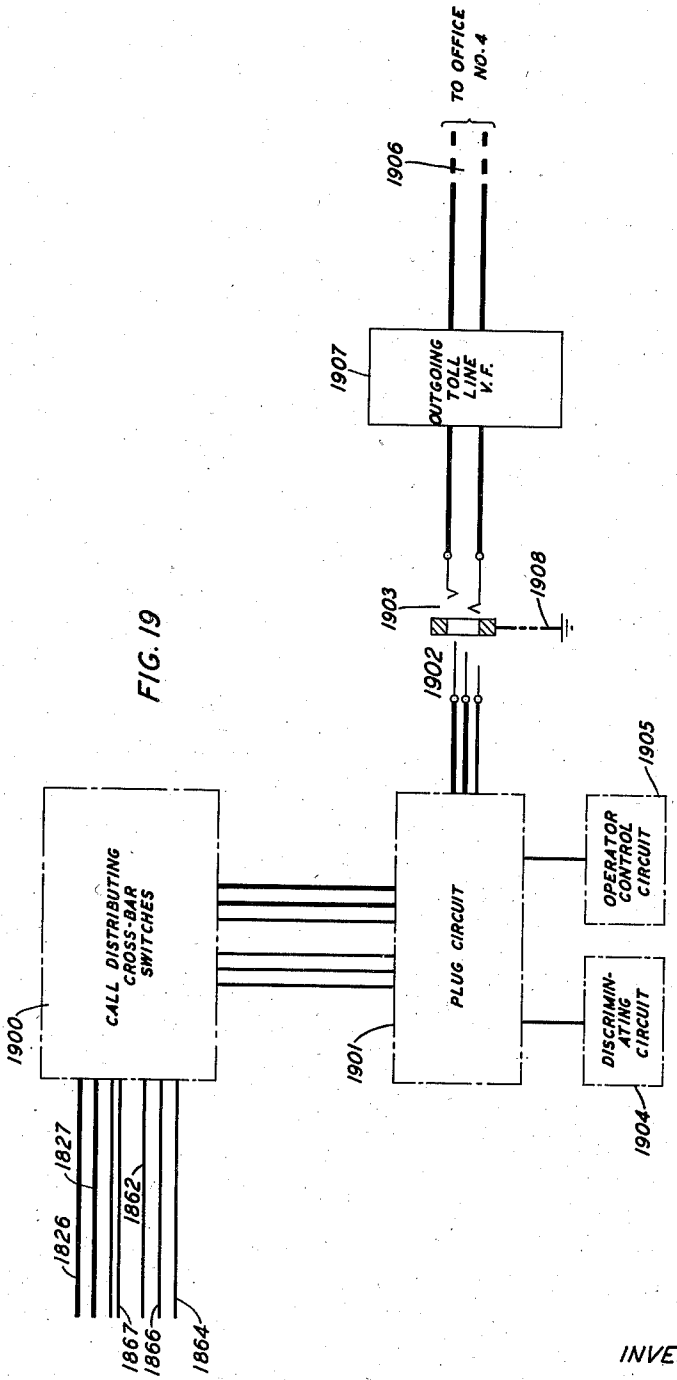


FIG. 19

INVENTORS: J. MESZAR
F. M. WIESE

BY

ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 20

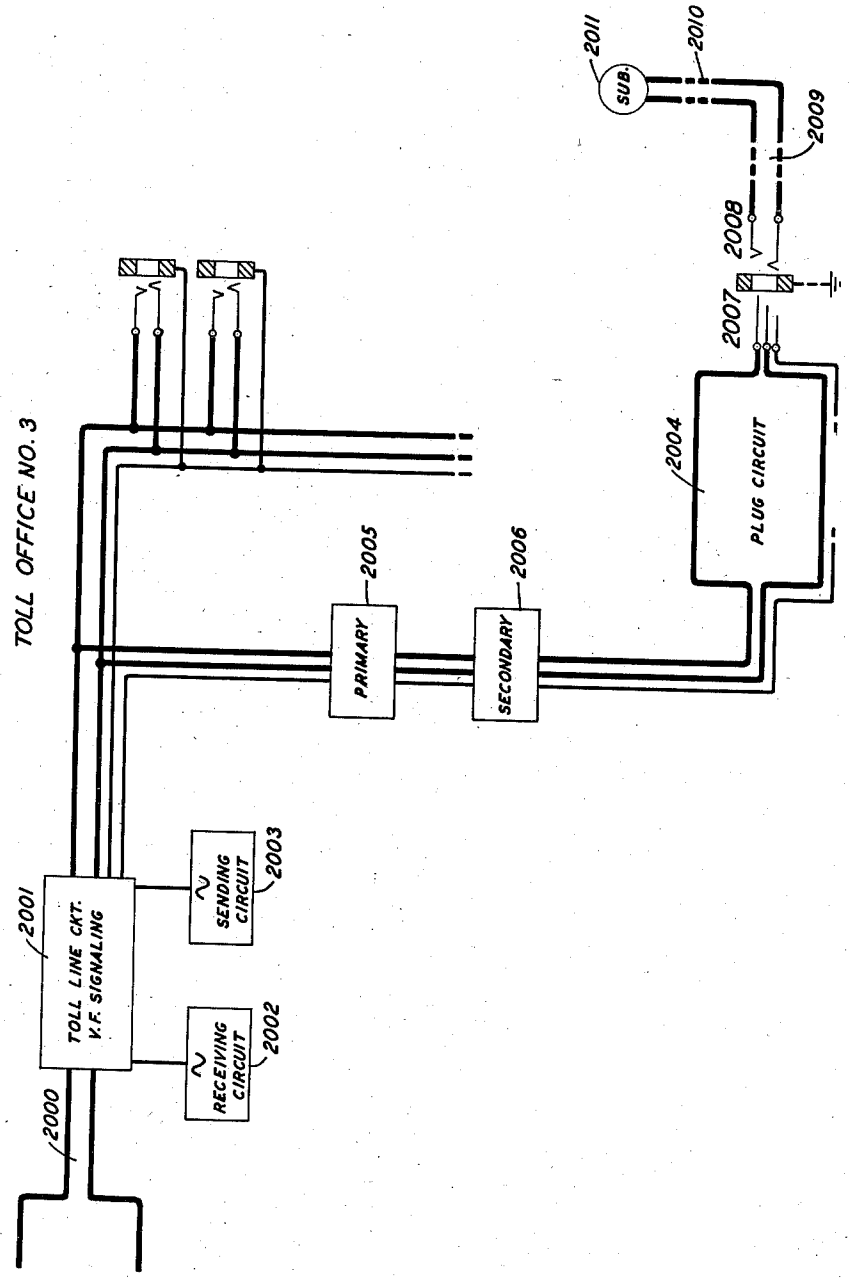


FIG. 20

INVENTORS: J. MESZAR
F.M. WIESE
BY
W. P. McInerney
ATTORNEY

May 31, 1938. J. MESZAR ET AL 2,119,239

TELEPHONE SYSTEM

Filed Oct. 29, 1936 21 Sheets-Sheet 21

FIG. 21

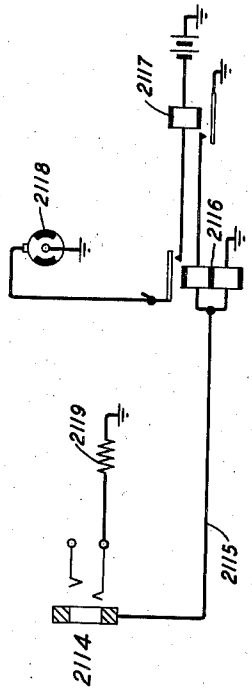
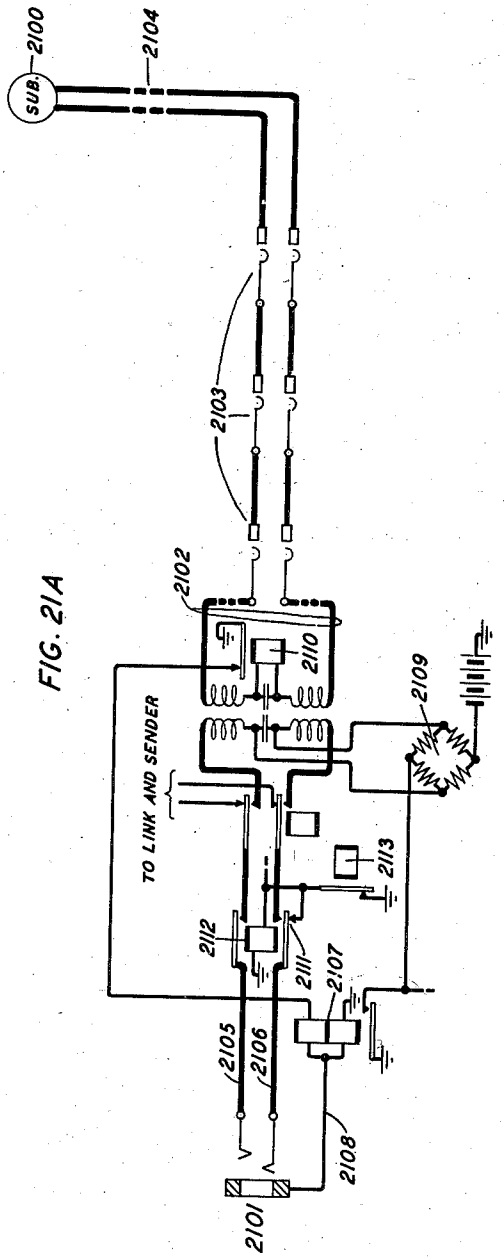


FIG. 21A



INVENTORS: J. MESZAR
F. M. WIESE

BY M. P. McKenney

ATTORNEY

Patented May 31, 1938

2,119,239

UNITED STATES PATENT OFFICE

2,119,239

TELEPHONE SYSTEM

John Meszar, Basking Ridge, and Floyd M. Wiese, Elizabeth, N. J., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application October 29, 1936, Serial No. 108,146

28 Claims. (Cl. 179—27)

This invention relates to telephone systems and particularly to systems for the establishment of toll or long distance connections.

The objects of the invention are to simplify the duties of the toll operator; to facilitate the establishment of connections involving toll lines of different character; to simplify and improve the supervisory operations; to guard against the failure of supervisory signals; to avoid undue delays in the event of double seizures; and otherwise to improve systems of the foregoing character.

It has been proposed heretofore to operate toll lines on a straightforward basis, in which the outward toll operator, upon seizing the line by inserting her plug causes the toll operator at the inward end of the line to be listened in automatically and an order tone to be returned to notify the outward operator she may pass the order. It is also old in such systems to employ voice-frequency currents for sending the various signals over the toll line in either direction and for sending in the opposite direction an acknowledgement to each of these signals. It is also, of course, old practice to operate toll lines on a ring-down basis.

According to a feature of the present invention the toll line circuits are so arranged that, when a connection has been established involving two or more toll lines in tandem, supervisory signals are sent over the connection from end to end without producing any supervisory effect at the intermediate operators' positions and without requiring any attention on their part.

Another feature is an arrangement for giving through supervision, as just described, over a connection involving toll lines of different character, such as straightforward lines and ring-down lines.

Another feature of the invention is a toll system in which a discriminating device associated with the toll operator's position becomes effective, whenever the operator puts up a connection between an incoming and an outgoing circuit, to examine both the incoming and outgoing circuits to determine their nature and to perform whatever operations are required under the circumstances and also to prepare the two connected circuits for the signaling operations that are to take place during the existence of the toll connection. More specifically, if the toll operator connects an incoming toll line either of the straightforward or ring-down type to a switching trunk for completion, the discriminator associates itself with the incoming line and makes a test to determine that the incoming line has been connected to a switching trunk. If the switching trunk extends to a dial office, the discriminator prepares the operator's dial or key-set for sending pulses over the switching trunk to complete the connection and lights a lamp to advise the operator that she must set up the number with her dial or key-set. If the incoming circuit is of the straightforward type and is connected to a switching trunk as above noted, making this toll position a terminating position, the discriminator prepares the inward circuit for terminating supervision. If, however, the operator connects an incoming straightforward circuit to an outgoing ring-down toll line, making her position a through position, the discriminator determines the nature of the two lines thus connected and automatically applies a connect signal to the outgoing ring-down line to signal the operator at the distant end and also prepares the lines for through supervision. Again, if the toll operator connects an incoming straightforward circuit to an outgoing straightforward line for a through connection, the discriminator conditions the circuit thus connected so that all supervisory signals, except the disconnect signal, are passed through without affecting the intermediate toll position.

Another feature is a two-way straightforward toll line so arranged that if the line is seized simultaneously by the operators at both ends, thereby conditioning the line to send the connect signal in both directions and disabling it from sending the acknowledgement signal in either direction, timing devices, one at each end of the line, count an interval of time and then arbitrarily acknowledge the connect signal coming from the opposite end of the line to remove the connect signal and switch the line into condition so that the operators may converse with each other. This permits one of the operators to withdraw and avoids the loss of time due to double seizures.

Another feature of the invention is a straightforward voice-frequency signaling toll line in which the rering signal applied by the originating operator for reringing the called subscriber is made sufficiently long to permit the on-hook signal to come back from the inward end to condition the supervisory apparatus at the outward operator's position before the rering signal terminates and conditions the circuits at the inward end for the transmission of the order tone signifying that the inward toll operator has been connected to the line and is ready to take the rering

order. By making this rering interval long enough to permit the return supervisory signal to be sent and completed before the order tones are applied to the line, the possibility of the order tones being masked out by the return on-hook signal is avoided.

Another feature of the invention is a line in which the multiple jacks appearing at different operators' positions are normally disconnected from the trunking conductors of the line by relays individual respectively to the multiple jacks and in which the seizure of one of said jacks by an operator causes the operation of the associated relay, if the line is idle, to operatively connect the seized jack to the line and also renders the relays associated with the remaining jacks inoperative. In this way an operator cannot interfere with a busy line even though she plugs into the jack of the line in disregard of the usual busy test or busy indication.

Another feature is a system so arranged that, when a voice-frequency straightforward toll line is connected to the outgoing end of a composite-signaling toll line, a signal is sent over the composite line to notify the inward end thereof of the character of the line ahead. If then the composite line is connected to an outgoing voice-frequency straightforward line, the circuits are conditioned so that supervisory signals are transmitted from one end to the other of the toll connection involving the straightforward lines and the composite line.

Another feature is a toll line having a timing device which is started in operation in response to the sending of each signal over the line and which measures an interval of time before the circuit will accept an acknowledgment signal coming back from the distant end. If a new signal is sent before the timing device has completed the measurement of the interval for the preceding signal, the device immediately restores to normal and begins to measure an interval of time for the new signal. This prevents the acknowledgment of a signal until it is determined that no succeeding signal is to follow.

Another feature of the invention is an arrangement in which the operator's plug circuit is provided with a toll line termination for preventing the repeaters from singing while the connection is being established, and means for disconnecting the termination and closing the incoming line through to an outgoing circuit when the operator inserts the plug in the outgoing circuit and in which the termination is maintained in the operator's plug circuit and the incoming line is not closed through to the plug circuit when said plug is inserted in a special jack, such as an overflow jack.

Another feature of the invention is an arrangement in which the repeated operation of the subscriber's switchhook causes the alternate sending of signals of different frequency over the toll line to the distant end to operate supervisory equipment to the operator's position, and in which the receipt of these signals at the distant end causes the opening of the established connection to prevent such signals from reaching the telephone of the operator or the telephone of the subscriber at the distant end of the connection.

These and other features of the invention will be more fully described in the detailed specification and will also be set forth in the appended claims.

In the drawings which accompany the specification:

Figs. 1 to 4 when arranged as illustrated in Fig. 22 give a diagrammatic illustration of the system as a whole and Figs. 5 to 21, inclusive, when arranged in the order shown in Fig. 23 disclose the detailed circuits of the system;

Fig. 1 shows an originating toll office and the outgoing ends of two toll lines one arranged for voice-frequency signaling and straightforward operation and the other for ring-down operation;

Fig. 2 shows a second toll office and the incoming ends of the toll lines extending from the office of Fig. 1. Fig. 2 also discloses distributing switches for extending the toll lines to operators' plug circuits together with certain controlling mechanisms;

Fig. 3 illustrates the outgoing end of toll lines appearing before the operators in the toll office of Fig. 2. This figure also illustrates a third toll office to which these outgoing toll lines extend;

Fig. 4 illustrates the outgoing end of a third type of toll line extending from the office of Fig. 2 to the distant toll office which is also illustrated in Fig. 3; Fig. 4 also discloses on the bottom part thereof a completing trunk extending from the toll office of Fig. 2 to a local machine switching central office;

Fig. 5 shows an originating toll office and the outgoing ends of two toll lines extending to a distant toll office;

Figs. 6 and 7 disclose the incoming end of a straightforward voice frequency toll line extending from the originating office of Fig. 1;

Fig. 8 discloses the incoming end of the other toll line extending from the office of Fig. 1, which is arranged for ring-down operation;

Fig. 9 discloses the call distributing switches for distributing the incoming toll lines to the operators' plug circuits;

Fig. 10 shows one of the operator's plug circuits;

Fig. 11 shows the operator's position equipment;

Figs. 12 and 13 disclose the details of a discriminating circuit common to the incoming and outgoing lines;

Figs. 14 and 15 are similar to Figs. 6 and 7 and disclose the details of a voice-frequency straightforward toll line extending from the second toll office to a third or distant toll office;

Fig. 16, like Fig. 8, discloses a ring-down toll line outgoing from the second toll office with the third toll office;

Figs. 17 and 18 disclose the details of a composite-signaling straightforward toll line outgoing from the second toll office and extending to the third or distant office;

Fig. 19 discloses the incoming end of the composite-signaling straightforward toll line at the third toll office together with the distributing and operator's equipment;

Fig. 20 discloses the incoming end of the toll line at the third toll office and also illustrates diagrammatically the distributing switches and the operator's equipment;

Fig. 21 discloses a service jack and circuit located at the operator's position in the second or intermediate toll office; and

Fig. 21—A shows a complete trunk extending from the operator's position in the second or intermediate office to switches in a local toll central office.

In the following description the reference characters used for convenience have been chosen in groups of 100, those from 100 to 199 referring to Fig. 1, 200 to 299 to Fig. 2, etc.

General description

The operation of the present system of the invention is briefly outlined as follows:

The calling line 100 connected with toll office No. 1 is indicated in Fig. 1, together with a toll operator's cord circuit 101 shown as connecting said line either with a two-way toll line 102 with voice-frequency signaling and straightforward operation or with a two-way toll line 103 arranged for ring-down operation. The other ends of said toll lines appear in toll office No. 2 as indicated in Fig. 2. At this office a call from the calling subscriber in Fig. 1 over said lines causes the connection to be extended through a set of primary switches 200 and secondary switches 201 to a cord plug 202 located in front of the operator at office No. 2. The latter operator upon receiving the number of the called subscriber from the operator at office No. 1 inserts the inward cord plug 202 into one of the outgoing jacks shown at the left-hand side of Figs. 3 and 4, thereby causing the common discriminating circuit 203, indicated at the bottom of Fig. 2, to automatically attach itself through the operator's control circuit 204 to the associated cord plug circuit. The discriminating circuit determines the type of toll line on which the incoming call has arrived and the type of selected outgoing toll line to which it has been connected and then automatically disconnects itself after preparing the two connected circuits for the signaling operations that are to take place during the existence of the connection.

For the purpose of illustrating the manner in which various types of selected circuits are prepared by the discriminating circuit for the supervision required of them, it has been chosen to describe a number of different types of connections which the operator at toll office No. 2 completes. She may, for example, serve as a terminating operator for calls to subscribers in an adjacent local office wherein said calls are assumed to be completed by way of a key pulsing completing trunk 400 and machine switching equipment in local office 2A indicated at the bottom of Fig. 4. The operator in office 2 also serves as the terminating operator when she inserts the incoming plug 202 into the busy back or reorder circuit jack 401, indicated in the middle left-hand side of Fig. 4. The operator in office 2 on the other hand may serve as a through operator; by connecting either of the incoming toll lines 102 and 103; either of which may appear on the plug circuit 202, with the outward jack 300 of a voice-frequency straightforward toll line 301 or with the jack 302 of a ring-down toll line 303 leading to distant toll office No. 3; or by connecting said plug with the outward jack 402 of a composite-signaling toll line 403 leading to toll office No. 3A.

The calls on toll lines arranged for straightforward and ring-down operation will both be described as reaching the terminating operator in toll office No. 3 through primary switches 304 and secondary switches 305, indicated at the bottom of Fig. 3. For the purposes of this description it will be assumed that the call is completed at this point over the usual toll switching trunk by the toll operator at office No. 3 inserting the inward plug 306 into the associated jack 307 leading to the "B" operator's position, not shown, having access to the line 308 of the desired subscriber. With regard to the through connection completed over the composited toll line to office No. 3A indicated at top of Fig. 4, the call will be described on the assumption that the operator in office No. 3A inserts the inward plug 404 into the associated jack 405 leading to another toll line 406 with voice-frequency signaling and eventually completing the call to a subscriber in the distant office.

For the purpose of illustrating a toll system to which the features of this invention are applicable, the drawings have been arranged to disclose an originating toll office, an intermediate toll office, and a number of terminating toll offices, and, to avoid unnecessary duplication of circuits, the details of the equipment are to a large extent disclosed in the intermediate toll office. It will be understood, however, that all of the toll offices disclosed, as well as other toll offices in the system, may be provided with the same equipment as that disclosed in detail in the offices represented in the drawings. For example, the voice-frequency and ring-down toll lines 102 and 103 may be provided in the originating toll office No. 1 with the same equipment as in the intermediate toll office No. 2. In toll office No. 1 these lines are illustrated as appearing in jacks at an outward operator's position for extending outward calls. Likewise in toll office No. 2 these same lines appear in jacks at outward positions for extending outward calls from the intermediate office to office No. 1. For inward calls at office No. 2 these lines appear in the primary and secondary crossbar switches, such as those illustrated in Fig. 2. Likewise these same lines may appear in primary and secondary switches at office No. 1 for the distribution of incoming calls to the inward operators' circuits. In a similar manner the toll lines shown outgoing from the intermediate office No. 2 to the distant offices are also two-way lines and may be provided at both ends with equipment such as that disclosed in detail particularly in office No. 2. While the composite-signaling toll line 403 is shown between offices Nos. 2 and 3A only, it will be understood that these composite lines may interconnect any of the offices in the system, such as offices No. 1 and No. 2, and that they are arranged for two-way service and appear in jacks at the outward operators' positions in both the offices which they interconnect, and that they also appear at distributing switches at both ends for inward calls.

