May 27, 1947. B. McKIM 2,421,034

TELEPHONE SYSTEM

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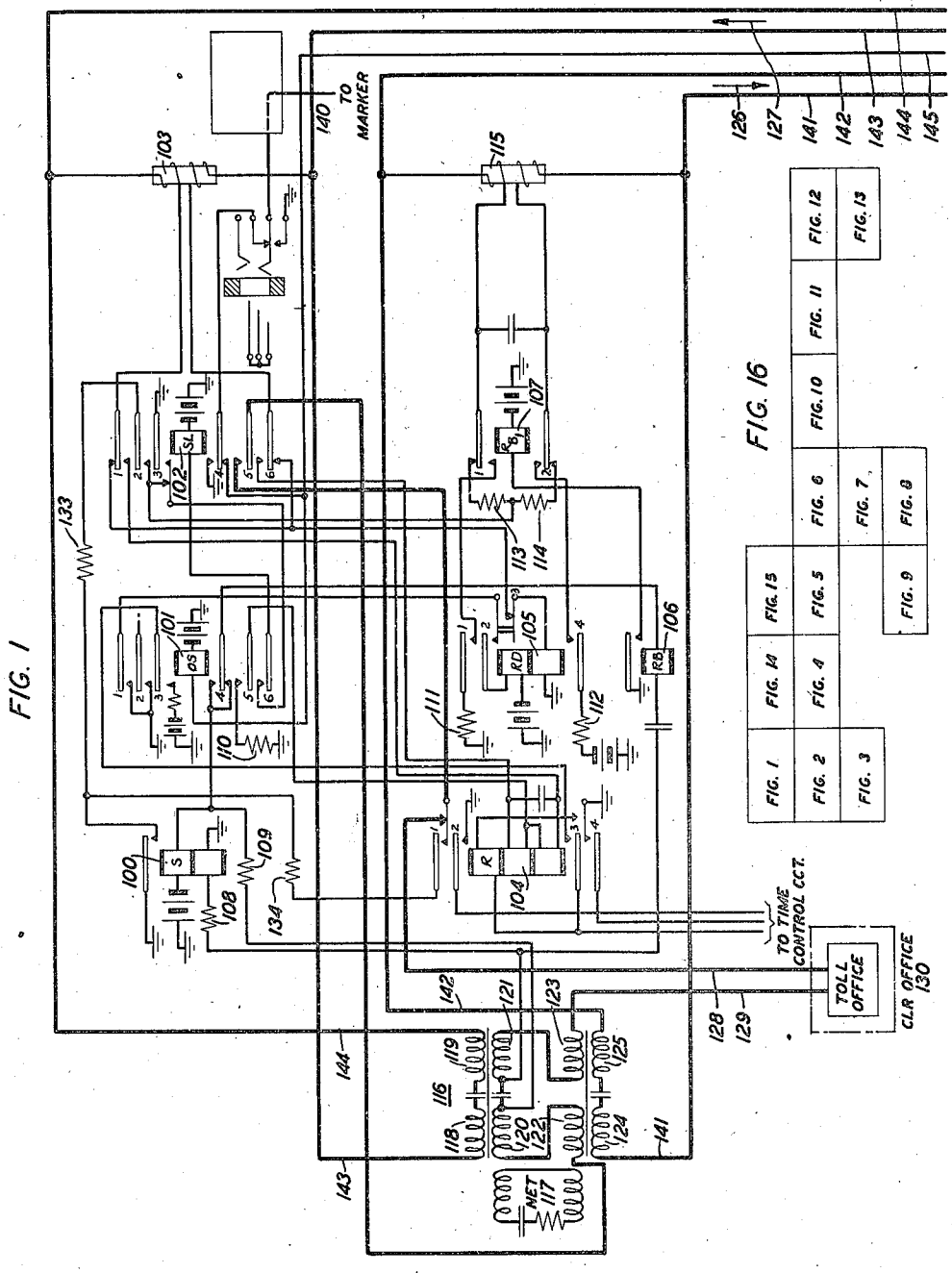