Detailed description

A more detailed description of the circuit operation involved in the above described toll line connections will now be given. And for this purpose reference is made to Figs. 5 to 20 of the drawings.

Connection between a toll line with voice-frequency signaling and a key pulsing trunk

The operator in toll office No. 1 is assumed to be connected with a calling subscriber 500 in Fig. 5 over the usual channels including subscriber line 501, intermediate local office circuits, jack 502 and plug 503 of an operator's toll cord. The toll operator, it is further assumed, has conversed with said subscriber and has learned that he wishes to be connected with another subscriber termed the called subscriber in local office No. 2A that requires the connection be completed over a two-way toll line arranged for voice-frequency signaling. Said toll line appears in toll office No. 1 at jack 505 and terminates at office No. 2 in the line circuit of Figs. 6 and 7. The first toll operator accordingly proceeds to insert plug 504 of her toll cord in jack 505 of the outgoing toll line, thereby causing cord lamp 506 associated

with said plug to light over a path traced from battery through lamp 506, front contacts of relays 507 and 515. Cord lamp 506 continues to burn until the called subscriber answers or until some flashing condition is encountered, such for example as a toll or subscriber line busy. The insertion of said plug in jack 505 also causes the toll line 509 and sending circuit 510 to send a connect signal through pad circuit 512, over toll line 513, through pad circuit 600 to toll line circuit of Figs. 6 and 7 in toll office No. 2.

The equipment of the toll line 513 in toll office No. 1 is indicated rather than given in any detail since this equipment is the same as that shown in full detail at the other end of the line in office No. 2. Briefly, the signaling between the ends of this toll line is accomplished by voice-frequency ringers employing carrier frequencies of 1000 cycles and 1400 cycles, each modulated by three frequencies of 15, 25 and 35 cycles. A ringer at each end of the toll line is arranged normally to send and receive signals having a carrier frequency of 1400 cycles. When, however, the toll line first is taken for use at one end or the other by a toll operator, that end is then made to respond to incoming signals of 1000 cycles. Thus, when the operator at toll office No. 1 inserts plug 504 in toll line jack 505 the associated network 510 of the ringer is caused to send out signals with the carrier frequency of 1400 cycles and signals having a carrier frequency of 1000 cycles are received by network 511. The first signal sent over the line is the connect signal and consists of 1400 cycle current modulated by 25 cycle current. The ringer, in Fig. 6 at toll office No. 2 upon receiving this signal at once adapts itself to continue receiving signals of 1400 cycles and to sending signals with 1000 cycles instead of 1400 cycles carrier frequency.

The connect signal just described first passes through transmission pad 512 then out over toll line 513 into toll office No. 2 where it again passes through the well-known form of transmission pad 600, thence over talking conductors 601 and 602, through a hybrid transformer 603, leads 604 and 605, respectively, into a receiving network 606. Said network, for the purposes of this description, may be of any suitable design, such, for example, as disclosed in the patent to Bailey et al. 1,860,446 of May 31, 1932, and a detailed disclosure and description are therefore deemed unnecessary. In general, it consists of transformers, amplifier and rectifier tubes for separating the low frequency current from the carrier frequency; vibrating polar relays for responding to said low frequencies; low frequency tuned circuits with associated rectifiers for determining which of the low frequencies is being received; and a direct current relay associated with each tuned network which, when operated due to the 15, 25 or 35 cycle low frequency current component, connects ground to leads 607, 608 or 609, respectively. The connect signal with its 25 cycle component thus results in connecting ground to lead 608 traced through winding relay 610 and over lead 611 to battery at bottom contact and armature of relay 612. Relay 610 operates and at its top and bottom contacts prepares the circuit for supervision on outgoing calls as will be described in connection with corresponding relay 1424 of Fig. 14. Relay 610 at contact 616 also connects ground to winding of the normally operated slow release relay 617, thereby causing it to be shunted in a battery circuit which includes resistance 618.

Because of the importance of preventing line surges or disturbances from prematurely producing the effect of a connect signal or a disconnect signal, a time interval of approximately 0.4 second is introduced in these signals. This time interval, in the case of the connect signal, is obtained by making relay 617 slow to release. Upon releasing, relay 617 connects ground to winding of relay 619 to battery. The operation of the latter relay at contact 620 closes a circuit for operating relay 703 of Fig. 7 traced from battery at contact 633 on relay 623, lead 634, through winding relay 703, thence to ground over leads 635 and 636, bottom back contact and armature relay 614, contact 620 and top armature on relay 619, lead 637, through bottom break contact to grounded armature of relay 705. Relay 619 also closes a circuit at its bottom make contact for operating relay 714 in a path traced from battery at contact 638 on relay 623, thence over lead 639, through winding relay 714, lead 640, bottom make contact relay 619, lead 641, to ground at back contact 716 on relay 702. The main function of relay 703 is to send back an acknowledgment signal of 1000–15 cycles to the line circuit in toll office No. 1, while relay 714 serves to cause an idle plug, as in Fig. 10, and idle operator circuit, as in Fig. 11, to be attached to the toll line at office No. 2.

The connect signal from toll office No. 1 is acknowledged when relay 703 at contacts 717 closes 1000–15 cycle current over leads 718 to front inner contacts on relay 630. Said acknowledgment signal is further extended to toll line conductors 642 and 643, and thence to toll office No. 1, due to operation of relay 630 over a circuit traced from battery through winding relay 630, lead 644, to ground at bottom inner make contact relay 703. Relay 703 at its bottom outer make contact also prepares a path for operating relay 707. The receipt of said acknowledgment signal at the toll office No. 1 end of this toll line results in opening the path of the connect signal in the manner disclosed in said Bailey et al. Patent 1,860,446, and which will also be discussed more fully hereinafter. When the incoming connect signal stops, relay 610 releases, causing relay 617 to reoperate and remove the operating ground for relay 619. The release of the latter relay in turn releases relay 703 and relay 630, thus stopping the acknowledgment signal.

While the action stated in the previous paragraph is going on, relay 714 having also operated closes a locking circuit for itself through its bottom inner make contact over lead 723, to ground at back contact 716 on relay 702 and thereafter remains operated throughout the connection. At its top outer contact relay 714 closes battery to lead 724 for operating the idle indicating circuit indicated at 645 to extinguish lamps 628 and 656 in the event of said lamps having previously been lighted to indicate a first idle toll line. For a detailed explanation of an idle indicating circuit of the general kind suitable for use in the present system, reference is made to Eagon 1,632,826 of June 21, 1927, and Johnson et al. 1,639,135 of August 16, 1927. Battery connected to lead 724 also operates relay 715 to ground which applies busy potential to leads 725 and 740 connected through normally made contacts on relays 627 and 657 respectively to jack sleeves 646 and multiple jack sleeve 658, said busy potential being obtained by battery being connected through resistances 726 to ground. At its top inner contact relay 714 opens the circuit of relay 631 in the

pad circuit 600 that normally is held operated from battery through a high resistance 647 at relay 626, thus leaving the circuit of relay 631 free; either to remain open by virtue of a simplex ground in the next toll line circuit, on through calls; or to be operated over leads 648 and 650 to battery in the circuit beyond, if as assumed in this case the call is completed locally. In the latter case relay 632 is released and connects the transmission pad in the circuit. A further function of relay 714 is to connect ground at contact 727 to lead 728 for controlling the operation of timing relay 708 presently to be described. Said ground is further traced through bottom outer contact relay 704, lead 729 and through top winding relay 706 to battery at timing switch offnormal springs 711. Relay 714 at its bottom outer contact closes a circuit for causing the cross-bar system of switches indicated in Fig. 9 to automatically connect this toll line with the idle plug 1024 of Fig. 10 located in front of an idle operator whose control circuit is shown in Fig. 11. Inasmuch as the aforementioned system of switches does not involve the features of this invention, a detailed description of the same is accordingly omitted. For the details of a distribution system suitable for use herein, reference may be had to the patent to J. Meszar, No. 2,059,596, granted Nov. 3, 1936.

Now the purpose of relay 708 in signaling circuits of this kind is to start the timing switch 731 under which the action of timing interrupter 741 and its associated relay 706 measures various time intervals dependent on switch arm 712 coming in contact with ground, thereby operating relay 707. Relay 707 stops said switch at the end of said time interval and thereupon at its top armature continues the ground supply to leads 730, 744 and 746. In this way voice-frequency signals are transmitted for definite intervals of time depending on the nature of the signal. For instance flashing signals require speed primarily and therefore are received after relatively short time delay intervals. On the other hand connect and disconnect signals require absolute immunity from interference and therefore are received after relatively long intervals. Locked-in supervisory indications likewise require the protection of a long delay interval. A system of signaling is therefore employed wherein each signal is acknowledged when it has registered in the distant office. This acknowledgment tells the originating end that the signal having registered correctly can be stopped. Stoppage of the original signal then stops the sending of the acknowledgment signal.

Relay 708 operating, at its bottom contacts, prepares the timing switch circuit 731. At contact 722 relay 708 closes a supplementary battery to its own windings, and at contact 732 supplies battery for relay 707 which operates at once over lead 721, winding relay 707, leads 720 to 719 to ground at bottom outer contact on operated relay 703. Operation of relay 707 at its bottom contacts prevents timing switch 731 from operating while at contact 733 it connects a supplemental ground to the ground on lead 720. The remaining contacts on relay 707, affecting leads 730, 744 and 746 place this circuit in a receiver-on-hook condition without sending back a supervisory signal, such signal being unnecessary since the outward end of this circuit at the toll office No. 1 is already in the receiver-on-hook condition.

There will now be described the manner in which the above toll line is extended to the operator's plug 1024 of Fig. 10. Relay 714 at its bottom outer contact connects ground to lead 734 and thence to the upper portion of terminal block 900 of the primary-secondary cross-bar switching mechanism shown in Fig. 9. Although not shown, an allotter circuit arrangement is provided in call distributing systems of this kind which permits only one calling toll line at a time to be connected with an idle plug circuit, such as Fig. 10, of a given operator position. Since the toll line with voice-frequency signaling is here assumed as the line that is calling, the ground lead 734 may cause the operation of what is termed a holding magnet such as 901. Corresponding to this magnet, arranged vertically, are ten selecting magnets 0 to 9 as represented by the magnets 902 and 903. It will further be understood that only one of said selecting magnets may be operated at any one time, due to suitable selecting means not shown, dependent on the associated cross circuits between the primary and the secondary switches being idle and upon there being available an idle operator and idle plug circuit such as in Fig. 10. Assuming the selecting magnet 903 to be in an operated condition at the time holding magnet 901 is energized, leads from the lower portion of terminal 900 will be extended to the associated cross circuits via contact springs 905. Grounded lead 908 likewise being connected to cross lead 909, the secondary switch holding magnet 910 causes the associated cross circuits to be connected with secondary contact springs 906 and thence to the terminal block 907. In this way, the seven leads indicated at 735 are shown to be extended to the corresponding leads indicated at 1000 in Fig. 10 through their respective primary switch contact springs 905 and secondary switch contact springs 906. Closure of contact 911 of secondary switch springs 906 connects ground to lead 912, which is further traced over lead 927 through the winding of relay 1006 to battery in the plug circuit of Fig. 10. The operation of this relay at its top contact closes a circuit for lighting the connect lamp CN traced from ground through the lamp, top break contact on relay 1012, top contact relay 1006 to battery at top contact and armature of relay 1004. This lamp informs the operator of the particular plug to which she is being connected. Relay 1006 at its contact 1025 closes ground to the lead which is further traced through the bottom contact on relay 1011, thence over lead 1026 to battery through winding relay 1108, the purpose of operating relay 1108 being to signify to connected circuits that the position is busy.

Referring again to the release of relay 619 upon the stoppage of the connect signal, said release at contact 652 connects ground to lead 653, traced further over lead 736 and through the cross-bar switches of Fig. 9 on leads 928, 929 and 930 to the winding and armature of relay 1011, thence through its bottom inner normal contact to start lead 1016, winding start relay 1013 and its contact 1017, lead 1018 to battery at back contact on relay 1104. The start relay 1013 thus operates to connect the toll line of Fig. 6 to the operator by closing a circuit for operating relay 1001 and 1012 as will presently be described. Each plug circuit has its own start relay for guarding against an operator being connected with a toll line on which a call has just originated and at the same time being connected with a toll line on which a distant operator may have just started a rering signal. The receipt of a rering signal on some other toll line, as will fur-

ther be described, causes relay 1011 of its associated plug circuit to release and start relay such as 1014 to operate. In this case both relays 1013 and 1014 operate but only one plug circuit at a time can be connected with the operator due to the series lead 1021 connected through the top armatures and back contacts of start relays 1013, 1014 and 1015 and start relays for other plug circuits indicated at 1022. Once any one or more start relays operate, relay 1104 operates from ground over lead 1023 to battery at lower middle contact on said start relay, thereby removing battery from lead 1018 and preventing any more start relays from operating. Relay 1104 remains operated until all start relays are normal again, thus holding the operator busy until she has taken care of the calls represented by their respective start relays being in an operated condition.

At this point, it should be observed that when a toll operator plugs her transmitter 1137 and receiver 1162 into telephone jacks 1163 and 1164 of a toll position, contact 1161 connects ground to winding of relay 1102, which then operates to battery to prepare the position control circuit of Fig. 11 for action. Relay 1102 in turn operates relays 1100, 1101, 1103 and 1127. It will also be observed that a two-position manual switch 1027 has been shown in the lower left corner of Fig. 10. Said switch, for the purposes of this description, may be considered to operate automatically and move its associated armatures such as 1028 to a second set of terminals such as 1029, whenever the calling toll line is of the ring-down type, connected over leads 750 and through the primary secondary cross-bar switches in the lower portion of Fig. 9 to leads 1000 of Fig. 10. Under actual operating conditions, the automatic control of said switches is a part of the call distributing system, details of which are unnecessary to a complete understanding of the present invention.

The operation of start relay 1013, mentioned above, at contact 1030 closes a circuit for operating relays 1001 and 1012 over a path traced from battery through said relay windings in parallel, contact 1030 on relay 1013, lead 1031, top contact on operated relay 1103, normal contact relay 1114, contact 1138 on relay 1112, top normal contact relay 1111, to ground at contact 1150 on relay 1110. Relay 1001 operated obviously connects the operator's telephone circuit to the talking conductors of both the toll line and the cord plug 1024. Relay 1012 at its top contacts causes lamp CN to flash by connecting it to lead 1032, traced further through contact on relay 1101 to battery through relay 1105. Lamp CN in this path does not light. Relay 1105 operates relay 1106 and in turn relay 1107 which connects direct battery through contact on relay 1101 to lead 1032, lighting lamp CN and short-circuiting relay 1105, thereby causing the latter to release and release relay 1106, then relay 1107 which removes said direct battery. This cycle repeats itself and lamp CN continues to flash as long as the operator is connected with the incoming call. Relay 1012 at contact 1033 operates relay 1130 in the operator's telephone circuit at bottom of Fig. 11 for the purpose of giving three spurts of tone to both the originating and the calling operator, informing the first that she may pass the wanted number. The called operator hearing said tone through condensers 1139 and 1140 knows that the calling operator is connected over a toll circuit arranged for straightforward operation and she therefore need not challenge. The operating circuit for relay 1130 just referred to may be traced through contacts 1034 on relay 1011, armature 1035 on switch 1027, lead 1036, left front contact relay 1101, bottom normal contact relay 1119, through winding relay 1130 to battery at tone removal key 1123. Operation of relay 1130 at its top inner contact connects tone device 1141 to the primary of tone coil 1121 and at its top outer and bottom outer front contacts connects the output of the tone coil 1121 to the incoming toll line over a path traced through top and bottom outside contacts relay 1129, top and bottom inner contacts on operated relay 1127, talking conductors 1143 and 1144, through top outer contacts on relay 1001 to conductors 1037 and 1038, thence over conductors 914 and 915, and conductors 931 and 932 of the primary secondary cross-bar switching equipment of Fig. 9, conductors 654 and 655 and through the top and bottom outside contacts of relay 630 to talking conductors 642 and 643 previously traced to toll office 1. At its bottom inner contact relay 1130 closes ground through contact 1142 on relay 1129, through winding relay 1115, to battery for the purpose of breaking up the tone from device 1141 to three spurts of tone. At the end of the third spurt of tone, relay 1118 operates relay 1119 which locks operated, opening previously traced circuit for relay 1130 which releases and leaves the two operators connected over the toll line of Fig. 6. The manner in which relays 1115 to 1119 operate to produce said tones is believed to be obvious and therefore no further description is given.

When the incoming toll line of Fig. 6 is extended through the switching equipment of Fig. 9 as above described, ground at terminal block 907 on lead 916 is connected to lead 917 at contact 918 on secondary switch 906. Said ground is further traced over lead 917, through contact 919 on primary switch 905 and lead 920 at terminal block 900, thence through contact 737 on relay 714 to battery through relay 705. Operation of relay 705 at its top outer contact opens the termination 738 across talking conductors 914 and 915. At its two top inner contacts and its bottom inner contact it prepares the circuit for sending subscriber-on-hook signals of 1000–25 cycle back over toll line conductors 642—643, but as previously explained the absence of ground on lead 744 prevents said signal being sent at this time.

Let it now be assumed that the operator in toll office No. 1 has heard the three spurts of tone and has passed the wanted subscriber's number to the operator in toll office No. 2. Let it further be assumed said subscriber number requires the connection be completed over a key pulsing trunk to a machine switching subscriber in a local office No. 2—A adjacent to toll office No. 2. The operator in toll office No. 2 thereupon takes up cord plug 1024, associated with flashing lamp CN, and plugs it into the first key pulsing trunk jack that is available. Plug 1024 may thus be assumed to be inserted in outgoing jack 2101, connected with key pulsing trunk 2102, thereby extending tip conductor 1041 to conductor 2105 which at this time is open at contact on relay 2112, and extending ring conductor 1042 to conductor 2106 which is connected to ground through contact 2111 on relay 2112 and back contact on relay 2113. Relay 2107 of the trunk circuit and relays 1009 and 1010 of the plug circuit operate in series over the sleeve of said plug and jack, traced from ground through lower high resistance wind-

ing sleeve relay 2107, leads 2108 and 1043, contact 1044 on relay 1008, lead 1045, winding marginal sleeve relay 1009 in series with winding sensitive sleeve relay 1010 to battery. Relay 2107 operating in this circuit connects ground to pad control bridge circuit 2109 and starts a link circuit (not shown) to hunting for a sender and for this particular trunk. Meanwhile ground at back contact supervisory relay 2110 is connected through low resistance top winding relay 2107 to sleeve lead 2108, thereby causing both sleeve relays 1009 and 1010 to operate as will presently be explained. Since a detailed description of the key pulsing trunk 2102 is not necessary to a full understanding of the features of this invention, only such portion of said trunk is indicated and described as is required to cooperate with the circuits that show the features of this invention.

Discriminating circuit

The description thus far has shown how a call originating in toll office No. 1 is received in toll office No. 2 and is automatically connected to an idle plug in front of an idle operator. Likewise it has shown how said operator receives the wanted subscriber's number from the originating operator and in accordance therewith has placed plug 1024 in key pulsing trunk jack 2101. There will now be described the manner in which this last act of the operator causes the discriminating circuit of Figs. 12 and 13 to be automatically associated with both the incoming circuit and the circuit to which the plug has been connected.

Completion of the plug sleeve, previously traced, causes relays 1009 and 1010 to operate. The operation of these relays connects direct ground for operating relays 1005 and 1004 respectively. Relay 1004 at its top outer contact removes battery which together with removal later on, of battery at top inner contact relay 1011, prepares for the extinguishment of lamp CN. Meantime lamp CN continues to flash as previously described. At its bottom outer contact, relay 1004 opens the path for the operator's usual busy test relay 1125, previously connected to the tip of plug 1024 through contact 1046 of relay 1001. Relay 1004 at its bottom inner contact connects ground to the bottom inner armature relay 1007 and thence through its back contact to the upper winding relay 1003 for the purpose of attaching the discriminating circuit shown in Figs. 12 and 13. The operating path through the upper winding relay 1003 is further traced over lead 1047, left outer contact operated relay 1100, lead 1145, upper low-resistance winding relay 1235, bottom outer contact relay 1215, lead 1241 to battery at bottom outer contact relay 1328. Relay 1003 closes a locking circuit for itself at its bottom inner contact, from battery at contact 1048 on relay 1004 to lead 1049, traced through contact on relay 1100, lead 1146, bottom inner contact relay 1215, lead 1242, to ground through relay 1328. The latter relay also operates in this circuit, thus at its bottom outer contact opening the battery supply to lead 1241 that enabled relay 1003 to operate. In this way relay 1003, which connects the leads from the plug to the discriminating circuit, can be operated only when the discriminating circuit is not already engaged.

The discriminating circuit is thus connected to the plug circuit of Fig. 10 almost instantly that the plug sleeve touches the jack sleeve. In order, however, to avoid a false test it is necessary to be sure that the tip and ring conductors of the plug are in contact with their corresponding jack terminals before permitting the test of the selected circuit to proceed. This is accomplished by making the operation of sleeve relay 1328 at its top inner contact close the ring circuit of the conductor 1042 of the plug through a sensitive relay 1330 to positive 8.6-volt battery. Said ring conductor 1042 more specifically is traced through a contact on relay 1003, over leads 1050 and 1243, bottom outer contact relay 1224, impedance coil 1223, armature 1244, and back contact relay 1221, lead 1245, bottom outer armature and contact relay 1323, bottom inner armature and contact relay 1324, and thence through top inner contact relay 1328, winding relay 1330, to positive 8.6-volt battery. Since it is physically impossible to make the ring of the plug touch any other part of the jack when the sleeve is made, it follows that the operation of relay 1330 indicates the plug is fully seated and that the test of the trunk over the tip and ring conductors may safely proceed. Relay 1330 is operated when ring conductor 1042 through plug 1024 and the jack of the selected circuit is connected to ground as previously traced.