FIG. 1

FIG. 16

FIG. 1	FIG. 14	FIG. 15	FIG. 6	FIG. 7
FIG. 2	FIG. 4	FIG. 5	FIG. 10	FIG. 11
FIG. 3			FIG. 8	FIG. 9
			FIG. 12	FIG. 13

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TELEPHONE SYSTEM

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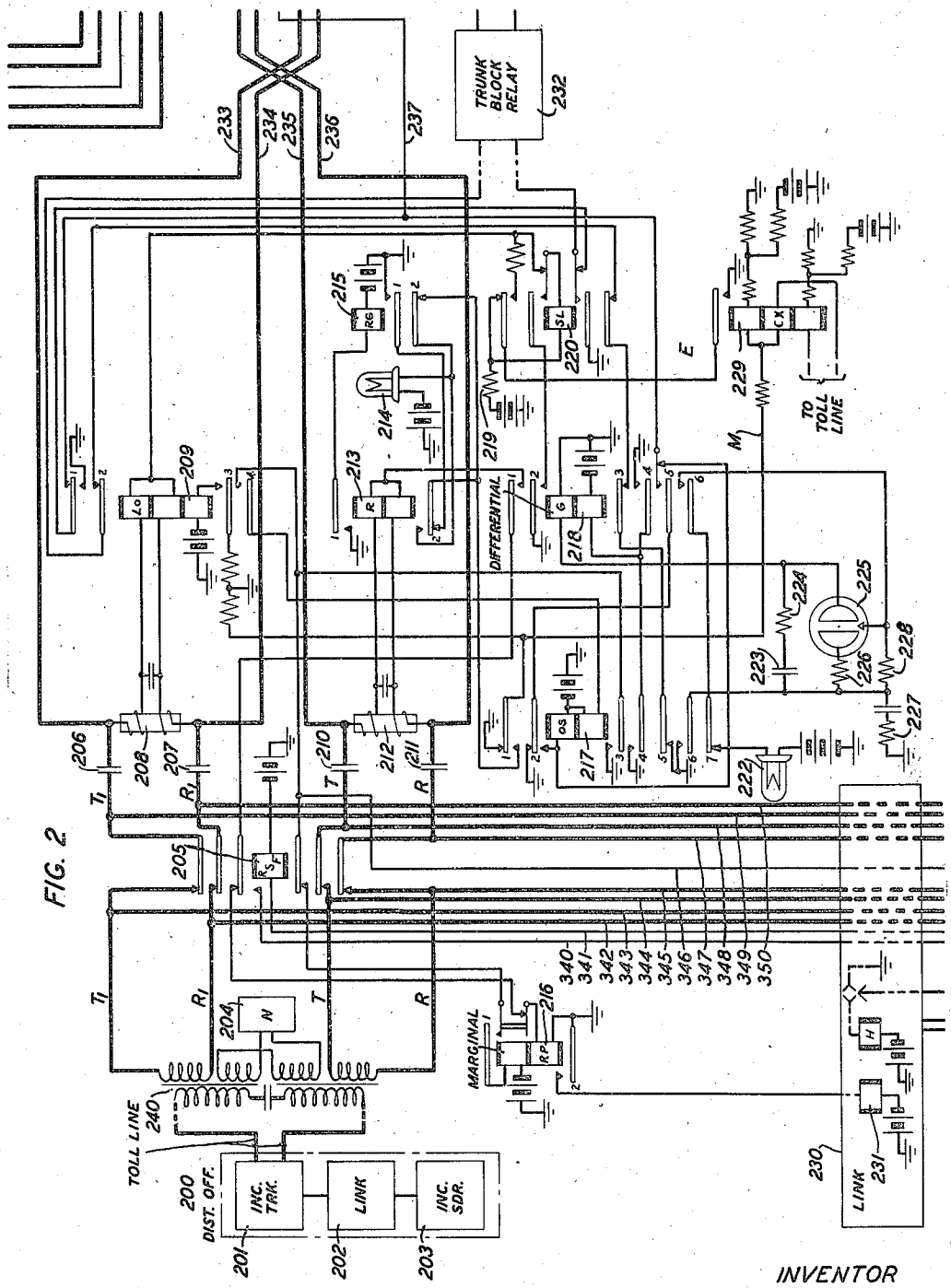


FIG. 2

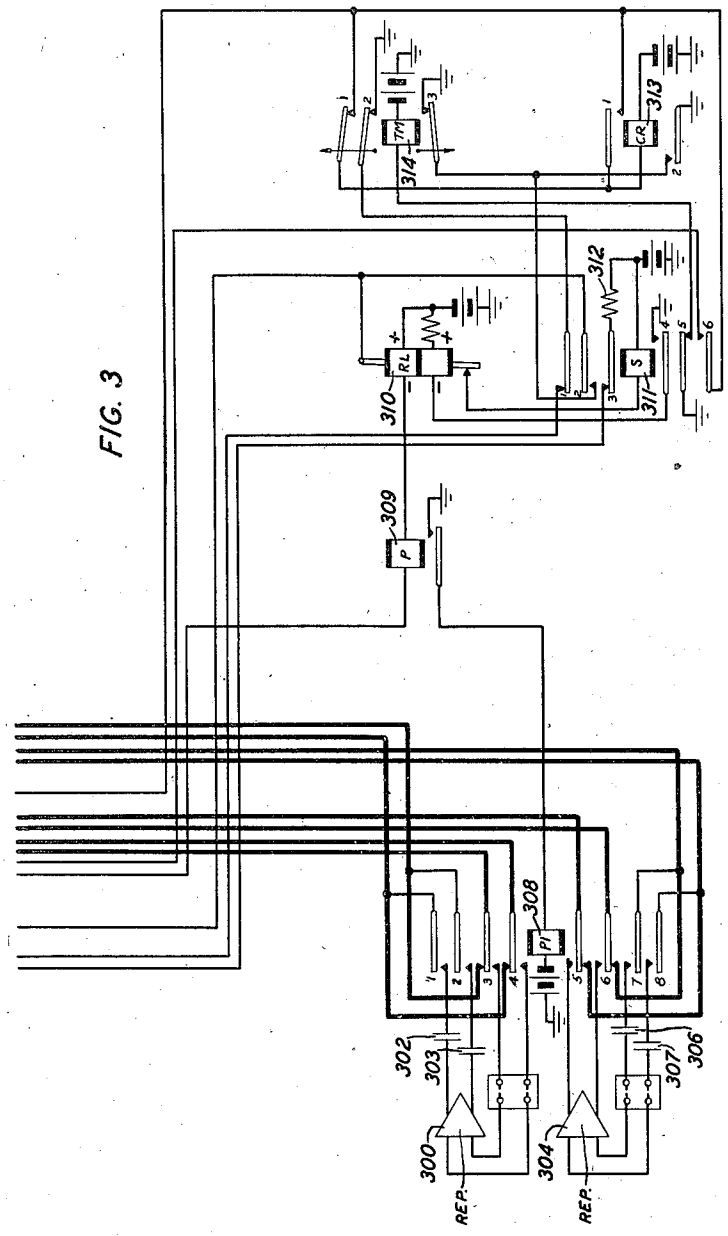
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TELEPHONE SYSTEM