In case the ring conductor 1042 just traced is open, or the plug is not fully seated at the time of plug-up, the discriminating circuit will automatically release from the plug and be available to serve other calls. This is accomplished due to the operation of relay 1328 closing ground at its bottom inner contact to lead 1333 top armature and back contact relay 1329, lead 1334, through winding relay 1202, thence over lead 1277 to battery through top outer contact relay 1237. The operation of relay 1202 thereupon connects timing impulse interrupter 1201 to rotary switch magnet 1206 which steps grounds rotary arm 1207 around to lead 1246. This ground through the top outer contact relay 1203 is further traced over lead 1247 to battery through winding 1215. Relay 1215 operating, then causes relay 1003 to release and the discriminating circuit to be disconnected as will later be more fully described. Assuming, however that the ring conductor 1042 is not open and that the plug is fully seated before the grounded arm 1207 reaches terminal 5, relay 1330 operates in the circuit previously traced and in turn operates relay 1329, the top outer contact of which opens the circuit of relay 1202. Release of relay 1202 at its bottom inner contact connects ground to off-normal spring 1204 and thence to release magnet 1205 to battery thus restoring said timing switch to normal.

Proceeding with a description of the manner in which the discriminating circuit identifies the circuit which the operator has selected, it should be observed that the operation of relay 1328 at contact 1335 connects battery to lead 1336 in preparation for the identification about to be described. Said battery traced further over lead 1336 operates the following relays in multiple; relay 1308 in series with resistance 1309, relay 1310 in series with resistance 1311, and relay 1315 in series with resistance 1313. Relay 1328 at its top outer contact also prepares the circuit by connecting battery to lead 1337. The operation of relay 1329 at its top armature closes a locking circuit for itself to ground on lead 1333 and at contact 1338 closes said ground to battery through winding relay 1324. Operation of relay 1324 thereupon connects leads 1339 and 1340 to ground through the winding of a sensitive marginal relay 1325. Conductor 1041 of the plug circuit is connected to lead 1339 over a path traced through top outer make contact on relay 1003, leads 1051

and 1250, top outer armature and contact relay 1224, impedance coil 1222, top armature and outer contact relay 1221, lead 1251, and top outer armature and back contact relay 1323. Conductor 1042 is similarly connected to lead 1340 as previously traced so that it will thus be obvious that relay 1325 acts as a test relay to determine whether these conductors in the selected circuit are connected to ground or to battery. If they are connected to ground, relay 1325 does not operate and relay 1306 therefore remains normal, causing ground test relay 1221 to operate over a path traced from battery through relay 1221, lead 1249, back contact and armature 1341 on relay 1306, armature and back contact slow release relay 1306, and lead 1342 which is connected to ground at bottom contacts of previously operated relay 1329. Relay 1221 operating in said circuit causes the ring lead at armature 1244 to be connected through the upper windings of polarized marginal relays 1226 and 1331 in series with resistance 1343 to positive 8.6-volt battery; and causes the tip lead at top armature to be connected through the upper winding of polarized marginal relays 1220 and 1219 in series with winding of sensitive polarized relay 1326 to positive 8.6-volt battery. In further preparation for this ground test, the relays just mentioned are polarized at this time by ground being connected to lead 1344 at bottom outer contact relay 1324 and thence through the windings in multiple of relays 1331, 1226, 1219 and 1220 to positive 8.6-volt battery. The operation of ground test relay 1221 in addition to closing the tip and ring leads to the test relays as above described, closes ground at its bottom outer contact to lead 1252, traced through winding relay 1327 to battery. The operation of the latter relay has three functions; first to prevent possibility of tie-up during the discriminating period, it closes ground at its top outer contact to lead 1334 for operating relay 1202 provided relay 1237 is not operated, thereby starting a time-out cycle within which the discriminating circuit must complete its function or be released; second that its bottom contact closes ground to lead 1346 traced further through resistance 1236 to battery through lower winding relay 1235, thereby holding the latter relay operated during the cut-through and release of the discriminating circuit; third at its top inner contact it connects ground to lead 1347 thereby short-circuiting slow release relay 1310 and causing it to release and prepare the circuit for cut-through and release, which will later be described.

Each type of selected circuit naturally has or is given an individual marking on the tip, ring, or both tip and ring, which consists of various combinations of open circuit, low-medium-high resistance grounds, low-medium-high resistance positive or negative battery. In the case under discussion of the key pulsing trunk of Fig. 21A the tip conductor 2105 will be found to be open at the upper contact on relay 2112. The ring conductor 2106 is, however, connected to direct ground. As a result of the ground test applied by the operation of relay 1221 in the discriminating circuit, relays 1326, 1219, and 1220, on the tip side do not operate, while on the ring side both relays 1226 and 1331 operate. The latter two relays in turn operate relays 1227 and 1332 respectively which, at their top inner contacts lock to ground, the battery supply for same being traced over lead 1345, bottom inner contact relay 1221, lead 1337 and through top outer contact relay 1328. Relays 1227 and 1332 thereby register the identity of the selected key pulsing circuit. In this manner, varying combinations of primary ground test relays 1326, 1219, 1220, 1311, and 1226 are made to operate which in turn operate corresponding combinations of secondary relays such as 1212, 1210, 1211, 1332, and 1227, respectively, which then lock in an operated position. The particular combination of operated relays 1227 and 1332 noted above will permit relay 1237 to operate when relay 1224 operates. The operating circuit for relay 1237 is traced from battery through relay 1237, lead 1264, top inner contact 1312, lead 1351, top inner contact on relays 1210 and 1211, lead 1265, top outer contact on operated relay 1227, lead 1257, top outer armature relay 1305, thence over lead 1349 to ground at top inner contact on relay 1224. Thus when the latter operates, relay 1237 will serve to identify the selected key pulsing trunk to the discriminating circuit in a manner presently to be described.

At this point attention is called to the fact that the discriminating circuit, when first seized, received an indication from the incoming toll line that it was a line arranged for voice-frequency signaling. The fact that relay 1232 operates is the basis of this indication as will later be described for through connections. Since, however, a terminating circuit has been assumed at this time to have been selected, the operation of said relay 1232 performs no useful function and relay 713 in the incoming toll line remains unoperated during the connection.

Registration by the discriminating circuit of the identity of the incoming and selected circuits on the connection now being described, does not require the discriminating circuit to make any change in the supervisory features of said circuits. The function of said identification in this case is to cause the dial or key-set circuit to be connected to the selected jack circuit and to light an associated pilot lamp indicating to the operator that she may dial or key the number of the called subscriber. There will now be described the manner in which the above is accomplished. Upon the release of relay 1310 previously described, a path is closed for operating the cut-off relay 1224, traced from battery through its winding lead 1259, armature and back contact relay 1310, lead 1342 to ground at bottom inner contact on operated relay 1329. Relay 1224, besides opening at its outside contacts the main leads to the primary test relays of discriminating circuit, connects ground to lead 1349 for completing the circuit previously described of relay 1237. The operation of relay 1237 at its top inner contact causes the operator's transmission path to the plug over leads 1079 and 1080 to be disconnected during the period of pulsing, due to opening the operating path of relay 1126 traced further over lead 1266 to battery through winding relay 1126. Relay 1237 at its top outer contact opens battery connected to lead 1277 thereby preventing relay 1202 from operating. Thus on connections where the key-set is involved the time-out cycle is made ineffective. The operation of relay 1237 at its bottom contact prepares the key-set 1238 for pulsing by connecting ground to the lead 1267. Inasmuch as the operation of the key-set does not involve any of the features of this invention, its detailed description is omitted. It will be sufficient to observe that since relay 1224 is operated, thereby opening the tip and ring leads 1250 and 1243, there will be no interference with dialing on the part of the discriminating test relays.

It will be obvious from the description thus far that the operating time of the discriminating circuit has been very short and that the probabilities are that an idle link and sender circuit associated with the key pulsing trunk of Fig. 21A will likewise be associated with the trunk conductors 2105 and 2106 through the operation of relay 2112. Therefore as soon as the operator at office No. 2 has set up the wanted subscriber number on her key-set, and has operated the start button, the automatic switches 2103 may be assumed to operate under the control of the key-set and to establish connection with the called subscriber 2100 over subscriber line 2104, in a manner well known in the art. When the setting up of the connection is thus completed, key-set circuit 1238 may be assumed to connect ground to lead 1270 traced further through a contact on jack 1240 thence over lead 1350 to battery through the winding of cut-through relay 1225. The operation of the latter relay at its bottom inner contact closes ground to lead 1261, traced further over lead 1055 and contact on operated relay 1003 to winding of relay 1002 to battery. Relay 1002 whose function is to prepare a path for connecting together the incoming and selected circuits, operates and locks to ground at top inner contact relay 1004 which is thereafter held operated under control of the plug sleeve 1043. Relay 1002 at its top inner and middle armatures removes termination 1066 and extends plug conductors 1041 and 1042 via contacts on operated relay 1001 to the conductors 1064 and 1065 respectively that lead to the operator's telephone by way of the top and bottom outer contacts on operated relay 1127.

The operation of relay 1225 at its top inner contact extends ground from its bottom inner contact to the winding of relay 1214 to battery for the purpose of dismissing the discriminating circuit of Figs. 12 and 13. Relay 1214 has slow operating characteristics in order to safeguard disconnecting the circuit prematurely but after a short interval operates slow release relay 1215. The operation of relay 1215 at its bottom inner contact opens a circuit between leads 1242 and 1246 which, as previously described, formed part of the holding circuit for relay 1003 and included winding of relay 1328. It should be noted that the upper winding of relay 1003 is open at this time due to the operation of relay 1007 over a path to ground when the cut-off relay 1224 of the discriminating circuit operated. This path may be traced from battery through relay 1007, inner contact relay 1003, lead 1056, to ground at bottom inner contact relay 1224. Relays 1003 and 1328 therefore release. Relay 1328 thus removes battery and ground from relays previously traced for controlling the identifying test relays and otherwise restores the circuit to normal, thereby making the discriminating circuit available to other plug circuits. Furthermore due to opening the circuit of the upper winding of relay 1003 at the bottom inner break contact on operated relay 1007, once said relay 1003 has released it cannot be operated again until the plug is pulled down and reconnected.

The toll operator at office No. 2 having completed her part in extending the connection to the called subscriber, now releases the control circuit of Fig. 11 from the plug circuit of Fig. 10 by operating telephone release key 1124. This connects ground to the winding of relays 1109 and 1110 which operate and in turn connect ground to lead 1148 in an obvious circuit that maintains relay 1012 operated. They also connect battery to lead 1149 which is further traced through an operated contact on relay 1012, winding of relay 1011, to ground that is present at this time on lead 930. Relay 1011 therefore operates and at its bottom inner contact opens the circuit of start relay 1013 which in turn releases, thereby making the operator available to other calls when relay 1110 at contact 1150 reconnects ground to armature relay 1111. Relay 1011 at its top inner contact closes battery to its own winding for locking itself to ground on lead 930 during the remainder of the call. Relay 1011 at its bottom outer contact opens one of the operating ground paths to lead 1026 and the position busy relay 1108, and at its contact 1034 opens the holding circuit for relay 1119, thereby placing the tone relays 1115 to 1118 in a position to function on the next call. Finally relay 1011 at its top outer contact prepares a path for passing supervisory signals from the selected circuit to the toll line of Figs. 6 and 7. Said path is traced from ground at top make contact on operated relay 1007, bottom armature and contact on relay 1005 when normal, top outer contact relay 1011, lead 1040, arm 1039 of switch 1027, leads 921 and 934, through contact on secondary switch 906 to lead 933, through contact on primary switch 905 to lead 739, thence to battery through winding of relay 704, of the incoming toll line. Since relay 1005 follows the called subscriber switchhook as will later be described, relay 704 of the incoming line is thus made to follow said switchhook.

Upon the release of key 1124 by the operator, relays 1109 and 1110 release. Relay 1110 being slow to release thus insures a reasonable closure of the contacts on these relays even if the operation of key 1124 is but momentary. Relay 1110 upon opening contact 1151 removes ground from lead 1148 which thereupon permits relays 1001 and 1012 of the plug circuit to release. Relay 1001 disconnects the talking conductors 1037 and 1038 of the incoming toll line from the conductors 1143 and 1144 connected with the operator and connects them through operated contacts on operated relay 1002 to conductors 1041 and 1042 respectively of the plug circuit. The release of relay 1012 at its top make contacts opens the circuit over lead 1032 that has been keeping the plug lamp CN flashing, said lamp thereafter remaining out. Relay 1012 at its bottom outer contact removes ground from lead 1026 thereby releasing the position busy relay 1108 and register 1136. It should be observed here that lamp 1057 is connected from ground over lead 1058 and armature 1059 of switch 1027 to bottom outer armature on relay 1008 for disconnect purposes as will later be described.

Without further attention from the operator at office No. 2, key pulsing trunk 2102 continues to function and ring the called subscriber in the well-known manner. When the subscriber answers, removal of his receiver from the switchhook operates relay 2110 in a manner common to trunks of this character, thereby removing ground from the upper low-resistance winding sleeve relay 2107, leaving the sleeve lead 2108 connected through the high-resistance lower winding of relay 2107. It will therefore be evident that any operation of the switchhook, on the part of the called subscriber, will directly result in raising or lowering the ground resistance of the sleeve lead 2108, which as previously traced over the sleeve 1043 of the connected plug circuit connects to battery through the plug relays

1009 and 1010. Sensitive relay 1010 remains operated on either high or low-resistance ground but marginal relay 1009 releases on high-resistance ground, in turn releasing relay 1005. Thus when subscriber 2100 answers relay 1005 releases and at its bottom armature and contact closes a previously traced circuit for operating relay 704 of the incoming toll line circuit.

The operation of relay 704 causes an off-hook signal of 1000–35 cycles to be sent back over toll line 513 to office No. 1 where its receipt results in increasing the ground resistance of the sleeve 508 of toll line 505, thereby extinguishing cord lamp 506 of the operator in toll office No. 1 and informing her that the called party has answered. For details of the supervisory operation here mentioned reference is made to said Bailey et al. patent, No. 1,860,446. The manner of sending back said off-hook signal will now be described. Operated relay 704 at its top contacts prepares a path for the 1000–35 cycle signal through normal contacts on relay 703 to leads 718 that connect with the inner front contacts of relay 630. The latter relay, when relay 707 releases, is made to operate over a path traced from battery through winding relay 630, lead 644, bottom inner contact operated relay 705, lead 735 thence to ground at top armature relay 707. Thus as long as relay 707 remains in a released condition, relay 630 will be operated and the off-hook signal will continue to be sent to toll office 1. The control of relay 707 is therefore given to the timing switch 731 through the functioning of relay 708 which in turn is controlled by relay 704, that is, up to the time relay 704 operated, relay 708 remained operated over lead 729, bottom outer contact relay 704, lead 728 to ground at contact 727 on relay 714, all as previously described. The operation of relay 704 however, opens the circuit just traced through the upper winding relay 708 and closes at its bottom inner contact, a ground circuit over lead 745 through the lower winding relay 708. Due to the windings of relay 708 being wound in opposite directions the effect of this is to cause the flux in said relay to pass through zero. Relay 708, therefore, releases and at contact 732 releases relay 707. Also at its bottom outer contact it closes ground to release magnet 710 of timing switch 731, through operated switch contact springs 711. When said switch is normal, battery is restored at switch contact springs 711 to the windings of relay 708 which then reoperates over lead 745 and remains operated as long as relay 704 continues operated, due to the called subscriber's receiver being off-hook. The release of relay 707, as previously stated, causes relay 630 to operate and send the off-hook signal back over toll line 513 to office 1. Relay 707 at its bottom contacts, however, closes circuits for again operating the timing switch 731. After approximately 1 second, armature 712 makes contact with lead 607 thus extending a battery circuit through winding relay 707 to lead 607. If, as usually happens, toll line circuit 509 has received the off-hook signal and is acknowledging the same, the acknowledgment signal of 1400–15 cycles will be coming in over lead 604 and 605 at this time and cause ground to be connected to lead 607, thereby operating relay 707, which locks and stops said timing switch thereby stopping the sending of the off-hook signal.

If, after conversation, called subscriber 2100 hangs up, relay 1005 operates and opens the circuit through winding relay 704, the release of which causes an on-hook signal of 1000–25 cycles to be sent back over toll line 513 to office No. 1 where its receipt results in lowering the ground resistance of sleeve 508 of toll line jack 505, thereby lighting cord lamp 506 and informing the operator in toll office No. 1 that the called subscriber has replaced his receiver on the switchhook. The manner of sending this on-hook signal from office No. 2 to office No. 1 is similar in most respects with that in sending the off-hook signal described above. The only difference lies in the fact that with the release of relay 704 a signal of 1000–25 cycles replaces one with 1000–35 cycles. Also, at its bottom inner contact it opens the circuit over lead 745 for releasing relay 708 and closes the circuit at its bottom outer contact for again operating relay 708 over lead 729. The timing switch again steps to terminal 3 which is connected with lead 607 and thus permits the acknowledgment signal to again operate relay 707.

If the called subscriber proceeds to flash his receiver switchhook in a desire to again talk with the operator, then the operation of said switchhook will alternately send off-hook and on-hook signals as above described. The timing switch in cases of this kind functions to prevent the acknowledgment of an off-hook signal from acting as an acknowledgment of an on-hook signal or vice versa. For example if the subscriber should operate his switchhook at certain definite rates he could cause the off-hook signal to be sent just long enough to start an acknowledgment signal at office No. 1 coming back to office No. 2. If the subscriber at this moment then causes an on-hook signal to be sent, it is possible due to time lag in disappearing, for the acknowledgment signal started by the off-hook signal to act as the acknowledgment signal for the on-hook signal. For this reason the acknowledgment signal is prevented, by the timing switch, from being registered until the acknowledgment of the preceding signal has surely released.

Let it now be assumed that called subscriber 2100 hangs up and that an on-hook signal is accordingly sent to the operator at office No. 1 as previously described. Let it further be assumed that said operator wishes to recall said subscriber to the telephone. In this event she will operate a ringing key not shown in the cord circuit, which will cause toll line 509 to send out, in any desired manner, a re-ring signal consisting of 1400–25 cycles for a minimum of approximately 3.3 seconds as will later be explained. The receipt of this signal at toll office No. 2 causes relays 610, 617 and 619 to operate, in the same manner as previously described for the receipt of the original connect signal. At this time, however, the connection previously having been extended to the called subscriber 2100, operation of relay 619 at contact 652 removes ground from lead 653, thence from lead 736 which as previously described has been maintaining relay 1011 of the plug circuit in an operated position. The release of the latter relay at its bottom inner contact prepares a path over lead 1016 and through start relay 1013 for connecting the operator to said plug circuit, when the ringing signal ceases and the relays 610 and 619 release. The release of relay 619 at contact 652 reconnects ground to lead 653 and then to lead 736 previously traced to winding and back contact of relay 1011, thereby operating start relay 1013 and connecting the operator in the same manner as previously described. The op-

eration of relay 1012 in this case at its top contacts closes an interrupted ground circuit for flashing the associated cord lamp CN. The operation of relay 1001 at the same time, connects the talking circuit of the incoming toll line to the operator's telephone set, and causes three spurts of tone to be sent back to the operator in office No. 1 informing her that a talking circuit is established to the operator in office No. 2 and that she may request whatever action she wishes said operator to take.

When the subscribers on a connection like that described above hang up their receivers, the operator at office No. 1 will be informed of this fact by the lighting of supervisory lamps 506 and 514. The operator upon withdrawing plug 504 from jack 505 thereby causes toll line 509 to send out a disconnect signal of 1400–35 cycles. This signal passing over toll line 513 enters receiver circuit 606 of the toll line in office No. 2, thereby causing ground to be connected over lead 609 to the winding of relay 700 which operates to battery on lead 743, placed there through the bottom contact on relay 612. Relay 700 at its bottom inner contact connects a shunting ground to winding of slow release relay 701 which, after a time interval of approximately 0.4 second, causes relay 701 to release and operate relay 702 to battery through its lower winding. The operation of relay 702 registers the receipt of this signal in office No. 2 and remains operated until the disconnect signal ceases. Relay 702 registers by virtue of removing ground, at contact 716, from lead 723 which held relay 714 operated during the connection. The release of relay 714 at its bottom outer contact then removes ground from lead 734 which causes the attached call distributing cross-bar switches to disconnect in a manner that is obvious, said switches in turn releasing relay 705. The release of relay 714 at contact 727 likewise opens a ground which has been holding relay 708 operated. Relay 708, and in turn 707, therefore release and permit the timing switch 731 to restore to normal. Meanwhile the operation of relay 702 at its bottom inner contact has closed the circuit of relay 703 for the purpose of sending back an acknowledgment signal to the toll line in office No. 1. The operating path for relay 703 may be traced from ground at bottom outer contact relay 700, bottom inner contact relay 702, thence through winding relay 703 and over lead 634 to battery at bottom inner armature of relay 623. Relay 703 at its top contacts 717, connects the acknowledgment signal of 1000–15 cycles to leads 718 so that upon the operation of relay 630 this signal will be sent back to office No. 1. Relay 630 is operated at the same time by ground connected to lead 644 at bottom inner contact relay 703. The acknowledgment signal upon its receipt at office No. 1 terminates the disconnect signal in the usual way thereby causing relay 700 in office No. 2 to release. Relay 701 then reoperates and causes relay 702 to release, thus restoring the toll line circuits in both offices to normal. During the time said circuits were being restored to normal, relay 702 at its bottom outer contact maintained battery on lead 724, thereby preventing idle line indicator circuit 605 from indicating a trunk line idle condition on calls to office No. 1.

The release at office No. 2 of the toll line and call distributing switches just described, causes relay 1006 of the plug circuit to release due to secondary switch 906 at contact 911 opening ground to lead 912 and then to 927 that is holding relay 1006 operated. The latter relay releases and at its bottom inner contact connects ground to bottom outer armature of operated relay 1007. Said ground is traced further over lead 1061, through armature 1062 on switch 1027, thence to battery through lower winding relay 1008 which at its bottom inner contact locks through a resistance to ground. Disconnect lamp 1057 therefore lights, due to battery connected through bottom outer contact relay 1008 to arm 1059 on switch 1027, traced further over lead 1058 and through lamp 1057 to ground. Operation of relay 1008 also opens the sleeve conductor 1043 which allows the release of the connected jack circuit 2101 which allows said circuit to be used again even though plug 1024 is still connected to it. When the operator in office No. 2 pulls down plug 1024, opening of the ring conductor 1042 increases the potential across the control electrodes of the cold cathode discharge tube 1053 causing it to break down. Said breakdown circuit is traced through upper winding 1008, control electrodes 1073, 1081, high resistance 1082, contact 1071 on relay 1008 to high potential battery, connected through ballast lamp 1072. The breakdown of the tube at gap 1073–1081 causes gap 1070–1073 to break down and thereby set up a flow of current in the top differential winding relay 1008 which causes said relay to release and at its bottom outer contact open the circuit for disconnect lamp 1057 previously traced. This restores the plug circuit to normal.

Connection between a straightforward toll line with voice-frequency signaling and busy back, reorder and overflow circuits

These types of connections result from some difficulty on the part of the operator at office No. 2 in completing a call such as that previously described. They all involve transmitting some sort of flashing signal back to the originating operator at office No. 1, to inform her of the nature of said difficulty. Two features are of interest in these connections. First, there will be described the way in which these circuits react on the test relays of the discriminating circuit when the operator first plugs into a busy back, reorder or overflow circuit. Second, the manner in which the flashing signals are received at office No. 2 is of interest and will further be described under connections between ring-down toll lines and straightforward toll lines with voice-frequency signaling.

Inasmuch as transmitting any flashing signal requires setting up the same safeguards presently to be explained, it will be obvious that said safeguards may be caused to be set up from the discriminating circuit, by making the flashing circuit always give the same indication to the discriminating circuit. This they all do when plugged into, by presenting an open tip conductor and a high resistance grounded ring conductor. For the purposes of this description it will, therefore, be sufficient to describe but one of said circuits such as the busy back circuit shown in Fig. 21. In this case reference may be had to the preceding description of a connection between a straightforward toll line arranged for voice-frequency signaling and a key pulsing trunk circuit. Said descriptions may be followed in detail up to the point where the operator at office No. 2 is about to insert plug 1024 in key pulsing trunk jack 2101. Continuing from this point, when the operator finds all the key puls-

ing trunks busy, plug 1024 will be inserted in jack 2114 of Fig. 21 in order to inform the operator in office No. 1 of this fact. This action completes a sleeve circuit which includes relays 2116 of the busy back trunk and relays 1009 and 1010 of the plug circuit, traced from ground through lower high resistance winding sleeve relay 2116, leads 2115 and 1043, thence through windings relays 1009 and 1010 as previously traced. Relay 2116 operating in this circuit connects grounded interrupter 2118 to winding relay 2117, thereby causing the latter to operate and release in accordance with ground from interrupter 2118. Relay 2117 thus opens and closes ground through the upper low resistance winding relay 2116 to sleeve lead 2115, which causes relay 1009 to follow the operation and release of relay 2117. Meanwhile relay 1010 remains operated and connects the plug circuit to the discriminating circuit in the same manner as heretofore described. Said description showed how the discriminating circuit attached the operator's key-set due to the operation of test relays 1226 and 1331. In the case of the busy back trunk of Fig. 21 the discriminating circuit finds the same test conditions as it did for the key pulsing trunk of Fig. 21A except that a very high resistance 2119 is connected in what was direct ground to the ring. The effect of this resistance, therefore, is to prevent the operation of test relays 1226 and 1331 and in turn their associated relays 1227 and 1332, thereby preventing relay 1237 from operating and connecting the key-set to the plug. This safeguard renders the key-set inoperative on connections of this kind. Also, instead of waiting for the key-set to connect ground to lead 1270 thereby operating relay 1225 and in turn relays 1214 and 1215, the fact that relays 1227 and 1332 remain normal causes relays 1214 and 1215 to operate without operating relay 1225. This path is traced from ground at top inner contact on operated relay 1224, over lead 1349, top outer normal contact relay 1306, thence over lead 1257, top outer armature and contact on relays 1227 and 1332, to lead 1256, thence through contact 1255 on relay 1211, contact 1271 on relay 1210, and contact 1352 on relay 1312, to lead 1248 which connects to battery through winding of relay 1214. Since relay 1225 does not operate, relay 1002 in the plug circuit likewise does not operate, thus a safeguard is provided of maintaining the termination 1066 on the incoming toll line as long as flashing signals continue to be sent to the operator in office No. 1. Otherwise, the description remains the same as previously given for the discriminating circuit and its release from the plug circuit. The operator having thus inserted plug 1024 in jack 2114, depresses her telephone release key 1124 thereby cutting off the operator's control circuit of Fig. 11 from the plug circuit of Fig. 10 as previously described. Meanwhile, interrupter 2118 continues to operate relay 2117 intermittently and send flashing signals back to the operator in office No. 1 by connecting ground intermittently through the upper low resistance winding relay 2116, thereby raising and lowering the resistance of sleeve lead 2115 and causing the flashing signals to be sent in the same manner as previously described for the key pulsing trunk connection.

The operator in office No. 1 then withdraws plug 504 from the outgoing toll line jack 505 and later on, again attempts to complete the connection. In the case of an overflow or reorder circuit the distant operator in office No. 2 would have plugged into said circuit due, for example, to the lack of an idle toll line. The operator in office No. 1 thus would receive a slow flashing signal informing her to wait until the flashing signal changes to a rapid flashing signal, indicating another line to be available. Then she would rering the operator in office No. 2 and request the connection be completed.

Connection between two straightforward, voice-frequency signaling toll lines

The description previously has shown how a call originating in toll office No. 1 is extended over a straightforward toll line to toll office No. 2, and is automatically connected to an idle plug in front of an idle operator. Likewise it has shown how said operator receives the wanted subscriber's number from the originating operator.

Let it now be assumed that the wanted subscriber's number requires the connection be extended through a third toll office and that only straightforward toll lines with voice-frequency signaling are available, such, for example, as shown in Figs. 14 and 15. The operator in toll office No. 2 thereupon takes up cord plug 1024 associated with flashing (CN) lamp and plugs it into the first line jack that is idle, indicated by a lighted lamp. The plug 1024 placed in jack 1401 extends the talking conductors 1041 and 1042 through the jack and operated contacts of relay 1403 to conductors 1426 and 1427, said relay 1403 being operated by ground at top front contact relay 1402. Relay 1402, however, will not operate if the operator has plugged in over the usual busy test described previously in connection with the operation of busy test relay 715. Under these circumstances busy test relay 1509 would be operated and at its break contacts would prevent sleeve relays such as 1402 and in turn 1403 from operating, thereby preventing any interference with existing calls. On the assumption that the circuit is idle, relay 1402 of the line and relays 1009 and 1010 of the plug circuit operate in series over the sleeve of said jack, traced from ground through lower high resistance winding sleeve relay 1402, leads 1428 and 1429, right outer contact and armature relay 1509, lead 1430, through contact 1431 on relay 1403, thence over jack sleeve 1432 and plug sleeve 1043, contact 1044 on relay 1008, lead 1045, winding marginal sleeve relay 1009 in series with winding sensitive sleeve relay 1010 to battery. Relay 1402 operating in this circuit operates relay 1403. Relay 1403 at contact 1433 then directly connects lead 1428 with sleeve lead 1432, thus enabling relay 1509 to later operate without opening the sleeve circuit previously traced. Relay 1403 at its bottom set of contacts removes ground from low resistance upper winding relay 1402 and extends said winding over leads 1434 and 1436 and through contacts on relays 1504 and 1507 in series to ground, for the purpose of enabling the toll line to pass supervisory signals to the plug circuit on those calls that originate in office No. 2. Where the call is a through call, as it is in this case, the low resistance top winding relay 1402 continues to remain in circuit to the sleeve lead 1432 as long as the connection remains up. Relay 1402 at its bottom contact operates relay 1411 whose function is to make this line busy to other operators and to prepare it for sending a connect signal to distant toll office No. 3 and for receiving an acknowledgment thereof as will presently be described.

On the through call at office No. 2 now being described, where two toll lines with voice frequency signaling are interconnected, it is necessary that the circuit of both the incoming and selected toll lines be changed in order to permit voice-frequency supervisory signals to pass through office No. 2 without the operator receiving on-hook, off-hook or rering signals. To set up the required changes it is necessary that relay 713 of the incoming line and relay 1414 of the outgoing toll line be in an operated condition. Thus there will now be described the manner in which the discriminating circuit of Figs. 12 and 13 associated with the operator's position in office No. 2, identifies the two voice-frequency toll lines and how it causes relays 713 and 1414 mentioned above to operate.

Reference may be had to the previous description; for the manner in which the discriminating circuit attaches itself to the plug circuit of Fig. 10; how it insures the closure of the tip and ring conductors through plug 1024 and jack 1401; and how the identifying means in the discriminating circuit is prepared for identifying the the selected toll line. In the case now under discussion of the toll line of Fig. 14 with voice-frequency signaling said toll line supplies a medium resistance ground on the tip, traced from tip conductor 1426 through upper winding impedance coil 1405, top inner armature relay 1421, and back contact through winding relay 1420 to lead 1459, thence to lead 1458 and to ground through relay 1435. Said toll line supplies a higher resistance ground on the ring, traced from ring conductor 1427 through lower winding impedance coil 1405, varistors 1406, lower winding relay 1414, thence to lead 1458 and to ground through relay 1435. The varistors in this circuit under the influence of positive battery of the ground test described above offer a high resistance to the passage of current. As a result of the ground test applied by the operation of relay 1221, relays 1326 and 1219, on the tip side operate, while on the ring side neither relays 1331 nor 1226 operate. Relay 1326 connects ground through winding relay 1312 to battery on lead 1345 and relay 1219 connects ground through winding relay 1210 to battery on lead 1345. Said relays 1312 and 1210 at their bottom contacts lock themselves to ground and thereby register the identity of the selected toll line circuit. This combination of operated relays 1312 and 1210 permits relay 1200 to operate when relay 1224 operates. The operating circuit for relay 1200 may be traced from battery through relay 1200, contact 1254 on operated relay 1210, back contact 1255 on relay 1211, lead 1256, top outer contact and armature relay 1332, lead 1348, top outer contact and armature relay 1227, lead 1257, top outer armature and contact relay 1306, lead 1349, to ground at top inner contact relay 1224. Thus when relay 1224 operates, relay 1200 will serve to identify the selected toll line to the discriminating circuit as will presently be described.

The discriminating circuit, when first seized, received an indication from the incoming toll line that it was a straightforward line equipped for voice-frequency signaling by virtue of relay 1232 being operated. Said relay operates in a path traced from ground through resistance 1230, winding relay 1232, back contact and armature relay 1233, leads 1258 and 1147, contact and armature on switch 1027, bottom front contact and armature relay 1003, armature 1028 and contact on switch 1027, lead 1052 and lead 1053 at terminal block 907, contact 923 on cross-bar switch 906, lead 924, contact 925 on cross-bar switch line 905, lead 926, upper winding and top inner contact relay 713, to 24-volt battery in series with lower winding relay 713. The latter relay does not operate at this time due to its marginal characteristics and to the shunting effect of 24 volts through resistance 1231 to the winding of relay 1232 in the above circuit. Relay 1232, however, operates in turn operating relay 1228 to battery on lead 1337 placed there by top outer contact on operated relay 1326. Relay 1228 at its top contact provides a locking ground for itself and at its bottom contact prepares a 48-volt circuit through resistance 1229 for connecting to the selected toll lines when relay 1224 operates as will presently be described.

The identity of the incoming and the selected toll line circuits having thus been shown, there will now be described; the manner in which 48-volt battery is caused to be connected through resistance 1234 for operating relay 713 in the incoming toll line circuit of Figs. 6 and 7 in order to make its supervisory features function with the selected toll line of Fig. 14; also the manner in which 48-volt battery is caused to be connected through resistance 1229 to the ring conductor for operating relay 1414 in the selected toll line circuit of Fig. 14 and thus make its supervisory features function with the incoming toll line circuit to which it is about to be connected. Upon release of relay 1310 previously described, a path is closed for operating the cut-off relay 1224. Relay 1224 besides opening at its outside contacts the main leads to the primary test relays of the discriminating circuit, connects ground to lead 1349 for completing the circuit of relay 1200. The operation of relay 1200 at its top outer contact connects ground to winding relay 1233, which in turn operates to disconnect the winding of relay 1232 and connect 48-volts through resistance 1234 to lead 1258, which as previously traced, connects with windings of unoperated relay 713 to 24-volt battery. Relay 713 now operates in this circuit and ground on its top inner armature locks said relay, for the remainder of the connection, through its upper winding to the 48-volt battery just traced for its operating path. When the discriminating circuit is dismissed, however, 24-volt battery at the top outer contact relay 1002 in the plug circuit replaces said 48-volt battery for holding purposes. Relay 713 at its bottom contact connects ground to lead 742, thereafter maintaining ground on lead 736 to lock out the operator at office 2 by preventing release of relay 1011 in the plug circuit. At its top contact relay 713 connects 48-volt battery to lead 743 for relaying rering signals as will later be described. In this manner the supervisory features of the incoming toll line, through its relay 713 are made to function with the connected toll line of Fig. 14.

Relay 1200 connects a 48-volt circuit traced through resistance 1229, contact relay 1228 to lead 1253, bottom contact relay 1200, and bottom outer back contact relay 1225, to ring lead 1243. Said ring lead to the selected toll line may be further traced over lead 1050 and contact on relay 1003 to ring conductor 1042, thence through the plug 1024 and jack 1401 and bottom inner contact relay 1403, conductor 1427, lower winding of impedance coil 1405, varistors 1406, lower winding relay 1414, lead 1458 to ground through winding relay 1435. Relay 1414 thereupon operates and through its upper winding locks to

ground at contacts 1460 on operated relay 1411. Relay 1414 at its bottom contact removes battery from lead 1462 and thereby disables relays 1424 and 1507. Thus on-hook signals of 1000-25 cycles and offhook signals of 1000-35 cycles that will later be sent out by the toll line in office No. 3 are prevented from having any effect at toll office No. 2. In this manner the supervisory features of the selected toll line through its relay 1414 are made to function with the incoming toll line of Figs. 6 and 7. The operation of relay 1200 at its top inner contact also connects ground to lead 1260 which shunts out the winding of slow-release relay 1315 in series with battery through resistance 1313 previously traced. When relay 1315 releases it connects ground that is on lead 1342 to lead 1350 which is connected through winding relay 1225 to battery.

Preparation is made for connecting the incoming toll line transmission circuit direct with the selected toll line by the operation of relay 1002 over a path traced from battery through its winding to lead 1054, thence through a contact on relay 1003 to lead 1055, top contact and sleeve of jack 1218, lead 1261 to ground at bottom inner contact on previously operated relay 1225. Relay 1002 then locks to ground at top inner contact relay 1004 which is held operated under control of the plug sleeve 1043. The discriminating circuit is then released from the plug circuit due to the operation of relay 1215 and release of relay 1003, as previously described for the connection between a voice-frequency toll line and key pulsing trunk circuit. The operator at office No. 2 having extended the call to the toll line of Figs. 14 and 15 leading to office No. 3 has no further need for remaining on the connection. She, therefore, operates and releases her telephone release key 1124, thus making her available to answer other incoming calls. With reference to the manner in which the operator's control circuit of Fig. 11 is thereby released and the incoming toll line connected with the outgoing toll line, the same will be found to have been previously described for connecting a voice-frequency toll line and key pulsing trunk.

Referring now to that part of the above description where the operator at toll office No. 2 has plugged into jack 1401 and caused relay 1411 to operate, there will now be described the sending of a connect signal to the distant toll office No. 3 which occurs simultaneous with connection to the discriminating circuit previously described. Relay 1411 at its top outer contact removes battery from high resistance 1410 that normally holds pad control relay 1435 operated, thus operating relay 1474 and thereby removing the pad circuit, indicated at 1437, from the toll line. Relay 1411 at its top inner contact first connects battery to winding relay 1417 to ground and second connects battery to winding relay 1412 traced further over lead 1438 to ground at top outside contact relay 1513. Relays 1417 and 1412 accordingly operate and perform the following functions. Relay 1417 at its top inner contact locks through resistance 1418 to battery and at its top outer contact connects battery to lead 1439 for operating idle line indicating circuit 1404 and for operating busy test relay 1509 which at its right inner contact connects a busy potential, created by resistances 1508, to other jack sleeves such as 1440 that are associated with the toll line of Fig. 14, said busy potential being connected over lead 1525. Relay 1417 at contact 1441 closes battery to lead 1442 connected with the voice frequency signaling equipment indicated at 1425 for the purpose of setting it to receive incoming signals of 1000 cycle carrier frequency instead of the normal 1400 cycle frequency. Relay 1417 at its bottom outer contact opens termination 1500 from across conductors 1443 and 1444 which connects with talking conductors 1426 and 1427 respectively. Relay 1417 at contacts 1445 and 1446 removes battery from relays 1503 and 1510 respectively, since these relays function only on calls incoming to this circuit. The operation of relay 1412 at its two top outer contacts closes 1400–25 cycles signal to leads 1447 and 1448 connected to front contacts of relay 1408 ready to send a connect signal to toll office No. 3. At its bottom outer contact relay 1412 closes ground to lead 1450 for operating relay 1408 which thereupon connects the 1400–25 cycle connect signal from leads 1447 and 1448 to toll line conductors 1451 and 1452 respectively. This signal passing through the directional selection circuit 1409, which prevents this frequency from being made effective in the voice frequency receiving circuit 1425, is carried over toll line 2000 to the terminating equipment at toll office No. 3 indicated at 2001. The receiving portion of this equipment is indicated at 2002 and the sending portion at 2003, said equipment being in all respects the same as shown in detail in Figs. 6 and 7. As described for the latter figures, the receipt of a connect signal causes a plug circuit indicated at 2004 to be attached to the toll line circuit 2001 through the call distributing primary and secondary cross-bar switches 2005 and 2006 respectively; lights the connect lamp associated with said plug circuit in front of the operator at toll office 3; and causes an acknowledgement signal of 1000–15 cycle to be returned over the toll line 2000 to the toll line circuit of Fig. 14. Said acknowledgment signal due to hybrid coil 1409 is shunted off over leads 1453 and 1454 into receiving circuit 1425 where it results in a ground being connected to lead 1455, thereby preparing a means of stopping the timing switch 1515. This switch, it will be recalled, was started when the circuit was first plugged into by virtue of the operation of relay 1512 traced from ground at bottom inner contact relay 1411, lead 1456, break contact on relay 1420, lead 1457, thence through upper winding relay 1512, to battery at top contact on off-normal springs 1516. Relay 1512 having thus previously operated when the plug was placed in jack 1401 circuits were thereby closed at contacts 1521 and 1522 for stepping switch 1515 by time interrupter 1520 and under control of relay 1513. Ground on lead 1455 previously described therefore stops this switch from further rotation due to switch arm 1528 extending said ground to winding relay 1513, thence to battery at top inner contact on relay 1512, thereby operating relay 1513 and at its bottom break contacts opening the circuit for stepping magnet 1518. Relay 1513 at contact 1523 locks itself to ground and at contact 1524 removes ground from lead 1438 thereby releasing relay 1412. The latter relay in turn releases relay 1408 thus stopping the connect signal being sent to toll office No. 3. The stoppage of the connect signal at the latter office thereupon stops sending the acknowledgment signal and leaves the toll line in a talking condition awaiting the passing of the wanted subscriber number by the first toll operator to the operator in office No. 3 after the first operator

has heard the three spurts of tone from the operator's control circuit at office No. 3.

It is now assumed that the operator in toll office No. 3 has received the wanted subscriber's number from the originating toll operator of office No. 1 and that she proceeds to complete the connection in the usual manner. Accordingly plug 2007 may be assumed to be placed in jack 2008 representing the usual toll switching trunk connected through a B operator's switchboard 2009, over subscriber's line 2010 with the called subscriber station 2011. The toll switching trunk sends out ringing current for ringing the called subscriber in the usual well-known manner, and, when subscriber 2011 answers by removing the receiver from the switchhook, a tripping relay in the circuit operates to remove the ringing current and permit 48-volt talking battery to be connected to the subscriber. A supervisory relay in this 48-volt battery supply registers this condition by operating, thereby lowering the resistance of the sleeve of jack 2008 to ground. This in turn causes a marginal sleeve relay in the plug circuit 2004 to operate, corresponding to relay 1009 in the plug circuit of Fig. 10. Said relay operates relay similar to relay 1005 of the plug circuit, which in turn causes ground to be connected over the equivalent of lead 921 through the secondary switches 2006 and primary switches 2005 to the winding of equivalent relay 704 of Fig. 7 in the incoming toll line circuit 2001. The equivalent relay 704 operating after the manner described for Figs. 6 and 7, causes a voice-frequency off-hook signal of 1000–35 cycles to be sent back over toll line 2000, through outgoing line conductors 1451 and 1452 of Fig. 14 at toll office No. 2, thence over plug conductors 1041 and 1042, primary secondary switch conductors 931 and 932, incoming toll line conductors 654 and 655 of Fig. 6 and toll line 513, to the outgoing toll line circuit 509 in toll office No. 1. The effect of this 1000–35 cycle signal in toll office No. 1 is to open the low resistance ground path in the sleeve 508 of outgoing toll line jack 505 and thereby cause the cord lamp 506 to be extinguished and the operator in office No. 1 to be informed that the called subscriber in distant office No. 3 has answered. The outgoing toll line 509 in accordance with the usual method of operating, returns an acknowledgment signal of 1400–15 cycles to the line which passes back over toll line 513 and through the plug circuit of Fig. 10 and toll line circuit of Fig. 14, toll line 2000 and toll line circuit 2001 in toll office No. 3. The receipt of this acknowledgment signal at toll office No. 3 results in opening the circuit for the receiver-off-hook signal. The discontinuance of the receiver-off-hook signal at toll office No. 1 then opens the circuit of the acknowledgment signal and the connection is ready for conversation.