Filed Aug. 18, 1944 18 Sheets-Sheet 3

FIG. 3



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TELEPHONE SYSTEM

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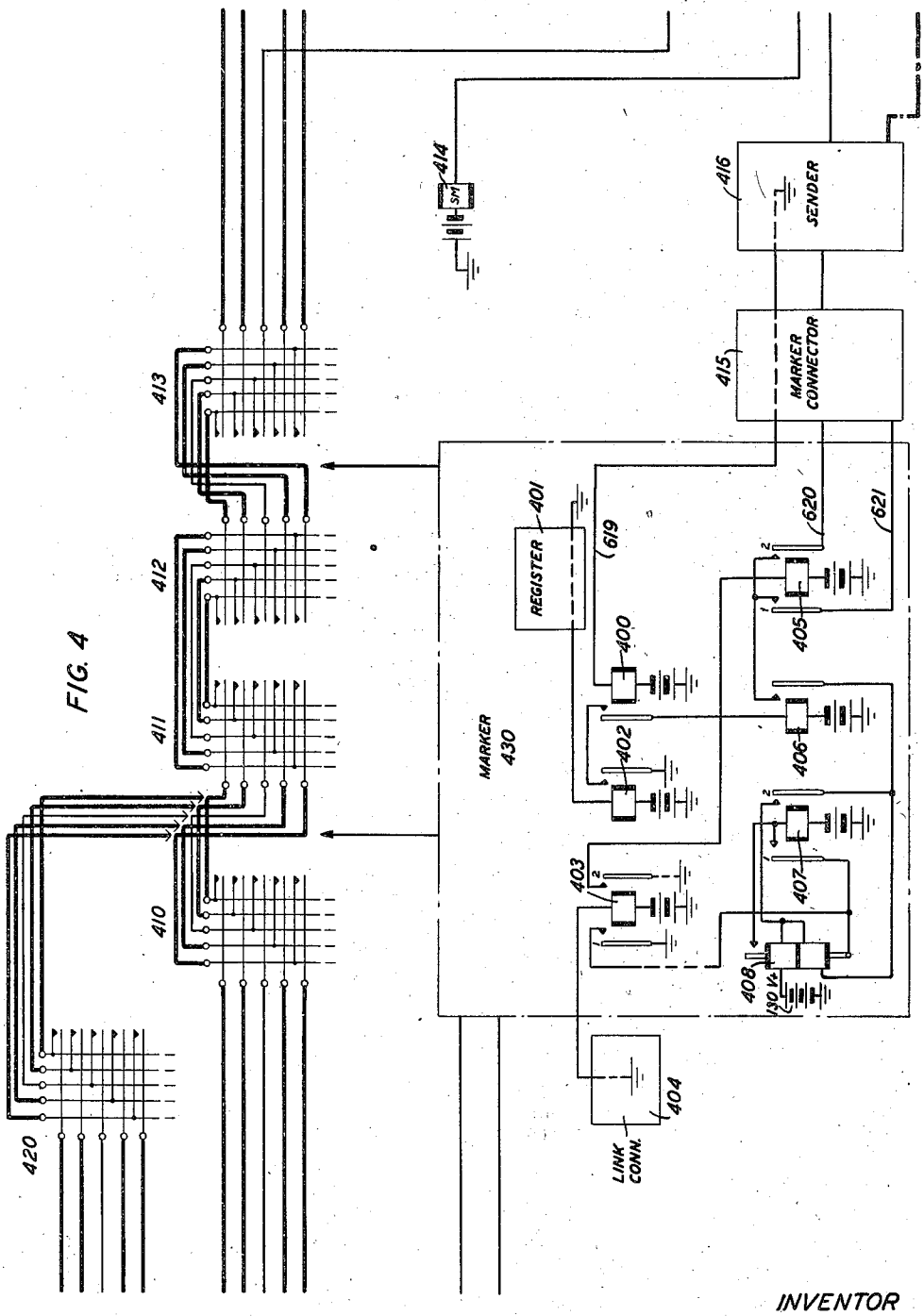