If the called subscriber 2011 on the connection above described flashes his switchhook for the purpose of calling in the operator, then toll line circuit 2001 will follow said flashing and transmit on-hook and off-hook signals of 1000–25 and 1000–35 cycles respectively back over said toll line as previously described for a terminating connection at toll office No. 2. These signals then pass through toll office No. 2 without affecting it, are registered in toll office No. 1, and appear as a flashing lamp 506 in the originating toll operator's position.

If the operator at office No. 1 wishes to call the terminating operator at office No. 3 back on the connection, she will operate her rering key, thereby causing toll line circuit 509 to send out a rering signal of 1400–25 cycles on the toll line 513. This signal likewise will pass on through office No. 2 and will be received at office No. 3 where it automatically causes the operator to be connected to the plug circuit 2004 and the associated CN lamp to flash as previously described for a rering signal in the connection between a voice-frequency toll line and key pulsing trunk circuit. It may be noted that said signal at office No. 2 also causes relay 619 to operate, relay 617 to release, and relay 619 to operate, thereby connecting 48-volt battery at top outer contact relay 713 to lead 743, traced further through top inner contact relay 619 to lead 648, outer winding impedance coil 629 to tip conductor of the toll line, thence on this conductor to the toll line circuit of Fig. 14. This 48-volt battery circuit is further traced through upper winding impedance coil 1405, lead 1463, contact 1475 on relay 1421, winding relay 1420, leads 1459 and 1458 to ground through winding relay 1435. Relay 1420 operates in this circuit and opens contact 1465 which would on other types of connection release relay 1512 and cause relay 1408 to operate and send the rering signal on out over toll line 2000. This would interrupt the rering signal that is already on the line, therefore the top outer contact on operated relay 1414, by means of leads 1466 and 1467, is connected in parallel with contact 1465 on operated relay 1420, thereby preventing any interference with the through rering signal.

On through connections between two toll lines as above described, supervision in the form of voice-frequency signals is thus always passed through office No. 2. Upon disconnecting, however, the operator at office No. 1, pulling down plug 504, causes toll line 509 to send a disconnect signal of 1400–35 cycles out over toll line 513 as previously described. This signal may be registered at each office by the receiving circuit associated with the incoming toll line at each of said offices, thus simultaneously breaking down the connection between each of said offices involved in the connection. It is unlikely, however, that the delay period, represented by slow relay 701, for registering this signal will be exactly the same in all offices, so that each incoming toll line may be caused to disconnect in almost any order. In any event the incoming toll line in office No. 2 will be sure to release, even if its delay interval is longer than the interval in office No. 3, due to the timing switch in toll line circuit 509 refusing to accept the acknowledgment signal for approximately one second. Thus sufficient time is allowed, before cutting off the disconnect signal, for operating even the slowest receiving circuit time interval relay.

Connection between a ring-down toll line and a key pulsing trunk

On the assumption that the toll operator in office No. 1 has answered a request from calling subscriber 500 for a telephone connection with called subscriber 2100, and that said connection is to be completed over the toll line 520 with ring-down signaling indicated in Fig. 5, there will now be described the manner in which said connection is completed.

In setting up this connection, the operator first inserts cord plug 504 in an idle outgoing toll line jack 521. Said toll line may be of any desired type such, for example, as shown in Fig. 16, wherein the ringing signal consists of 20 cycle

ringing current superimposed on a voice-frequency current of 1000 cycles, and by suitable means is connected to the line for a minimum period of approximately two seconds. The resistance of the sleeve 522 normally is high and remains so as long as a ringing signal is not received from the called end. Thus cord lamp 506 remains extinguished until a ringing signal is received, indicating either that the called subscriber has hung up or that a distant operator wishes to speak with the operator in office No. 1. The operator, in order to call office No. 2, throws a ringing key (not shown) in the toll position cord, which causes a relay in toll line 520 to operate and send a ringing signal of 1000–20 cycles for a minimum period of approximately two seconds. This signal passes through transmission pad circuits 523 and 800 on toll line 524, which are the same as pad circuits 512 and 600 previously referred to on toll line 513. Said ringing signal is received on talking conductors 801 and 802 and passes thence through the directional selection circuit 803 to receiving circuit 805, where it results in a ground being connected to lead 831 in a manner well understood in the art. Ground on lead 831 is traced through lower winding relay 827 to battery. The latter relay operates and, at its top inner contact, closes a locking circuit for itself traced from ground through its top inner contact and top winding, top outer contact relay 829 to battery at contact 832 on relay 816. Relay 827 then closes the following circuits which cause the trunk leads indicated at 750 to be extended through the primary and secondary cross-bar call distributing switches, said circuits include; a ground path for operating primary switch traced from bottom outer contact relay 816, bottom inner contact relay 827, bottom outer contact relay 829, thence over lead 833 to battery through holding magnet 941 of primary switches assigned to ring-down toll lines; and a battery path through winding relay 829 for operating start leads to said switches after they have extended the call to the plug circuit of Fig. 10, traced through top outer contact relay 827, contact 834 on relay 816, then over lead 835 to ground in associated plug circuit of Fig. 10. Relay 827 at its bottom outer contact removes ground from lead 836 which prevents the operator from being connected to the associated plug circuit until the relay 827 has been released as will presently be described. Relay 827 at contact 837 also connects battery to lead 838 connected to idle indicating circuit shown at 810 for preventing said circuit from indicating an idle trunk condition to operators who might try to originate calls to office No. 1 over this same toll line.

The cross-bar distributing switches illustrated in Fig. 9 are arranged to distribute different kinds of toll lines to the plug circuits at the operators' positions. For example, straightforward toll lines are distributed through these switches to plugs which serve these lines. Similarly ring-down lines are distributed through these switches to other plugs which serve ring-down lines. Although a plug circuit may be converted by certain wiring changes, such as illustrated in Fig. 10, at any given time a plug circuit serves only to receive calls from a particular class of toll lines. To simplify the drawing as much as possible a single plug circuit (Fig. 10) has been disclosed. In the preceding description it was assumed that this plug circuit is wired to serve calls incoming from straightforward toll lines. In this case it will be remembered the incoming straightforward toll line 513 was extended through the cross-connecting frame 900, primary selector switch, secondary selector switch, thence through the cross-connecting frame 907 over the leads 1000 to the plug circuit shown in Fig. 10. For converting the plug circuit of Fig. 10 from a circuit suitable for serving voice-frequency lines to a circuit suitable for serving ring-down lines a conversion switch 1027 is provided. When the plug circuit is serving voice-frequency lines, as it was in the foregoing description switch 1027 occupies the position shown in the drawing. To convert the plug circuit for use with ring-down lines it is only necessary to shift the switch 1027 to its ordinate position. Although various arrangements of the primary and secondary switches are possible in the condensed illustration given in Fig. 9 it is assumed that voice-frequency lines appear in the upper set of primary switches and are extended thereover, and by way of the secondary switches in the upper part of the drawing to plug circuits serving voice-frequency lines. It is also assumed that the ring-down lines are connected similarly through the primary and secondary switches shown in the lower part of the drawing to plug circuits allotted to ring-down lines. For the purpose of the call now being considered, namely, a call over a ring-down toll line 524 it is assumed that the switch 1027 is moved to its alternate position to convert the plug circuit of Fig. 10 for use with ring-down lines and that the group of conductors 1000 individual to this plug circuit are connected across the sides of the distributing frame 948 and are disconnected at the distributing frame 907.

When the ringing signal ceases to be received, ground will be removed from lead 831 connected to lower winding relay 827. Under normal conditions the locking path through upper winding relay 827 will also have previously been opened at top outer contact relay 829, due to the operation of the latter relay resulting from the operation of the primary and secondary switches causing a plug circuit to be connected. Relay 827, therefore, releases and at its bottom outer contact connects ground to lead 836 for connecting the operator to the associated plug circuit. Ground on lead 836 may further be traced through terminal block 940 on primary switch frame, contact 942 on primary switch 943 to lead 944, thence through contact 945 of secondary switch contact set 946 through terminal block 948, thence over lead 930 to winding and back contact 1011 of the associated plug circuit. Said ground is further traced through the bottom inner contact relay 1011, lead 1016, through start relay 1013 and its back contact 1017, thence over lead 1018 to battery at back contact relay 1104. Start relay 1013 operates in the above circuit, thereby closing a circuit for operating relays 1001 and 1012, which as previously described connect the plug circuit with the operator's telephone and control circuit of Fig. 11. Relay 1006 operates the same as it does on voice-frequency toll lines, in a path traced from ground at contact 949 on secondary switch 946, to lead 950, thence over lead 927 to battery through winding relay 1006. Relay 1006 lights connect lamp CN, informing the operator of the plug on which the incoming call is connected, and otherwise performs the functions described in previous calls. The operation of the relay 1001 extends the incoming plug circuit conductors 1037 and 1038, to which the toll line conductors 839 and 840 are connected, to the operator's telephone set over conductors 1143 and 1144. The operation of relay 1012 at its top con-

tacts changes lamp CN from a steady to a flashing lamp signal and at contact 1033 connects ground through contact 1034 on relay 1011 to armature 1035 on switch 1027, further traced over lead 1074, contact 1154 on operated relay 1101, lead 1155, thence through top normal contact relay 1119 and winding relay 1129 to battery at tone removal key 1123. Relay 1129 functions in this circuit to prevent the three spurts of tone being sent back to office No. 1 by opening the transmission circuit at its top and bottom outer contacts and by opening circuit at contact 1142 leading to the tone interrupter relays 1115 to 1118. Said relay 1129 further functions at its bottom inner contact to close the circuit for relay 1130 which thereupon operates, and, at its bottom inner contact, connects ground through top inner contact relay 1129 and winding relay 1119 to battery. The operation of the latter relay at its top contact then locks to lead 1155 and permits relays 1129 and 1130 to release, thus connecting the incoming toll line talking conductors 1143 and 1144, which are extended through inner contacts on operated relay 1127, to the operator's telephone set in the lower right corner of Fig. 11.

The operator at office No. 2, having now received a flashing lamp CN associated with plug 1024, knows that the call is coming in over a ring-down type of toll line due to hearing a single spurt of tone through condensers 1139 and 1140 at the time relay 1130 was operated. She, therefore, challenges the operator at office No. 1 who then passes the number of the wanted subscriber. Let it be assumed that this number required the call be completed by the operator in office No. 2 over the key pulsing trunk such as shown in Fig. 21A. The insertion of plug 1024 in jack 2101 then closes a previously traced sleeve circuit through the windings of relays 1009, 1010 and 2107, which operates relay 1003, for attaching the discriminating circuit of Figs. 12 and 13 to the plug circuit and operator's control circuit. The manner in which the key pulsing circuit is identified by the discriminating circuit and the manner in which the resulting connection of the key-set enables the operator to set up the connection over switches 2103 to the called subscriber 2100 also has previously been described. It may be noted in passing that relay 1003 at its bottom outer contact closes a circuit for operating relay 1307 in the discriminating circuit, which relay, however, is without effect on this particular connection. The toll operator, having finished keying the subscriber's number, releases the control circuit of Fig. 11 from the plug circuit of Fig. 10 by operating the telephone release key 1124, likewise previously described, for connections between toll lines with voice-frequency signaling and said key pulsing trunk. In said description, a path was traced through the top outer contact on relay 1011 for passing supervisory signals from the key pulsing trunk to the toll line of Figs. 6 and 7. Said path in this case remains open at arm 1039 on switch 1027 and another path is closed at arm 1075 on said switch which prepares a circuit for the lighting of lamp 1057 whenever the called subscriber's receiver is on hook. The circuit from ground through lamp 1057 is traced over lead 1058, arm 1075 on switch 1027, thence over lead 1076 to battery at top contact on relay 1005. Since relay 1005 operates directly from ground through a contact on marginal sleeve relay 1009, it will be obvious that lamp 1057 therefore lights whenever the resistance of the sleeve lead 2108 of the key pulsing jack is of low resistance and will be extinguished when the said sleeve is of high resistance. As previously described, whenever the subscriber's receiver is on hook, relay 2110 does not operate thereby making sleeve lead 2108 low in resistance, and whenever the receiver is off hook, relay 2110 being operated thereby removes ground from upper winding relay 2107, making sleeve lead 2103 high in resistance.

Key pulsing trunk 2102 continues to function and ring the called subscriber in the usual manner. When the called subscriber 2100 answers, removal of the receiver causes ringing current to be disconnected and relay 2110 to operate, thereby removing ground from the upper low-resistance winding sleeve relay 2107 and leaving sleeve lead 2108 connected through high-resistance lower winding relay 2107. It thus will be observed that the operation and release of the subscriber's switchhook acts to control lamp 1057 in front of the operator in office No. 2, rather than lamp 506 in front of the operator in office No. 1, as it did in the case of the voice-frequency toll line previously described. This is due to the incoming toll line being ring-down in character which does not have facilities for passing switchhook supervision.

If after conversation the called subscriber 2100 flashes his switchhook, lamp 1057 will follow said switchhook and indicate to the operator in office No. 2 that the called party wishes again to speak with the operator. In this case, the operator depresses key 1060 associated with lamp 1057 and plug 1024, to listen in on the connection. The operation of key 1060 connects ground to bottom outer armature of operated relay 1006 traced further through upper winding relay 1012, over lead 1152, left inner contact and armature on operated relay 1101, thence through winding relay 1111 to battery through back contact relay 1113 and bottom break contact relay 1109. Relays 1012 and 1111 operate in the circuit just traced and automatically bring the operator in on the connection so that she may take whatever action is required.

If the operator in office No. 2 finds it necessary to bring in the operator in office No. 1, she does so by operating her key 1131 which at contact 1156 connects battery through resistance 1157 to conductor 1143 previously traced to toll line conductor 839, thence traced through upper winding impedance coil 809, upper winding relay 815, to ground through winding of transmission pad relay 804. Relay 815 operates in said circuit and at its top outer contact connects battery through winding relay 806 for sending a ringing signal back to office No. 1. Relay 815 at its top inner contact locks itself from ground to battery through resistance 841, thereby insuring that relay 806 continues sending the ringing signal at least until arm 822 of the timing switch contacts with terminal 5. If the operator has released key 1131 by this time, then relay 815 will release due to the ground on the armature 822 shunting out the locking winding of relay 815, thus sending the ringing signal for a minimum period of approximately two seconds. Release of relay 815 at its bottom contacts opens the operating circuit for said timing switch which in turn is restored to normal by ground from the top inner armature of relay 815 being connected through the switch off-normal contact 821 and winding of release magnet 823 to battery. Relay 806 at its inner front contacts sends a 1000–20 cycle signal back over toll line 524 to office No. 1. Relay 806 at its bottom outer contact short-cir-

cuits the receiving circuit 805 to prevent said signal from interfering with the sending of same. Relay 806 at contacts 842 and 843 prevents noise to the operator by connecting the termination 807 to the line toward the operator in office No. 2 during this period, thus supplementing the termination 1158 connected towards the operator when the operator first depressed ringing key 1131. The receipt of the above ringing signal by toll line circuit 520 at office No. 1 results in lowering the resistance of jack sleeve 522 thereby lighting lamp 506 to inform the operator of office No. 1 that her attention is wanted on the call.

The called subscriber upon hanging up at the end of a conversation causes lamp 1057 to light steadily. The operator at office No. 2 then operates key 1060 to listen in on the connection in the same manner as previously described, and observing that the conversation is finished, pulls down plug 1024. The operator in office No. 1 upon observing lighted lamp 514 which denotes that the calling subscriber has hung up comes in on the connection and upon receiving no response to her challenge withdraws plug 504 thereby restoring line circuit 520 to normal. The operator at office No. 2 pulling down plug 1024 causes the key pulsing circuit of Fig. 21A to restore to normal, and due to opening of sleeve lead 1043 causes relays 1009 and 1010 of the plug circuit to release, thereby automatically releasing the discriminating circuit. She then operates her telephone release key to disconnect herself from the connection.

Connection between two toll lines with ring-down signaling

Reference is made to the preceding description wherein the calling subscriber 500 is shown to have been connected over a ring-down toll line circuit 520, line 524, incoming ring-down toll line circuit of Fig. 8, plug circuit of Fig. 10 with the operator telephone and control circuit of Fig. 11 in office No. 2. It will now be assumed that said call, instead of being connected over a key pulsing trunk, is required to be connected over a second ring-down toll line such as shown in Fig. 16.

The operator in office No. 2 upon being automatically connected to the plug circuit of Fig. 10, as previously described, and having received the number of the wanted subscriber from the operator in office No. 1, takes up plug 1024 and inserts it in the first idle ring-down toll line jack such, for example, as in Fig. 16. As described for voice-frequency toll line connections, the multiple jacks 1600 and 1601 appearing at different operators' positions are normally disconnected from the line conductors by relays individual, respectively, to each jack appearance. When, therefore, plug 1024 is inserted in jack 1600, relay 1605 operates from ground through its high-resistance left winding over sleeve lead 1630 to battery on sleeve 1043 of the plug circuit, thereby operating relay 1606 in the toll line circuit of Fig. 16 which extends talking conductors 1041 and 1042 of the plug circuit over conductors 1631 and 1632 to conductors 1633 and 1634 of the toll line. Relay 1606 at contact 1635 connects ground for operating relay 1619 to battery, thereby preparing the circuit for use as later will be described. Relay 1619 also opens the circuits of normally operated relay 1637 in transmission pad circuit 1613, thereby causing said pad to be disconnected from the outgoing toll line in the same manner as previously described as used for pad circuit 609 of Fig. 6. The ground circuit of relay 1637 may be traced over leads 1638 and 1639, through contact 1636 on relay 1619 and contact 1642 on relay 1621, thence to battery through high-resistance 1622. At this time ground through the low-resistance relay 1637 over lead 1638 may be traced; to tip conductor 1633 over lead 1639, upper winding relay 1620, lead 1641, and upper winding impedance coil 1608; and to ring conductor 1634 over lead 1640, impedance coil 1609 and lower winding impedance coil 1606. Thus a ring-down toll line presents a medium resistance ground on both tip and ring conductors 1631 and 1632 to the discriminating circuit when the operator first inserts plug 1024 in jack 1600.

Connection of the discriminating circuit automatically to the plug circuit of Fig. 10 when the plug 1024 is first inserted in jack 1600 has been described previously. As a result of the ground test applied by the operation of relay 1221 in the discriminating circuit, relays 1326 and 1219 on the tip side, and relay 1331 on the ring side are caused to operate. Relays 1326 and 1219 in turn operate relays 1312 and 1210, respectively, and relay 1331 operates relay 1332. Relays 1312, 1210 and 1332 therefore register the identity of the selected ring-down toll line circuit. This combination of operated relays thus permits relay 1203 to operate when relay 1224 operates. The operating circuit for relay 1203 is traced from battery through winding relay 1203, leads 1272 and 1273, top outer contact on operated relay 1210, top outer contact on normal relay 1211, lead 1274, top outer closed contact on operated relay 1332, lead 1348, top outer contact on relay 1227, lead 1251, top outer contact relay 1306, thence over lead 1349 to ground at top inner contact on relay 1224 when it operates. Relay 1203 thus serves to identify the selected ring-down toll line as will presently be described. Relay 1224 as previously described functions at this time, to cut off testing of the selected circuit, after a definite time interval, sufficient to allow for said test. Thus when relay 1221 operates to connect the test relays it also operates relay 1327 which connects ground for shunting out the winding of relay 1310. The latter relay under this condition releases slowly thereby providing the time interval above mentioned.

On this type of connection where two ring-down toll lines are interconnected, two functions are performed by the discriminating circuit. First, relay 1203 at its top inner contact closes an obvious circuit for operating relay 1233 to ground at back contact on relay 1300. Relay 1233 operating, connects 48-volt battery through a protecting resistance 1234 to lead 1258 which on this type connection remains open but would be traced to lead 926 and relay 713 if the incoming toll line were straightforward in character, as previously described. The second function is to cause the selected ring-down toll line to send a ringing signal to the next office. Thus relay 1203 at its bottom contact closes ground to arm 1208 on timing switch controlled by rotary magnet 1206 and releases magnet 1205. It will be remembered in the previous description of the discriminating circuit, where it makes a test to insure the plug being fully seated in the selected toll line jack, that relay 1328 closes ground for operating relay 1202 thereby causing rotary switch magnet 1206 to step arms 1207 and 1208 around over their respective terminals. On step 2 arm 1208 closes an obvious circuit for operating relay 1209 which

impresses 48-volt battery on the tip conductor 1041 of the plug during the time that said switch arm is passing over terminals 2 to 5. Said 48-volt battery circuit may be traced through protecting resistance 1285, front contact on operated relay 1209, lead 1276, top outer armature and contact on relay 1225 to tip leads 1250 and 1051, thence over previously traced path to tip conductor 1041. This path is further traceable through the plug and jack to conductor 1631, top armature and contact relay 1606, conductor 1633, thence through upper winding of impedance coil 1608, lead 1641, upper winding relay 1620, lead 1639, and over lead 1638 to ground through winding relay 1637. Relay 1620 thereupon operates in this circuit for the purpose of sending out a ringing signal to office No. 3, and locks operated from ground at its top inner contact thence through its lower winding to battery connected through resistance 1643 to lead 1644. The manner of sending said signal will presently be described.

On this type of connection the time-out signal of the discriminating circuit is relied upon to prepare the discriminating circuit for cut through and release. The timing switch arm 1208 moving off terminal 5 opens the circuit of relay 1209 which releases and breaks the 48-volt battery connected to the tip conductor described above. When arm 1207 contacts with terminal 6 ground is connected to lead 1246, traced further through contact 1278 on operated relay 1203, thence to battery over lead 1350 and winding relay 1225. The latter relay then causes the discriminating circuit to cut through and release as previously described. The operator at office No. 2 in the meantime waits until shoe receives a challenge from the toll line at office No. 3 and then passes the wanted subscriber's number. After this she operates and releases telephone release key 1124 to disconnect her telephone set and connect the incoming talking conductors to the conductors of the plug circuit.