FIG. 4

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TELEPHONE SYSTEM

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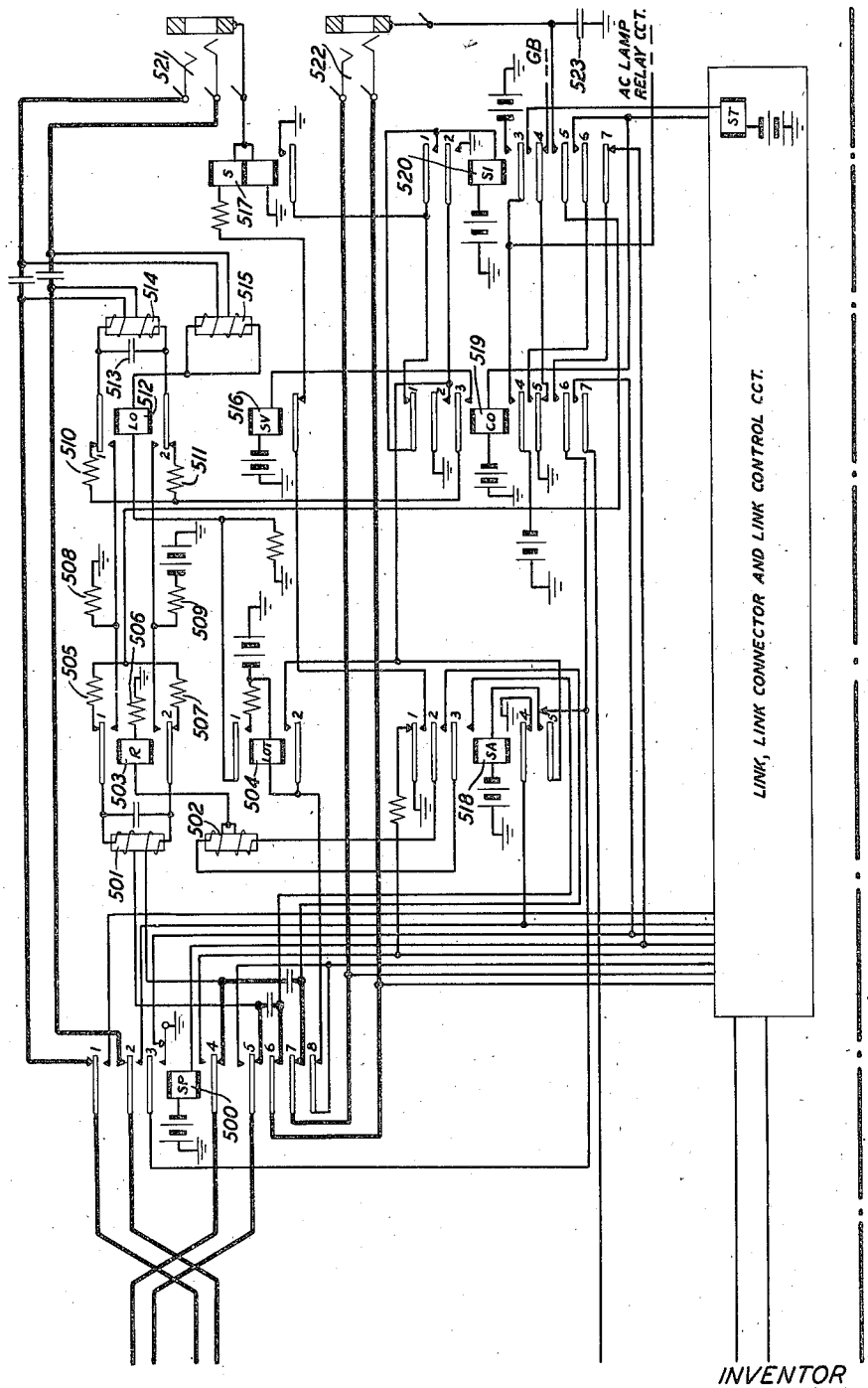