Under certain traffic conditions the operator may be required to plug into a busy ring-down toll line, in which case it means that a ringing signal must not be sent out. A non-ring key 1216 is therefore provided which the operator depresses momentarily before placing the plug in the multiple toll line jack. The operator may also operate this key on certain other types of trunk connections, thereby saving the operating time of the discriminating circuit. Depressing key 1216 causes relay 1213 to operate and lock over an obvious path to ground at the top inner contact on relay 1212. When the discriminating circuit is finished with the previous call, relays 1329 and 1215 release, causing relay 1212 to operate over a path traced from battery through relay 1212, top break contact on relay 1215, through bottom make contact on relay 1213, thence over lead 1281 to ground at bottom outer armature on relay 1329. Relay 1212 at its top contact locks to ground through the top contact on relay 1215. The operation of relay 1212 opens the holding circuit of relay 1213 causing it to release. When the next call is plugged into what above is assumed to be a busy toll line, relay 1329 upon operating, connects ground to lead 1359, which at contact 1282 on relay 1212 connects said ground to lead 1262, thence over lead 1056 for operating the cut through relay 1002 of the plug circuit. Relay 1212 at its bottom outer contact closes ground to lead 1350 for operating relay 1225, thus causing the discriminating circuit to cut through and release as previously described.

The operation of ringing relay 1620 by battery received over the tip talking conductor from the discriminating circuit, thereupon closes battery at its top outer contact for operating relay 1611 which does two things. First, it connects 1000–20 cycle ringing current to conductors 1645 and 1646 which then passes directional selection circuit 1612 and transmission pad 1613, thence out over toll line 1647 to office No. 3. For the purposes of this description, the incoming ends of the line in office No. 3 may be assumed to be similar in all respects to the incoming ends of the ring-down toll lines shown in Fig. 8, also indicated in Fig. 3. Second, relay 1611 closes an obvious circuit for connecting the termination 1610 to the calling toll line conductors 1633 and 1634 during the ringing period, thereby preventing disturbances in any repeater that may be connected in the toll line. Relay 1611 at its bottom outer contact also short-circuits receiving circuit 1614, thereby preventing its functioning. Relay 1620 at its two bottom contacts starts timing switch arm 1629 to rotating which on the fifth step connects ground directly to resistance 1643 and thereby shunts out the grounded holding winding of relay 1620 causing it to release and disconnect the 1000–20 cycle ringing signal from the line. The grounded arm 1629 continues this shunting condition to give sufficient time for the 48-volt battery signal from the discriminating circuit to be disconnected.

The outgoing ring-down trunk circuit of Fig. 16 thus serves to extend the call to office No. 3. In accordance with usual practice the supervisory lamp 1057 of the associated operator's plug circuit is out at this time. This is due to ground being connected to sleeve lead 1630 through the left high-resistance winding of relay 1605, thereby preventing relay 1005 of the plug circuit from operating. The operator at office No. 3 then takes whatever action is needed to complete the connection to the called subscriber. When the called subscriber in office No. 3 afterwards hangs up, the operator in said office will receive a lighted signal and will then operate her key to ring back on the toll line 1647. Said signal will thus come into receiving circuit 1614 and cause ground to be connected to lead 1648 traced then through lower winding relay 1623 to battery. The latter relay does not lock operated due to relay 1619 being operated, and holding said locking circuit open at contact 1649. Relay 1623 at contact 1650 connects ground to lead 1651, traced thence through bottom outer contact on operated relay 1606, through right low-resistance winding relay 1605 to sleeve lead 1630. The lowering of this sleeve resistance thereupon operates relay 1009 in the plug circuit and lamp 1057 as previously described. The ringing signal sent back over the line may or may not cause supervisory lamp 506 in office No. 1 to light, as is characteristic of ring-down toll line operation. The operator at office No. 2 then removes plug 1024 from the toll line jack and in turn sends a ringing signal to office No. 1 as previously described. The operator at office No. 1 receiving a lighted signal 506 then disconnects, restoring all circuits to normal.

Connection between a ring-down toll line and a straightforward toll line

Referring to the description of a connection between a ring-down line and key pulsing trunk, there is shown the manner in which the operator

at office No. 1 originates a call over toll line circuit 520 and how the operator in office No. 2 receives the number of the wanted subscriber. It is now assumed that the called party is located in office No. 3 and that only straightforward toll lines are available for this connection. The operator at office No. 2, therefore, inserts plug 1024 in an idle line jack such as 1401 to complete the connection. For a description of the manner in which the selected circuit functions and the way in which the discriminating circuit makes its test of said circuit, reference may be had to the description of a connection between two toll lines with voice-frequency signaling. On the through call at office No. 2 now being described, one line is equipped for ring-down operation and the other for straightforward operation; therefore, supervisory signals cannot be passed through office No. 2. In this case neither the incoming nor selected toll line need have any changes made in their wiring in order that they may work together on a through call. In following the previous description of the discriminating circuit test where two voice-frequency toll lines are involved, the same manner of identifying the selected straightforward toll line is used. Thus when relay 1224 operates, relay 1200 will serve to identify the selected toll line to the discriminating circuit.

The incoming toll line being ring-down in character does not operate relay 1232 when the discriminating circuit is first seized, and hence relay 1228 does not operate. The failure of the latter relay to operate thereby prevents the closure of 48-volt battery through resistance 1229 to the ring conductor and prevents relay 1414 in the selected toll line from operating. Upon the release of relay 1310, a path is closed for operating relay 1224 which in turn operates relay 1200. Although the latter relay causes relay 1233 to operate and connect 48-volt battery through resistance 1234 to leads 1258 and 1147, said action has no effect because lead 1147 is open at arm 1077 of switch 1027. Thus it will be evident that no wiring changes are set up in the incoming ring-down toll line at office No. 2.

The operation of relay 1200 at its top inner contact also connects ground to lead 1260, which shunts out winding of slow release relay 1315. When the latter relay releases it operates relay 1225 for cut through and release of the discriminating circuit as previously described. Although relay 1225 connects a 48-volt battery circuit, traced through resistance 1229, for operating relay 1414 of the selected toll line, the failure of the relay 1228 to operate prevents relay 1414 from operating. In this manner circuit changes are prevented from being made in the selected toll line circuit. As previously described; the incoming toll line is then connected with the selected toll line; the discriminating circuit is released from the plug circuit; and the operator dismissed from the connection.

The operator at toll office No. 2 upon inserting plug 1024 in jack 1401 causes a connect signal to automatically be sent to the distant toll office No. 3 as previously described. This signal at office No. 3 causes a plug circuit indicated at 2004 to be attached to the toll line circuit 2001 through primary and secondary call distributing crossbar switches 2005 and 2006, respectively, and lights the connect lamp CN associated with said plug circuit. Assuming the call is intended for subscriber 2011 the operator will then complete the call in the usual manner. For the purposes of further description it may be assumed that the plug circuit indicated at 2004 is the same as shown in Fig. 10, and that the removal of the subscriber's receiver from the switchhook thereby provides a high-resistance sleeve of jack 2008 to ground. The effect of this, as previously pointed out, is to cause the toll line circuit 2001 to send back a voice-frequency off-hook signal of 1000–35 cycles which on this type of connection will be registered in the outgoing toll line of Fig. 14 in office No. 2, due to relay 1414 of said circuit being in a normal position also previously described.

It will now be shown how the removal of the called subscriber's receiver to send an off-hook signal, causes supervisory lamp 1057 associated with the plug circuit of Fig. 10 to go out, and how this signal causes the toll line circuit of Fig. 14 to return an acknowledgment signal to the line circuit at office No. 3 for effecting the discontinuance of the off-hook signal. The incoming signal at office No. 2 from the toll line 2000 will pass through transmission path circuit 1437 and directional selecting circuit 1409, and come in over leads 1453 and 1454 to voice-frequency receiving circuit 1425. The 35 cycle component of this signal thereupon operates a relay (not shown) causing ground to be connected to lead 1461, traced further through winding relay 1507, lead 1462, thence through bottom contact relay 1414 to battery. Relay 1507 operating in said circuit removes ground at contact 1529 from the previously traced circuit through low-resistance upper winding of sleeve relay 1402, leaving only the high-resistance winding connected, thereby causing the supervisory lamp 1057 of the plug circuit to be extinguished in a manner previously described. At the same time relay 1507 at contact 1530 connects ground to the winding of relay 1505, thereby shunting out the winding of the latter relay, normally operated in series with resistance 1506 to battery. After a time interval of approximately 0.2 second relay 1505 releases and operates relay 1504 through its lower winding for the purpose of keeping lamp 1057 dark and for sending an acknowledgment signal back to office No. 3. Relay 1504 through its upper winding and top inner contact locks itself, over lead 1527 to battery at bottom inner armature relay 1417, and over lead 1526 to ground at bottom inner armature relay 1421. Relay 1504, at its top outer contact, continues to hold the circuit open through the low-resistance upper winding of sleeve relay 1402, thus maintaining supervisory lamp 1057 in a darkened condition. Relay 1504 at its bottom inner contact closes a circuit for operating relay 1413 to prepare the circuit for sending an acknowledgment signal. Said circuit is traced from ground through bottom outer contact relay 1507, bottom inner contact relay 1504, lead 1449, thence through winding relay 1413, top inner contact relay 1412, to battery through top outer contact on operated relay 1411. Relay 1413 operating closes a ground circuit at its bottom contact for operating relay 1408 over lead 1450. The latter relay at its inner contacts then closes a 1400–15 cycle acknowledgment signal to line conductors 1451 and 1452 towards office No. 3, said signal being previously connected to leads 1447 and 1448 at top contacts on operated relay 1413. Relay 1403 at its outermost contacts also connects termination 1407 toward the office No. 1 end of the toll connection, thereby preventing any interference with repeater circuits that may be connected in the line.

Receipt of the above acknowledgment signal by the toll line 2001 in office No. 3 results in disconnecting the off-hook signal which has been holding relay 1507 operated, thereby releasing it and reoperating relay 1505 and leaving the circuit ready for conversation to begin.

At the end of conversation when the called subscriber hangs up his receiver, the toll line 2001 is made to send an on-hook signal of 1000–25 cycles back over toll line 2000 to office No. 2 where it is registered in the voice-frequency receiving circuit 1425 by connecting ground to lead 1468. Relay 1424 thereupon operates from said ground, traced further over lead 1462 to battery through bottom contact relay 1414, and at contact 1469 closes ground to lead 1434. Ground on said lead is further traced through bottom outer contact on operated relay 1403, thence through low-resistance upper winding of sleeve relay 1402 to the sleeve 1432 of jack 1401, thereby resulting in the lighting of lamp 1057 of the associated plug circuit. At the same time relay 1424 closes a ground circuit at contact 1470 for shunting the winding of relay 1422, normally operated through resistance 1423 to battery. Relay 1422 after an interval of approximately .2 second releases and operates relay 1421 for the purpose of sending back an acknowledgment signal. Relay 1421 at its top outer contact closes a circuit for operating relay 1413 traced from ground at bottom outer contact relay 1501 over lead 1531, through top outer contact operated relay 1421, bottom outer contact relay 1415, thence over lead 1449, through winding relay 1413 and top inner contact relay 1412 to battery at top outer contact on operated relay 1411. Thus the operation of relays 1413 and 1408 as above described function to send an acknowledgment signal to office No. 3, upon receipt of which, the incoming on-hook signal is cut off. Hence relay 1424 releases, thereby reoperating relay 1422. Supervisory lamp 1057 continues to burn because ground remains connected through the low resistance upper winding of sleeve relay 1402, said ground now being connected over lead 1436 to lead 1434 for this purpose, due to relay 1421 at its bottom inner contact having released relay 1504 when the relay 1421 first operated.

Rering and flashing signals

Assuming that the called subscriber operates his switchhook to call in an operator on the connection, it will be obvious from the above description that off-hook and on-hook signals will be sent out by the toll line circuit indicated at 2001, corresponding to the position of the switchhook. The same is also true, if on first setting up the connection the operator at office No. 3 inserts plug 2007 in a busy back or overflow and reorder circuit. Under this condition where the signals follow each other at intervals of 0.5 seconds or less, acknowledgment of the on-hook signal is withheld in order to reduce disturbances toward the incoming end of the toll line. Relay 1415 and slow releasing relay 1416 therefore function at this time to maintain relay 1408 in an operated condition, thus holding termination 1407 in contact with the incoming end of the toll line. This is accomplished by connecting the circuit of relays 1415 and 1416 to the upper contacts on relays 1424 and 1507. Relay 1507 operating on an off-hook signal closes a circuit for operating slow release relay 1416, traced from battery through said relay, lead 1471, upper contact relay 1507, leads 1532 and 1472 to ground at bottom outer contact on operated relay 1411. The off-hook signal now stops and releases relay 1507 but relay 1416 being slow to release remains operated. Then the following on-hook signal immediately operates relay 1424, thereby closing a circuit for operating relay 1415 traced from battery through winding of said relay, top outer contact relay 1424, to ground at contact on operated slow relay 1416. Relay 1415 at its top inner contact then locks to ground on the contact of slow relay 1416. Relay 1415 at its bottom inner contact also locks relay 1416 operated through top inner contact relay 1424 to ground previously traced on lead 1472. Therefore, relays 1415 and 1416 cannot release as long as the flashing continues and ground at top outer contact relay 1415 holds relay 1406 operated, thereby maintaining the connection of termination 1407 across the incoming end of the toll line. An acknowledgment signal is prevented from being connected to leads 1447 and 1448 at this time because the flashing signals are not of long enough duration to cause relay 1422 or 1505 to release. The supervisory lamp 1057 of the associated plug circuit in office No. 2 is thus caused to light whenever relay 1424 is operated and to go out when relay 1507 operates.

Assume now that an overflow signal is being sent, which indicates to the operator in office No. 2 that no toll lines are available at office No. 3 for extending the call to another office. When a toll line becomes available, the overflow and reorder circuit at office No. 3 will change the character of the flashing to a reorder flash. The operator at office No. 2 upon noting this signal, then depresses key 1060 to attach her telephone and control circuit to the plug circuit of Fig. 10, provided she was not already so connected. She then operates ringing key 1132 to rering the operator at office No. 3 and bring her back on the connection. The operation of key 1132 connects 48-volt battery through resistance 1157 to the tip conductor 1041 of the plug circuit, traced over lead 1159, top outer contact relay 1127, lead 1064, top outer contact relay 1001, contact 1078 on relay 1002 to tip conductor 1041. Said battery is further traced through the plug 1024 and jack 1401, through top contact on operated relay 1403 to tip conductor 1426, thence through upper winding impedance coil 1405 and over lead 1463, through contact 1475 on relay 1421, winding ringing relay 1420, leads 1459 and 1458 through winding relay 1435 to ground. Relay 1420 operates in above circuit and at contact 1465 opens the ground holding circuit through the upper winding of relay 1512 thereby permitting the latter to release in order to start the timing circuit 1515 to function. The release of relay 1512 releases relay 1513, thereby reconnecting ground at the top outer contact to lead 1438 for operating relay 1412. The latter relay at its bottom inner contact then locks to the top contact on ringing relay 1420. Relay 1412 at its bottom outer contact operates relay 1408 over lead 1450 and thus sends a rering signal of 1400–25 cycles out through directional selecting circuit 1409 to office No. 3. At the same time the flashing signals with 1000 cycle carrier frequencies are being received from office No. 3.

It is necessary in a situation like the above to be sure that the toll line circuit of Fig. 14 does not extend the connection to office No. 3 at a time when an off-hook signal is being received, otherwise the supervisory lamp would go out and it would appear to the operator that the subscriber had answered. For the same reason it is necessary that, when the operator at office No. 3

is brought in on the connection, the toll line in said office be in an on-hook condition. In describing how this is accomplished reference should be had to Fig. 6 and Fig. 7 as representing the toll line at office No. 3, and previously referred to as toll line **2001**. Relays **705**, **707**, **708**, **714** and **715** in said toll line circuit will at this time be in an operated condition, and relay **704** will be operating and releasing over lead **739**, in accordance with the flashing ground being received from the associated plug circuit. The associated plug circuit may be assumed to be a duplicate of that shown in Fig. 10. Said plug circuit at this time is not connected to the operator's control circuit of Fig. 11 and the following relays are in an operated condition. Relays **1002**, **1004**, **1006**, **1007**, **1010**, **1011**. Relays **1009** and **1005** are operating and releasing as they follow the fluctuation in the resistance of the sleeve circuit coming from the overflow and reorder circuit. It will be evident that relay **704** thus faithfully follows the operation and release of flashing relay **1005** due to the circuit of relay **704** being traced over lead **739**, cross-bar leads **933**, **934**, **939** and **921**, arm **1039** on switch **1027**, lead **1040**, top outer contact on operated relay **1011**, bottom contact on flashing relay **1005** to ground at top inner contact relay **1007**.

Assuming at the start of the rering signal that the toll line in office No. 3 is in an on-hook condition, meaning that relay **1005** is operated causing relay **704** to be non-operated, then said signal will operate relay **610** and release relay **617** causing relay **619** to operate. The latter relay at contact **652** thus removes ground from lead **653**, thereby as previously described releasing relay **1011** of the plug circuit in order to prepare said circuit for bringing in the operator. Relay **1011** released, at its top outer contact thereupon opens the previously traced path for relay **704** so that the on-hook condition of the toll line remains an on-hook condition. When the rering signal finally stops, relay **619** releases and reconnects ground at contact **652** to lead **653**. Relay **1011** now being released permits this ground path to operate start relay **1013** over lead **1016** as previously described in connecting the operator's control circuit with the plug circuit, thereby bringing in the operator.

Assuming at the start of the rering signal the toll line in office No. 3 is in an off-hook condition, wherein relay **1005** is released causing relay **704** to be in an operated position, then said signal will operate relay **610**, release relay **617** and operate relay **619** as before. Relay **1011** releases as described above and now opens the circuit for relay **704** causing an on-hook instead of an off-hook supervisory signal to be sent back to office No. 2. Said on-hook signal must now be sent long enough for it to register at office No. 2, that is by operating relay **1421**. The rering signal at office No. 2 is therefore sent to office No. 3 for an interval that will permit it to register and for the on-hook signal returned from office No. 3 to register. Some additional time for the latter registration is also required in the event that the intervening toll line includes several composite and voice-frequency circuits. Still more time is required to insure a clear line, because once the ringing signal stops, the operator at office No. 3 may be brought in as above described and the three tones returned over the toll line the same as on an incoming call. Rering signals therefore are not acknowledged so as to allow free sending of the on-hook signal.

The rering signal is made a minimum of approximately 3.3 seconds in order to guard against sending order tone back to office No. 3 until the line is clear from other signals as just described. The manner in which this time interval is provided for will now be described. When the operator at office No. 2 first operated ringing key **1132** it caused relay **1420** of the outgoing toll line to operate as previously described. Relay **1420** at contact **1465** thus opens the circuit through the upper winding of relay **1512** which has been holding it energized ever since the circuit was first taken for use. The release of relay **1512** thus releases relay **1513** which now remains normal until again reoperated over lead **1533**. Relay **1513** at its top outer contact connects ground to lead **1438** for operating relay **1412** as previously traced. Relay **1408** already being operated, a rering signal of 1400–25 cycle current is sent over the toll line to office No. 3 and will continue to be sent until relay **1513** is reoperated by the timing switch **1515**. Arm **1528** of said switch starts stepping over its terminals when the relay **1412** first operates as above described. This is due to ground being connected, at contact **1473** on relay **1412**, to lead **1457** which again energizes the upper winding of relay **1512** causing it to operate and step the switch from interrupter **1520** as previously described. When arm **1528** reaches grounded terminal **8**, said ground will operate relay **1513** over lead **1533** and stop the switch and by releasing relay **1408** will stop the sending of the rering signal. Previous to this the operator would have released her ringing key, thereby releasing relay **1420**. It should be observed that the contacts on relay **1420** are so arranged that when said relay releases contact **1465** will close before the upper contact opens, thereby preventing the possibility of a second rering cycle being started.

Simultaneous connections to a two-way voice-frequency straightforward toll line

The operator at office No. 2, in completing a through call to office No. 3 over a two-way toll line arranged for voice-frequency signaling such as shown in Fig. 14, may insert her cord plug in jack **1401** just at the moment when the operator at office No. 3 in the same manner inserts her cord plug in jack **646** at the other end of the same toll line such as shown in Fig. 6. The toll line of Fig. 14 will therefore have its receiving circuit **1425** tuned to receive signals having a carrier frequency of 1000 cycles by battery being connected to lead **1442** at contact **1441** on operated relay **1417** as previously described. Similarly the other end of the toll line, Fig. 6, will cause its receiver circuit to be tuned to incoming signals having a carrier frequency of 1000 cycles. Each end of the toll line proceeds to send a connect signal having a carrier frequency of 1400 cycles but both receiving circuits are already tuned for 1000 cycles, so neither signal is registered. It will be recalled in sending a connect signal, that the timing switch **1515** is started by virtue of the operation of relay **1512**, when the operator first plugs into the circuit. Under normal conditions timing switch arm **1528** would be stopped on terminal **3** because of the acknowledgment signal received from office No. 3 in the form of a ground on lead **1455**. Since no acknowledgment signal is received, the timing switch arm **1528** continues to step around until it contacts with ground at terminal **8** when it stops the switch by operating relay **1513** as previously described. The same action takes place at office

No. 3 so that neither operator can receive the connect signal from the other operator. The operation of relay **1513** in office No. 2 and of the corresponding relay **707** in office No. 3 thereupon remove both connect signals from the line by releasing relays **1412** and **625** respectively. The operators may then talk and noting that the connection is one of simultaneous seizure they will then disconnect. Since no acknowledgement signal is sent if the distant end cannot receive the disconnect signal, it follows that the timing switch at each office will again go through its timed cycle in order to prevent further sending of the disconnect signal.