FIG. 5

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TELEPHONE SYSTEM

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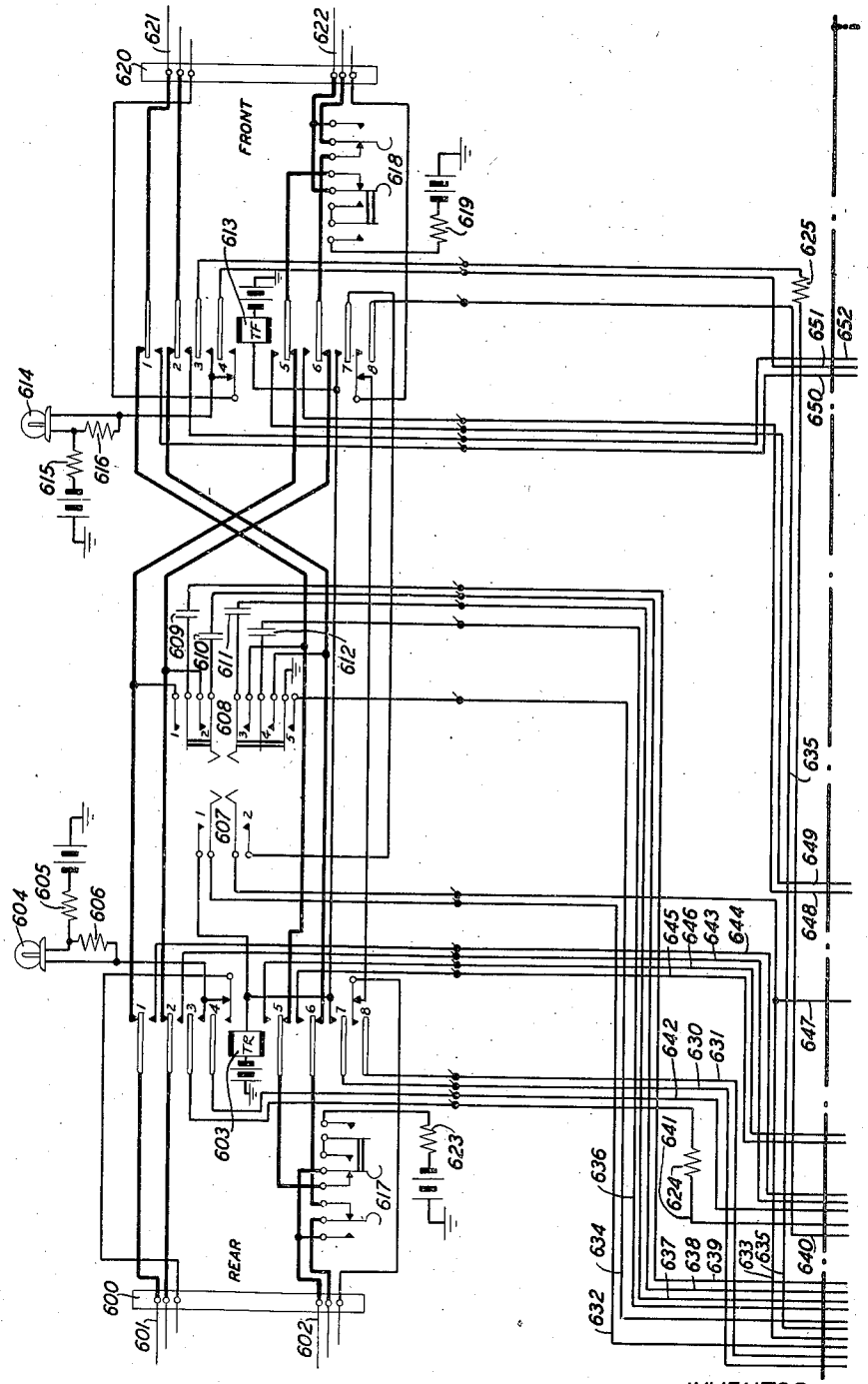


FIG. 6

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TELEPHONE SYSTEM

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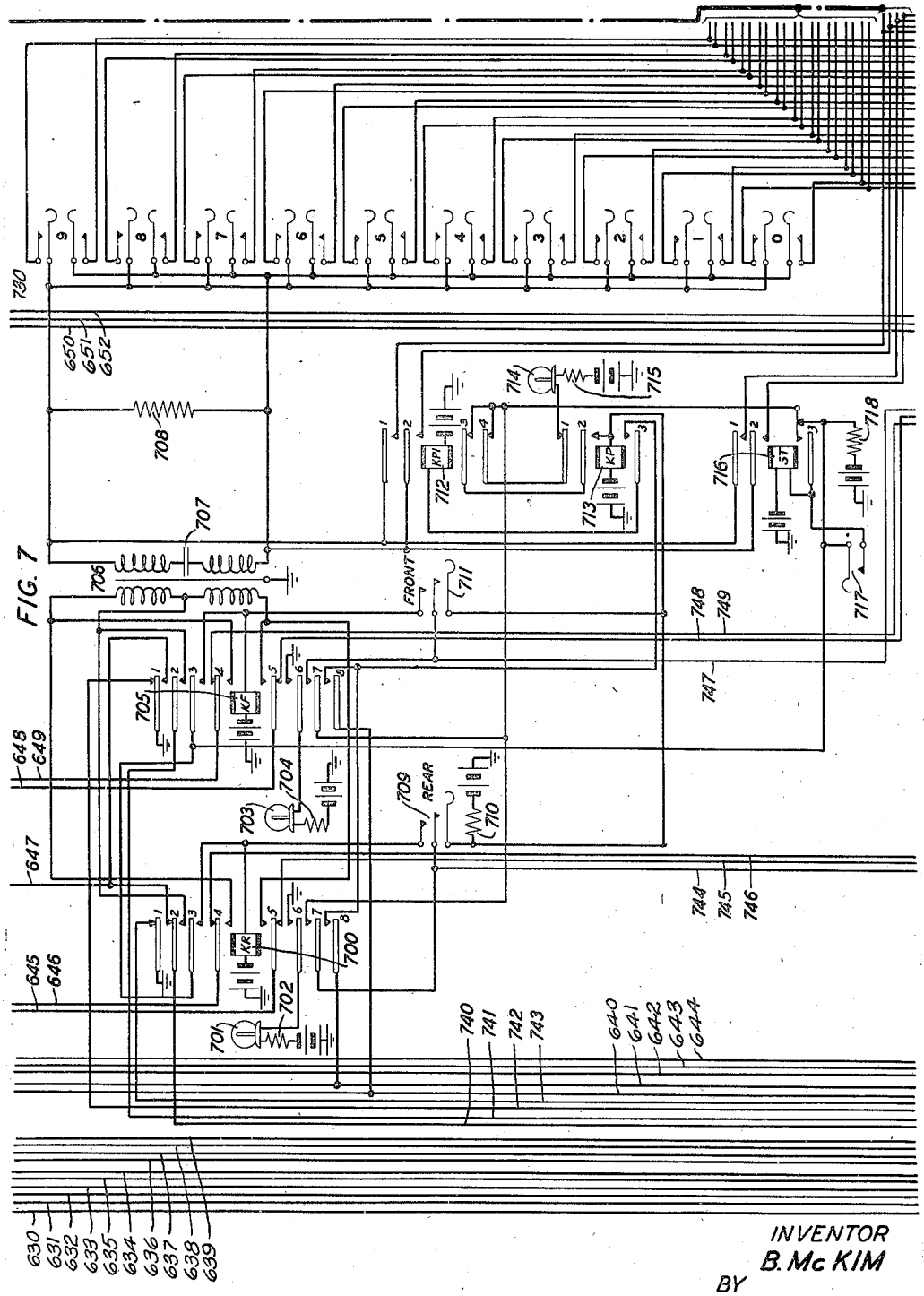