Connection between a straightforward toll line arranged for voice-frequency signaling and a ring-down toll line

On connections of this type the functioning of the respective voice-frequency and ring-down toll lines is the same as previously described. The effect on through signals in this case, however, will be further explained. Reference should be had to the description of a connection between a toll line with voice-frequency signaling and a key pulsing trunk, in which is described the manner in which a call from subscriber **500** is extended as far as the operator in office No. 2. The manner in which the operator's control and discriminating circuits are attached to the plug circuit of Fig. 10 is also described. At this point the operator, instead of plugging into a key pulsing plug jack **2101**, is assumed to plug into the outgoing jack of the toll line arranged for a ring-down signaling. From this point on reference should be had to a connection between two ring-down toll lines which describes the functioning of the selected ring-down toll line of Fig. 16 when the operator at office No. 2 inserts plug **1024** in jack **1600** of said toll line. The manner in which the discriminating circuit makes a test of the ring-down toll line is also essentially the same as described. Due however to the incoming toll line being arranged for voice-frequency signaling, relay **713** of Fig. 7 will be operated as referred to in said description. Relay **713** at its bottom contact maintains a ground on lead **742** connected in turn to sleeve **736**, thereby preventing the operator at office No. 2 from being brought in on the connection in the event that the operator at office No. 1 should rering on the circuit.

From the above it will be evident that if the operator at office No. 1 should rering, said rering signal of 1400–25 cycles will come into receiving circuit **606** causing the operation of relay **610**, the release of relay **617**, and the operation of relay **619**. The latter relay at its top inner contact thereupon extends lead **743**, to which 48-volt battery is connected by relay **713**, to lead **648** and thence over the tip conductors of call distributing switches and plug circuit to ringing relay **1620** of the ring-down toll line connected to ground through relay **1637** as previously described. The operation of relay **1620** then operates relay **1611** to send rering signal of 1000–20 cycles out over toll line **1647** to office No. 3 in the same manner as previously described where the operator at office No. 2 throws ringing key **1132** and connects 48 volts to the tip conductors for operating relay **1620** in sending said signal.

On the other hand, if the operator in office No. 3 desires to bring the operator in office No. 1 back on the connection, it will be necessary for her to operate her ringing key to ring back on the ring-down toll line as described on previous ring-down toll line connections. In this case the ringing signal is relayed through office No. 2 and appears in front of the operator at office No. 1 in the form of a lighted lamp **506**. When the called subscriber disconnects on this type connection the operator at office No. 3 receives a steady lamp signal indicating this fact. She then rings back on the toll line to give the operator at office No. 1 a steady lamp during the ringing interval and then pulls down the connection. The operator at office No. 1 comes in on the connection by operating key **516**. Upon receiving no answer to her challenge she disconnects cord **504** from jack **505**, causing a disconnect signal to be sent to the operator at office No. 2. Thus it will be seen on connections of this kind that the ringing signals are sent through the intermediate office without bringing the operator thereat in on the connection.

Connection between a voice-frequency straightforward toll line and a composite signaling straightforward toll line

Subscriber **500** in Fig. 5 originates a call which is answered by the toll operator at office No. 1. To complete a toll connection to the called subscriber in this case, the operator finds it necessary to route the call through two intermediate offices before reaching the fourth or terminating office. The connection, when established, is assumed to include; a two-way straightforward toll line with a voice-frequency signaling between office No. 1 and office No. 2; a two-way straightforward toll line with composite signaling between office No. 2 and office No. 3A; and a voice-frequency toll line between office 3A and office No. 4. On connections of this kind, it is necessary that off-hook and on-hook signals, originated by the toll line at office No. 4, be sent back over the transmission circuit of the toll line to office No. 1 without bringing in the operator at either office No. 2 or office No. 3A, and without relaying the signal at either of said offices in order to prevent the signal from being broken up. On the other hand, if we assume a similar built-up connection to the above, but with the toll line between office No. 1 and office No. 2 arranged for composite signaling, then it is necessary to have the signal relayed at each office. Therefore, in building up a connection, it is necessary for the discriminating circuit in office No. 3A to know whether the circuit between office No. 1 and office No. 2 is a voice-frequency straightforward toll line so that the voice-frequency toll line to office No. 4 may be conditioned accordingly. The manner in which this is accomplished will now be described.

Subscriber **500** calls the operator in office No. 1 who then inserts plug **504** in jack **505** to build up the connection to office No. 4. Upon hearing three spurts of tone from office No. 2, she passes the wanted subscriber's number. For a detailed description of this operation reference should be had to that portion of the specification which describes a connection between a voice-frequency toll line and key pulsing trunk. The operator in office No. 2 then inserts plug **1024** in jack **1701** of a composite toll line leading to office No. 3A. It will be observed that this toll line presents the same appearance to the discriminating circuit as the toll line with voice-frequency signaling did, that is, the tip conductor **1726** is connected to ground through a medium resistance path, traced through the upper winding of impedance coil **1705**, thence through upper armature and contact on relay **1718**, upper winding relay **1720**,

lead 1747, to ground through winding of relay 1748 in transmission pad circuit 1749. The ring conductor 1727 is connected to the same ground through a high resistance, traced through the lower winding impedance coil 1705, varistors 1706, lower winding relay 1714, lead 1747 and ground through winding relay 1748. The same test relays of the discriminating circuit therefore operate as fully described for connections between two voice-frequency toll lines, thereby resulting at office No. 2 in the operation of relay 713 in the incoming toll line with voice-frequency signaling, and in the operation of relay 1714 in the outgoing toll line with composite signaling. It will be recalled in the aforementioned description that the 48-volt operating path for relay 1414 corresponding to relay 1714 included a contact on operated relay 1228 of the discriminating circuit. The latter relay, however, operates only when the incoming or preceding toll line is arranged for straightforward operation and voice-frequency signaling. Therefore, by virtue of the operation of relay 1714, the incoming end of the toll line in office No. 3A is warned that there is a voice-frequency toll line ahead as will presently be described. This warning indication at office No. 3A enables the discriminating circuit at that office to condition the circuits for through supervision whenever the operator plugs into a voice-frequency straightforward toll line.

Let it now be assumed that the operator at office No. 2 inserts plug 1024 in jack 1701 of the composite toll line of Fig. 17 to extend the connection to office No. 3A. As previously described for voice-frequency toll lines, each multiple jack such as 1701 is connected to the toll line by a cut-on relay such as 1703, through its associated sleeve relay 1702. Only one multiple can be cut-on at a time on an outward call and none on inward calls. This prevents interference in case an operator plugs in over the busy indication. Supplementing the idle line indication all of the multiples are artificially made busy as described for voice-frequency toll lines. Assuming this circuit is idle, the operation of sleeve relay 1702 at its bottom contact connects ground to the winding of relay 1711 which at contact 1750 opens a battery path through high resistance 1710 which normally is connected to lead 1747 and relay 1748 to ground, for removing the transmission pad 1749 from the line. Relay 1711 at its top inner contact removes the termination 1707 from across the toll line. At its bottom outer contact, ground is connected to winding of relay 1717 causing it to operate and lock to ground through a contact on relay 1719. Said circuit is traced from battery through winding relay 1717 and bottom inner contact to leads 1751 and 1752, to ground through top outer contact relay 1719. Relay 1717 at its top outer make contact connects battery to busy potential resistances 1724 and to the idle line indicating circuit 1704 to prevent this circuit being used by another operator. The operation of relay 1703 at its top outer contact closes an operating circuit for slow operate relay 1761 which serves to delay the application of battery to lead 1762 until after the associated discriminating circuit has had time to operate relay 1714 in case the preceding toll line is a voice-frequency line. Shortly after relay 1714 operates, relay 1761 operates to close a battery path for sending the signal to office No. 3A. If the incoming toll line at office 2 were arranged for composite signaling then relay 1714 would not have operated and the operation of relay 1761 would operate relay 1708 continuously. Since, however, the toll line is arranged for voice-frequency signaling and therefore is capable of passing through supervisory signals, the toll line at office No. 3A will be advised of this by the sending of two impulses of signal current prior to the operation of relay 1708 continuously as will now be described.

Assuming that relay 1714 is operated by the discriminating circuit as described above, said relay locks at its top inner contact through the bottom inner contact relay 1711 to ground at contact 1756 on relay 1719. Relay 1714 thus closes a direct ground path to the winding of relay 1708, traced from the top outer contact relay 1740, through bottom contact relay 1714 to winding relay 1708, which acts to shunt out the winding of said relay and make its operation for sending the signal to office No. 3A dependent on the relay 1740 being operated. The operation of relay 1761 now connects battery to lead 1762; which through the bottom outer contact on relay 1717 feeds battery to the top outer armature of operated relay 1711, traced thence through resistance 1712 to direct ground at top outer contact relay 1740, and to ground through winding relay 1708; and through the top outer contact on relay 1714 connects battery to lead 1757 for operating relay 1736 through its lower winding to ground at off-normal springs 1737.

Relay 1736 at its bottom inner contact operates relay 1740, by connecting ground through bottom inner contact relay 1719, traced further through top contact slow relay 1738, thence through winding relay 1740 to battery. Relay 1736 at its top contact supplies a locking ground for itself, and at its bottom outer contact opens a path through the release magnet 1745 of the timing switch. Relay 1740 operates at its top break contact to open the shunt around relay 1708, thereby permitting the latter to operate and send a signal. Relay 1740 at its top inner contact operates rotary magnet 1744 causing it to step arm 1746 to terminal 1, and at its bottom contact close an obvious path for operating relay 1738. The latter relay in this circuit requires approximately 0.25 second to operate and approximately 0.25 second to release. When it does operate, it opens the circuit of relay 1740 previously traced, thereby releasing said relay and closing the previously traced ground for shunting out signaling relay 1708 thus closing the line signal for 0.25 second. Relay 1740 also opens the circuit for relay 1738 which in approximately 0.25 second releases, thereby reoperating relay 1740 and permitting relay 1708 to operate to again send the line signal. Again relay 1740 operates the rotary switch magnet 1744 causing arm 1746 to step to terminal 2 and closes a circuit for operating relay 1738. After 0.25 second, the latter relay operates and opens the circuit for relay 1740, thus permitting it to release and reclose the shunt around relay 1708, thereby releasing same. The release of relay 1740 again causes relay 1738 to release in 0.25 second and again closes a circuit for relay 1740. The operation of relay 1740 at this time steps the timing switch arm 1746 to terminal 3, thereby operating cut-off relay 1719 to stop further interruption of the signaling current. Said path may be traced from battery through winding relay 1719, arm 1746 on terminal 3 of timing switch, thence over lead 1760 to ground at top outer contact relay 1720. Relay 1719 at its bottom inner contact opens the circuit of relay 1740, thereby disabling

the interrupter relays 1738 and 1740. The operation of relay 1719 at contact 1756 opens the ground path previously traced for holding relay 1714 operated, thereby causing it to release and open the shunting path on relay 1708. Thereafter relay 1708 remains operated during the connection. The release of relay 1714 opens the circuit of the lower winding of relay 1736 causing its release and the restoration of the timing switch to normal. Release of said switch in turn releases relay 1719.

The sending of two pulses of signal current preceding the steady signal from office No. 2 as just described passes over the telegraph leg or channel (not shown) to the relay 1816 in office No. 3A as is well known in the art. Relay 1815 follows the relay 1816 in operating and releasing. The first time relay 1815 operates it closes ground at its top outer contact to the winding of relay 1813, thence through winding relay 1813 to battery at top outer contact relay 1817. Relay 1813 at its bottom inner contact locks to ground through top outer contact on relay 1819. Relay 1813 at its top outer contact closes battery to the bottom inner armature of relay 1815, traced thence through its front contact and through the lower winding relay 1836 to ground at bottom spring on off-normal springs 1837. Relay 1813 at its top inner contact connects battery to idle line indicating circuit 1804 to prevent the outgoing end of this toll line from being taken for use. Relay 1836 operates and at its top contact locks itself to ground. Relay 1836 at its bottom inner contact closes ground to the bottom inner armature relay 1819, traced further over lead 1851, top contact relay 1838 to battery through winding relay 1840. The latter relay operates rotary magnet 1844 of timing switch and steps arm 1846 to terminal 1.

Relay 1840 closes the circuit of relay 1838 which operates after 0.25 second and releases relay 1840. After 0.25 second, relay 1838 would release but in the meantime a break in the incoming signal as previously described releases relays 1816 and 1815, thereby releasing relay 1836. Relay 1836 at its bottom outer contact closes an obvious circuit for operating release magnet 1845 of the timing switch, which when it has restored to normal permits relay 1836 to again operate over a path traced through its upper winding, and lead 1854, bottom inner normal contact relay 1815, to battery at top outer contact on operated relay 1813. When the timing switch restored to normal, it also closed a path at its top outer off-normal springs 1837 for operating relay 1821, traced from battery through its winding and bottom normal contact, contact 1855 on springs 1837, lead 1856, contact 1857 on relay 1813 to ground at bottom outer contact on relay 1815. Relay 1821 thus operates and locks at its bottom armature to ground at top outer springs relay 1819. Relay 1836 operating causes relay 1840 to operate and start the timing switch again.

Presently the incoming signal is closed and relays 1816 and 1815 again operate. Relay 1815 at contact 1858 thus closes a ground path through the top inner contact relay 1821 for operating relay 1822 to battery at top outer contact relay 1817. Relay 1822 locks to ground through top outer contact relay 1819. The operation of relay 1815 at its bottom inner make contact again closes a circuit through the bottom winding relay 1836, causing said relay to release, due to its windings being wound differentially. The timing switch is thus restored to normal which again permits relay 1836 to operate and start a new timing period.

The incoming signal now opens for a second time, causing relays 1816 and 1815 to release. Relay 1815 at its bottom inner normal contact again closes battery to lead 1854 and thence through upper winding relay 1836 to ground, causing it to release and restore timing switch to normal. Relays 1818 and 1835 thereupon operate in multiple, traced from battery at top outer contact relay 1817; through winding relay 1818 and its bottom contact to lead 1859; and through upper winding relay 1835, top inner contact relay 1828 to lead 1859. Said path is further traced over lead 1859, through bottom contact on operated relay 1822, contact 1855 on off-normal springs 1837, lead 1856, contact 1857 on relay 1813 to ground at bottom outer contact relay 1815. Relay 1836 reoperating again starts the timing switch.

The incoming signal now closes for the third time and thereafter remains closed, thus relays 1816 and 1815 reoperate and start the timing switch which as previously described in sending the signal from office 2, takes one step every 0.25 second. On step 2, the arm 1846 connects lead 1852 with lead 1860, thereby operating cut-off relay 1819 from ground at bottom outer contact relay 1811. Relay 1819 thus operates after 0.5 second steady signal and obviously releases at its top outer contact relays 1821, 1822 and 1818. Relay 1835 when it operated closed a locking circuit through its own lower winding and contact to battery at top outer contact relay 1813. Thus, relays 1813, 1815, 1816, 1819, 1836, and 1835 remain operated for the remainder of the connection.

The operation of cut-off relay 1819 in addition to releasing the above relays; stops the timing relays 1838 and 1840 by opening lead 1851 at bottom inner contact relay 1819; applies ground at its top inner contact through contacts on relays 1813 and 1828 to the start lead 1862 of the crossbar call distributing circuit 1900, causing an idle plug circuit 1901 to hunt for the line in the usual manner; and closes a path through relay 1828 for stopping the call distributing circuit on this particular line. The latter path may be traced from battery through winding relay 1828, bottom outer contact relay 1819, contact 1863 on relay 1813, and lead 1864 to the call distributing circuit 1900. When this line is found, relay 1828 operates; at its top outer contact to remove termination 1807 from across the line; at contact 1853 to open the start lead to the call distributing circuit; at its bottom outer break contact to open battery through high resistance 1810, thereby releasing relay 1848 and removing the transmission pad 1849 from the circuit. In this manner, the call is extended to an idle plug circuit represented by the dotted enclosure 1901 at office No. 3A. The operator's control circuit is likewise attached and three spurts of tone are sent back to the originating operator at office 1 who then passes the wanted subscriber's number. The operator at office 3A extends the connection to office 4 by inserting the plug 1902 to which the originating operator is attached, into jack 1903 connecting with another toll line 1907 with voice-frequency signaling.

At office No. 3A the discriminating circuit indicated at 1904 similar in all respects to that shown in Figs. 12 and 13, knows that a composite toll line with a voice-frequency line ahead is calling, due to relay 1835 in the incoming toll line being operated. The discriminating circuit also

knows that the selected toll line is a voice-frequency line, due to the tip conductor being connected to medium resistance ground and the ring conductor to high resistance ground. For a detailed description of the manner in which the discriminating circuit makes its test, reference may be had to that part of the description which relates to connections between two toll lines with voice-frequency signaling. Relay **1835** of the incoming toll line being operated removes ground from the resistance **1834**, thereby setting up an unbalanced circuit to lead **1865**. The other part of the balanced circuit is traced from battery at the bottom outer make contact on operated relay **1828**, thence through resistance **1830** to lead **1865**, the resistances **1830** and **1834** being equal in value. Therefore, when the discriminating circuit attaches itself to the plug circuit, indicated at **1901**, lead **1865** may be traced through the top inner contact and winding of relay **1829**, lead **1856**, thence over leads **926**, **924** and **1053** of the called distributing switches of a circuit equivalent to Fig. 9, lead **1052** of a plug circuit equivalent to Fig. 10, arm **1028** of switch **1027**, bottom outer contact relay **1003**, arm **1077** of switch **1027**, lead **1147** through contact on relay **1100** of an operator's control circuit the equivalent of Fig. 11, lead **1258**, through armature and back contact relay **1233** of a discriminating circuit equivalent of Figs. 12 and 13, thence through winding relay **1232** to the balanced battery and ground circuit through resistances **1230** and **1231**. The unbalanced condition in the toll line thus permits relay **1232** to operate and close a ground path for operating relay **1228** previously described for connections between two voice-frequency toll lines. Therefore, when the cut-off relay **1224** of the discriminating circuit at office No. 3A operates, two actions take place. First, a 48-volt battery is connected through resistance **1234** to lead **1253** in the circuit just traced through the winding of relay **1829** of the incoming toll line, causing said relay to operate and lock at its top inner contact over a circuit formerly traced to 24-volt battery at the top outer contact relay **1002** of the plug circuit. Thus relay **1829** remains operated during the connection and at its top outer contact connects 48-volt battery to the front contact of the supervisory relay **1818**, which passes supervisory signals through office 3A from the calling to the called end of the line by connecting said battery to tip of toll line whenever relay **1818** operates as will presently be described. Also at its bottom contact, ground is connected to lead **1867** which prevents bringing in the operator at office No. 3A whenever relay **1818** is operated. The second action that takes place when relay **1224** operates is to connect 48-volt battery through resistance **1229**, thence over lead **1253**, bottom contact relay **1200**, to ring lead at bottom contact relay **1225** which as previously described is connected to the ring conductor of the selected toll line circuit. This battery results in operating the equivalent of relay **1414** of Fig. 14 which figure may here be assumed to represent the voice-frequency toll line indicated at **1907**. Supervisory signals from the called to calling end of the connection will therefore be passed through office No. 3A without affecting it due to relay **1414** being operated.

At office No. 4 it may be assumed for the purpose of this description, that toll line **1906** terminates in a circuit similar in all respects to Fig. 6, and that the operator at this office upon learning the wanted subscriber number from the operator in office 1 proceeds to establish the connection over a toll switching trunk in the usual manner. Ringing is started automatically which is tripped off when the called subscriber answers, causing the toll line circuit at office No. 4 to send back an off-hook signal of 1000–35 cycles on the toll line **1906**. Said signal does not affect the resistance of jack sleeve **1908** because the toll line circuit at **1907**, similar in all respects to the circuit shown in Fig. 14, has previously been conditioned by the operation of relay **1414** previously described. The sleeve resistance therefore continues to remain low in value, thereby maintaining a relay in the sleeve of plug **1902** operated, in turn preventing relay **1808** of Fig. 18 from operating. The off-hook signal therefore really signals office No. 1 by passing back over the transmission circuit through offices Nos. 3A and 2. At office No. 1 receiving circuit **511** of toll line circuit **509** functions to raise the resistance of jack sleeve **508** and extinguish lamp **506**. When the called party hangs up an on-hook signal of 1000–25 cycle current is sent back over the toll line causing circuit **509** to function and lower the resistance of jack sleeve **508**, thereby again lighting lamp **506**. A flashing signal from office No. 4 applies the signal current for the off-hook condition and removes it for the on-hook condition, causing the cord supervisory lamp in office No. 1 to flash synchronously.

The operator at office No. 1 may rering the operator at office No. 4 by operating the ringing key (not shown) of her toll cord, causing toll line circuit **509** to send out a signal of 1400–25 cycle current as previously described. This signal actually passes over the transmission path of each toll circuit in the connection until it reaches office No. 4 where the operator will be brought in on the connection as previously described for a connection between a voice-frequency toll line and key pulsing trunk circuit. When the rering signal first reaches the toll line of Fig. 6 at office No. 2 another signaling path through offices Nos. 2 and 3A is also brought into action because the circuit does not know whether the connection terminates at said offices or not. This additional signal would provide means for bringing in an operator, for example, in the event the built-up connection involves a section of toll line with ring-down signaling. Since the combination of toll lines here described does not involve additional features, only the following brief outline will be given of the manner in which this additional signal is transmitted.

The rering signal is received at office No. 2 by the toll line circuit of Figs. 6 and 7, causing 48-volt battery to be connected to the tip side of the toll line, due to relay **713** having previously been operated by the discriminating circuit. Said battery finds a path to ground in the composite toll line of Fig. 17 through relay **1720** which locks, starts the timing combination of relay **1738** and **1740**, and operates relay **1736** to send a series of quarter second impulses to the signal channel leading to the composite circuit of Fig. 18 at office No. 3A. These impulses continue until arm **1746** of the timing switch of Fig. 17 contacts with terminal **7**, whereupon the ground on said terminal operates relay **1719**. When the operator at office No. 1 stops ringing and relay **1719** is operated, relay **1720** releases thereby stopping the timer, releasing relay **1736**, and restoring the timing switch to normal. At office No. 3A these impulses release relays **1815** and **1813** and start the timing switch arm **1846** to stepping. Relays **1821**, **1822** and **1818** operate, caus-

ing 48-volt battery to be connected to the tip conductor of the toll line, because relay 829 had previously been operated by the discriminating circuit. Said battery finds a path to ground through relay 1420 in the voice-frequency toll line indicated at 1907 but due to the discriminating circuit having previously operated the equivalent of relay 1414, the operation of relay 1420 is prevented from sending out a voice-frequency rering signal to office No. 4. Thus for this particular combination of toll lines only the original rering signal of 1400–25 cycle current is finally effective in bringing in the operator at office No. 4.

After conversation, the operator at office No. 1 withdraws cord plugs 503 and 504 from their respective jacks thus causing toll line circuit 509 to send a disconnect signal of 1400–35 cycle current to office No. 2 as previously described. This signal at office No. 2 is effective in lighting lamp 1057 as a disconnect signal to the operator who then withdraws plug 1024 from the composite toll line jack 1701. Opening of the sleeve circuit 1732 releases relay 1761, thereby releasing relay 1708, which thus removes the line signal, causing the inward end to disconnect in 0.5 second. All signaling interruptions are on a basis of ¼ second as previously described. Line disturbances are also less than 0.5 second in duration thus protecting the circuit from false disconnection. Opening of the sleeve 1732 also causes timing switch 1758 to measure off a 0.5 second interval before the circuit restores to normal. The purpose of this is to keep the circuit busy while the inward end at office No. 3A is testing for 0.5 second to find that the line signal is really removed. This prevents the circuit from being seized before the distant end is ready for a new call. Relay 1721 provides a parallel holding path for the relay 1717 which holds the circuit busy. Said holding path serves to hold relay 1717 operated after the operator has disconnected in case a rering signal were being sent at the time wherein relay 1719 at the moment is operating. In this case relay 1717 would falsely disconnect were it not for relay 1721 which is not allowed to operate until the actual disconnect has first released the timing switches. At office No. 3A the incoming end of the composite line, shown in Fig. 18, releases and restores to normal after the line signal has been removed for at least 0.5 second, as measured by the timing relays 1838 and 1840 and timing switch in a manner that is readily traced. As noted above, line disturbances are less than ¼ second in duration and when they do occur, relays 1816 and 1815 momentarily release. The latter relay every time it operates or releases, causes relay 1836 to start the timing cycle anew. At the end of the last line disturbance, relays 1816 and 1815 reoperate and restart the timer cycle, all in a manner previously described. This cycle eventually operates relay 1819 which releases relays 1821 and 1822 causing the circuit to return to its normal set-up condition. Relay 1821 is made slow in releasing to be sure that on a disconnection, relay 1813 will release before relay 1821 releases, thereby preventing the closure of locking ground at the top outer contact relay 1821 for relay 1813 before the latter has had a chance to release. The operator at office 3A upon receiving the lighted disconnect lamp, removes plug 1902 from jack 1903 thereby causing voice-frequency circuit 1907 to send a disconnect signal of 1400–35 cycle current as previously described for voice-frequency toll lines. This signal at office No. 4 lights a disconnect lamp in front of the operator who pulls down the connection to the completing trunk circuit thus restoring all circuits to normal.

Connections to tributary toll lines with ring-down signaling

There are situations where it is necessary to furnish toll service to communities in which the office in said community does not have facilities for handling tool business. In this case or sometimes for other reasons a distant toll office is made to serve the community by connecting toll calls to it over what are termed tributary ring-down toll lines. If the toll office happens to be a plug-ended board of the kind previously described, it will be necessary on connections to said tributary toll line for the discriminating circuit of Figs. 12 and 13 to determine that it is a tributary line in order that it may condition said line to prevent ringing signals from going through the toll office to the local community office. The manner in which the discriminating circuit functions illustrates another combination for determining the marking of the selected toll line.

Assuming a connection from the calling subscriber 500 in office No. 1 has been extended to office No. 2 over a straightforward toll line 513 with voice-frequency signaling, and that the discriminating circuit of Figs. 12 and 13 has automatically attached itself through the operator's control circuit of Fig. 11, to the plug circuit of Fig. 10, also that the operator at office No. 2 has just inserted plug 1024 in the jack of a tributary toll line (not shown), there will now briefly be described the manner in which the discriminating circuit recognizes the selected circuit. The selected circuit contains a sensitive polar relay in the ring side of the line, which operates and connects a high resistance battery on the tip conductor, when positive 8.6 volt battery through relay 1330 of the discriminating circuit is connected to the ring lead, at top inner contact of relay 1328. Relay 1330 operates in this circuit indicating that the tip and ring conductor of the plug are firmly connected to like conductors of the tributary toll line jack. Said relay in turn operates relay 1329 to prepare the discriminating circuit for testing as previously described. Among other things relay 1329 closes a circuit for operating relay 1324 which in turn connects grounded relay 1325 to both the tip and ring leads for the purpose of determining whether the selected circuit has a ground or a battery marking. On previous connections it will be read the markings were always of a grounded character. On this connection the selected circuit has a battery marking, therefore relay 1325 operates, closing a circuit for the operation of relay 1306 to battery, placed on lead 1337 by relay 1328. Relay 1306 at contact 1353 closes a circuit through a contact on relay 1308 to ground that is present on lead 1342, for the purpose of operating battery test relay 1323. Relay 1306 at its bottom contacts closes circuits through the lower biasing windings of the test relays 1317 to 1320 inclusive, thereby preparing them for testing the tip side of the toll line to determine approximately how high a resistance to battery the selected circuit has. For example, if the selected circuit has approximately 2000 ohms in its battery path, then relay 1317 operates, the other relays not receiving enough current for operating. If the selected circuit has approximately 800 ohms, then relays 1317 and 1318 receive enough current to operate.

Similarly, with approximately 500 ohms relays 1317, 1318 and 1319 operate, or if said circuit only has approximately 30 ohms then all four relays operate. This provides for four different kinds of selected circuits and arrangement is made at 1354 for connecting two more test relays when required. In the case of the tributary toll line the resistance is of the order of 2000 ohms so that only relay 1317 operates. Under the above test condition relay 1322 is connected to the ring side of the selected circuit through contact 1356 on relay 1323 but does not operate.

Assuming that test relay 1317 operates under the above test conditions, a ground circuit through corresponding relay 1301 will be closed which may further be traced through top inner contact relay 1323 to battery, placed on lead 1337 by relay 1328. Relay 1301 at its bottom contact locks to ground and at its top make contact closes the circuit for operating relay 1300 when the cut-off relay 1224 operates. The latter relay operates after a time interval determined by the release of relay 1310, said interval being long enough to cover the testing and conditioning of the selected tributary toll line. The operation of relay 1224 in addition to other functions formerly described connects ground at its top inner contact to lead 1349, traced further through the top armatures and back contacts of relays 1302 to 1305 inclusive, thence through top armature and front contact on operated relay 1301, through winding relay 1300 to battery. The latter relay operating connects ground to winding of relay 1203 to battery, thereby operating said relay which sends the circuit through all of the steps formerly described for a ring-down toll line. In this case, however, relay 1233 does not operate and therefore 48-volt battery through resistance 1324 is not connected to lead 1258 for operating relay 713 in the incoming toll line arranged for voice-frequency signaling. Relay 713 in the incoming toll line remaining normal, therefore prevents sending the ringing signal through and permits the regular toll operator to be connected to the circuit.

Connections to switchboard positions handling delayed calls

It may happen on some calls that all outgoing toll lines are in use or for other reasons it may be necessary to handle an incoming call on a delayed basis. In such cases the incoming call will be routed to special switchboard positions over special trunks which contain a simplex bridge that throws the discriminating circuit to the battery test condition in the same manner as above described for connections to tributary toll lines. When battery test relay 1323 operates and connects the tip lead through relays 1301 to 1305 inclusive to ground, and connects relay 1322 to 48-volt battery, it will be found that only the latter relay operates. This is due to 48-volt battery through relay 1322 first functioning the selected trunk circuit and causing it to connect a low resistance ground on the ring conductor. Said low resistance ground then causes relay 1322 to operate. The operation of the latter relay closes an obvious circuit for operating relay 1305. None of the test relays 1301 to 1304 on the tip side of the circuit operate, so that when relay 1224 operates ground at its top inner armature is connected to lead 1349, traced further through top outer make contact on relay 1306 to the top armature and make contact on relay 1305, thence through the armature and back contact relay 1307 to battery through winding relay 1314. In the circuit thus traced, relay 1307 will be normal, only if the incoming circuit is a straightforward toll line. Thus relay 1314 connects ground to winding of slow release relay 1315, thereby shunting it out and causing it to release after a definite time interval. During this interval the operation of relay 1314 closes a 48-volt battery circuit through resistance 1275, and over lead 1279 to lead 1357, traced thence over lead 1276, through top outer contact relay 1225 to the tip lead 1259 leading to the tip conductor of the delayed call trunk. The closure of this battery thereupon conditions said trunk for straightforward operation. When relay 1315 finally releases it closes a circuit for operating relay 1225, traced from ground at the bottom inner contact relay 1329, lead 1342, contact on relay 1315, lead 1350 to battery through winding relay 1225. The latter relay in operating then causes the discriminating circuit to cut through and release as previously described.

If an incoming toll line arranged for ring-down signaling is being connected to a trunk handling delayed calls, then relay 1307 referred to above would have been operated over the following path immediately upon the discriminating circuit being attached to the plug circuit. Said path is traced from battery through winding relay 1307, lead 1358, contact and sleeve jack 1217, lead 1280, inner contact and armature relay 1100, lead 1160, arm 1035 on plug switch 1027, bottom outer contact relay 1003 thence through arm 1028 on plug switch 1027 to ground. Switch 1027 as previously discussed takes this setting automatically whenever the incoming toll line is arranged for ring-down signaling. Therefore when relay 1305 operates as described above, instead of its operating relay 1314, it operates relay 1225 which immediately causes the discriminating circuit to cut through and release without connecting 48-volt battery to the tip conductor of the delayed call trunk, thereby conditioning said circuit for ring-down operation.

What is claimed is:

1. In a telephone system, two terminal toll positions, an intermediate toll position, toll lines, means at said intermediate position for interconnecting two of said lines to establish a through connection between said terminal positions, supervisory devices at each of said positions, means for sending signaling current from one terminal position directly through the intermediate position to the distant terminal position without rendering effective the supervisory devices at the intermediate position, and means at said distant terminal position responsive to said signaling current for operating the supervisory devices thereat.

2. In a telephone system, two terminal toll positions, an intermediate toll position, toll lines, means for interconnecting two of said lines at the intermediate position to establish a through connection between said terminal positions, supervisory devices at each of said positions, means for sending signaling current from either of said terminal positions directly through the intermediate position to the distant terminal position without operating the supervisory devices at the intermediate position, and means at said distant terminal position responsive to said signaling current for operating the supervisory devices thereat.

3. In a telephone system, two terminal toll positions, an intermediate toll position, toll lines, means for interconnecting two of said lines at the intermediate position to establish a through connection between said terminal positions, super-

visory devices at each of said positions, means for sending supervisory signal currents from either terminal position directly through the intermediate position to the distant terminal position, means for acknowledging said supervisory signals by sending an acknowledgment signal in the opposite direction from one terminal position through the intermediate position to the other terminal position, means at each terminal position responsive to the supervisory signals sent from the opposite terminal position for operating the supervisory devices thereat, and means at each terminal position responsive to the acknowledgment signal sent from the other terminal position.

4. In a telephone system, two terminal toll offices, an intermediate toll office, toll lines, means at the intermediate office for interconnecting two of said lines to establish a through connection between said terminal offices, supervisory and disconnect signals at each of said offices, means for sending signaling current over the established connection from one terminal office directly through said intermediate office to the distant terminal office to operate the supervisory signals at said distant office without operating the signals at said intermediate office, and means for sending signaling current from one terminal office over said established connection to operate the disconnect signals at the intermediate office and at the distant terminal office.

5. In a telephone system, two terminal toll offices, an intermediate toll office, toll lines, means at the intermediate office for interconnecting two of said lines to establish a through connection between the terminal offices, supervisory and disconnect signals at each of said offices, a plurality of sources of current of different frequency, means for sending current from one of said sources over said established connection from one terminal office to the distant terminal office to operate the supervisory signals at said distant office without operating the signals at said intermediate office, and means for sending current from another of said sources over the established connection to operate the disconnect signals at the intermediate office and at one of said terminal offices.

6. In a telephone system, two terminal toll offices, an intermediate toll office, subscribers' lines, toll lines, means at the intermediate office to interconnect two of said toll lines to establish a connection between said terminal offices, means at said terminal offices for joining a calling subscriber's line and a called subscriber's line to the respective ends of said toll connection, supervisory signals at each of said toll offices, and means controlled by one of said subscriber's lines for sending signaling current from a single source over the established toll connection to the terminating office at the distant end for operating the supervisory signal at said distant terminating office without operating the supervisory signal at said intermediate office.

7. In a telephone system, an originating toll office, a terminating toll office, an intermediate toll office, subscribers' lines, toll lines, means for interconnecting two toll lines at the intermediate office to establish a through toll connection from the originating office to the terminating office, means for connecting a calling subscriber's line to the originating end of said toll connection, means for connecting a called subscriber's line to the terminating end of said toll connection, supervisory and disconnect signals at each of said toll offices, means controlled by one of said subscribers' lines for sending signaling current from a single source over the established toll connection and through the intermediate office to cause the operation of the supervisory signal at the distant toll office without causing the operation of the supervisory signal at said intermediate office, and means for sending signaling current over said toll connection from the originating office to cause the operation of the disconnect signals at the intermediate office and at the terminating office.

8. In a telephone system, an operator's position, incoming lines, outgoing lines, means at said position for interconnecting an incoming line and an outgoing line to establish a connection, a mechanism common to said lines for making a test to determine the character of the connected incoming and outgoing lines, and supervisory signal circuits for the connected lines controlled by said mechanism in accordance with the determined character of said lines.

9. In a telephone system, an operator's position, incoming lines and outgoing lines of different character, means at said position for interconnecting two of said lines to establish a through connection, supervisory signals at said position, means for sending signaling current over the established connection, a discriminating mechanism common to said lines for making a test to determine the character of the connected incoming and outgoing lines, and means controlled by said discriminating mechanism for preparing the connected lines either to transmit said signaling current through said position or to receive said signaling current for causing the operation of said supervisory signals according to the character of the connected lines.

10. In a telephone system, a toll operator's position, incoming and outgoing toll lines of different character, means for interconnecting two of said lines at said position to establish a through toll connection, supervisory signals at said position, means for sending signaling current from either end of the established connection towards said position, a discriminating mechanism for determining the character of the connected toll lines, and means controlled by said discriminating mechanism for preparing the connected lines either to transmit said signaling current directly through said position or for receiving said signaling current to cause the operation of said supervisory signals.

11. In a telephone system, an operator's position, incoming lines and outgoing lines of different character, means for interconnecting an incoming line to an outgoing line at said position to establish a through connection, a discriminating device common to said lines, means responsive to the interconnection of two of said lines for associating the discriminating device with said lines, means in said device for testing to determine the character of the incoming line and the character of the outgoing line, a supervisory signal at said position, means for sending signaling current over the established connection towards said position, means controlled by said discriminating device for preparing the connected lines to transmit said signaling current through said position without causing the operation of said supervisory signal or for preparing said connected lines to receive said signaling current at said position to cause the operation of the supervisory device dependent upon the character of the two connected lines, and means for disasso-

ciating said discriminating device from said connected lines.

12. In a telephone system, a toll operator's position, incoming and outgoing toll lines, a completing trunk outgoing from said position, means at said position for interconnecting an incoming toll line and an outgoing toll line or for interconnecting an incoming toll line and said completing trunk, automatic switches at the distant end of said trunk, an impulse device at said position, a discriminating mechanism at said position for determining whether the incoming toll line is connected to an outgoing toll line or to said trunk, means controlled by said discriminating mechanism for rendering said impulse device effective to control said switches if connection has been made to said completing trunk, and supervisory means at said position prepared by said discriminating mechanism if the incoming toll line is connected to an outgoing toll line.

13. In a telephone system, a toll operator's position, an incoming toll line, an outgoing straightforward toll line, an outgoing ring-down toll line, means at said position for connecting said incoming line to either of said outgoing lines, means for sending signaling current over said incoming line towards said position, a discriminating mechanism for determining whether the incoming line is connected to the straightforward line or to the ring-down line, means controlled by said discriminating mechanism for preparing the incoming line to transmit said signaling current directly through said position if the incoming line is connected to said straightforward outgoing line, and means controlled by said discriminating mechanism for preparing said incoming line to relay said signaling current to the ring-down line when the incoming toll line is connected to said ring-down line.

14. The combination with a toll line of supervisory devices associated with the end of said line, other lines, means for connecting said toll line with one of said other lines, means for sending signaling current over said toll line, and supervisory circuits associated with the end of said toll line serving to cause said signaling current either to pass directly between said toll line and the line to which it is connected or to cause the operation of said supervisory devices.

15. In combination, a two-way line, means effective when said line is seized at either end for sending signaling current over the line from the seized end to the distant end, means responsive to the receipt of the signaling current at the distant end for sending an acknowledgment signal back to the seized end, and means effective at the end of a predetermined interval if said acknowledgment signal has not been received for terminating the transmission of said signaling current.

16. In combination, a two-way line, means effective when said line is seized at either end to send a connect signal to the distant end, means responsive to the receipt of said connect signal to send an acknowledgment signal back to the seized end, means responsive to the receipt of the acknowledgment signal for terminating said connect signal, and means at either end for terminating said connect signal after a measured interval in case the connect signal being sent from that end has not been acknowledged.

17. In combination, a toll connection established between an originating position and a terminating position, a supervisory signal at the originating position, a source of current at the originating position for sending a rering signal to the terminating position, means operative at the end of the rering signal to send an order tone back to the originating position, means responsive to the receipt of said rering signal for sending a supervisory signal back to the originating position, and means for maintaining said rering signal on the connection until the sending of said supervisory signal is completed.

18. In combination, a toll connection established between an originating position and a terminating position, a supervisory signal at the originating position, an operator's set at said terminating position, means for sending a rering signal over said connection, means operative at the end of the rering signal to listen-in said operator's set automatically and to send an order tone back to the originating position, means responsive to the receipt of said rering signal for sending a supervisory signal back to the originating position, and means for maintaining said rering signal on the connection until the sending of said supervisory signal is completed.

19. In combination, a line terminating in multiple jacks at a plurality of operators' positions, relays, one for each jack, the conductors extending from the contacts of said jacks to the line being normally open at the contacts of the respective relays, means for operating the corresponding relay when an operator seizes one of said jacks to complete the connection to the line, and means controlled by an operated one of said relays to prevent the operation of another one of said relays.

20. In a telephone system, an incoming toll line, outgoing toll lines of different character, means for connecting said incoming toll line to any one of said outgoing toll lines, and means effective when the incoming line is connected to a particular one of said outgoing lines for transmitting a signal over said particular outgoing line to the distant end thereof to identify the character of said incoming line.

21. In a telephone system, two operators' positions, a line incoming to the first position, a second line outgoing from the first position and incoming to the second position, a third line outgoing from said second position, means for connecting said first line to the outgoing end of said second line, means responsive to such connection for sending a signal over the second line to the incoming end thereof to identify the character of said first line, means for connecting said second line to the outgoing end of said third line, and means controlled in accordance with the information sent over said second line concerning the identity of the first line for conditioning the established connection for the transmission of signals over said first, second, and third lines through said first and second positions.

22. In a telephone system, a toll line arranged for voice-frequency signaling, a second toll line arranged for composite signaling, means for connecting said voice-frequency line to said composite line, means responsive to such connection for transmitting the signal over the composite line to the distant end thereof, a second voice-frequency toll line, means for connecting the distant end of said composite line to said second voice-frequency toll line, and means responsive to the receipt of said signal for conditioning the established connection involving said three lines in series for the transmission of signaling current from one end of the established connection to the other.

23. In a telephone system, a line, means for sending signals over said line from one end to the other, a timing device at the sending end of said line, means for causing said device to begin the measurement of a new interval of time in response to the sending of each signal, means for sending a signal back over the line in the opposite direction, and means rendered effective by the signal sent back over said line after said timing device has completed the measurement of said interval for disabling said first means.

24. In a telephone system, a toll line, means for sending supervisory signals over the toll line from one end to the other, a timing device at the sending end of the toll line responsive to the sending of said supervisory signals for measuring a predetermined interval of time, means for causing said device to release and start a new interval in response to a subsequent signal sent before the timing device has completely measured the interval for a preceding signal, means for sending a signal back over the line to acknowledge the receipt of a supervisory signal, and means controlled by the acknowledgment signal and effective upon the measurement by said device of the full predetermined interval for terminating the sending of the supervisory signal.

25. In a telephone system, an incoming line terminating in an operator's connecting circuit, a bridge connected across said incoming line at the operator's connecting circuit, lines outgoing from said operator's position, means responsive to the connection of the operator's connecting circuit to one of said outgoing lines for removing said bridge for completing talking conductors of the incoming line through to said outgoing line, an auxiliary circuit at the operator's position, and means effective when said operator's circuit is connected to the auxiliary circuit for preventing the removal of said bridge from the incoming line and for preventing the closure of the talking conductors of said incoming line through to said auxiliary circuit.

26. In a telephone system, an operator's position, an incoming toll line terminating in a plug circuit at said operator's position, a terminating bridge connected across the conductors of said incoming line in said plug circuit, outgoing lines, means responsive to the insertion of said plug in one of said outgoing lines for removing said terminating bridge from said incoming line and for completing the conductors of said incoming line through to said outgoing line, an overflow jack, a discriminating device, and means controlled by said discriminating device when the operator inserts said plug circuit into said overflow jack for preventing the opening of said terminating bridge and for preventing the closure of the conductors of the incoming line.

27. A telephone system, an operator's position, an operator's telephone, a line outgoing from said position, means for establishing a connection to said line at said position, means at the distant end of said line for sending a succession of supervisory signals back over the line toward said position, supervisory means at the operator's position responsive to said signals, and further means responsive to said signals for opening the established connection to prevent the signals from passing to the operator's telephone.

28. In a telephone system, a subscriber's line, an operator's position, a toll line outgoing from said position, means at said position for establishing a connection between the subscriber's line and the outgoing end of said toll line, supervisory means at the operator's position, means at the distant end of the toll line for sending a succession of signals of current of different frequencies over the line toward said position, means at the outgoing end of the toll line responsive to said signals to operate said supervisory means, and means at the outgoing end of said line responsive to said signals for opening the established connection to prevent said signals from passing to said subscriber's line.

JOHN MESZAR.
FLOYD M. WIESE.