FIG. 7

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TELEPHONE SYSTEM

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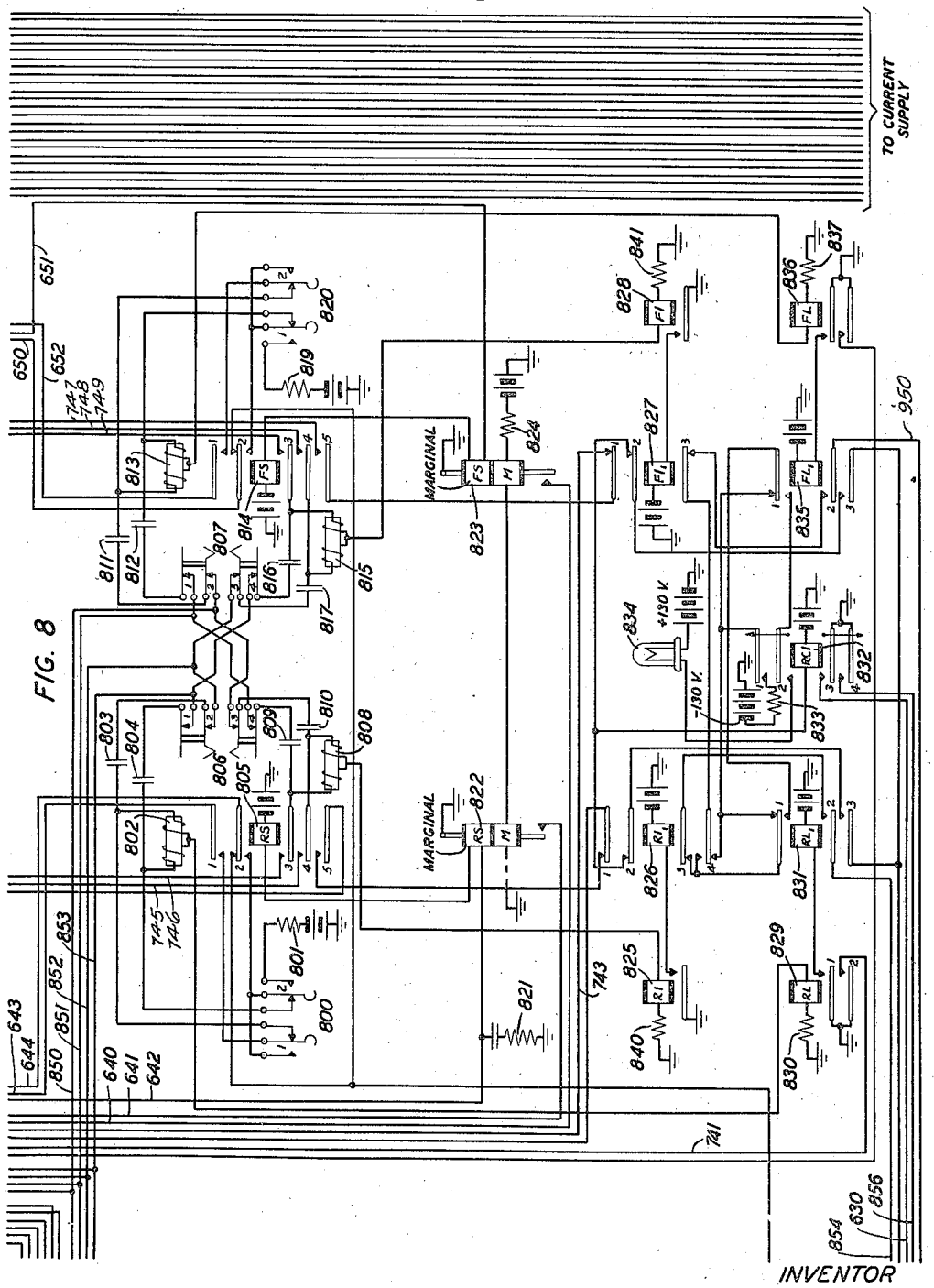


FIG. 8

May 27, 1947. B. McKIM 2,421,034

TELEPHONE SYSTEM

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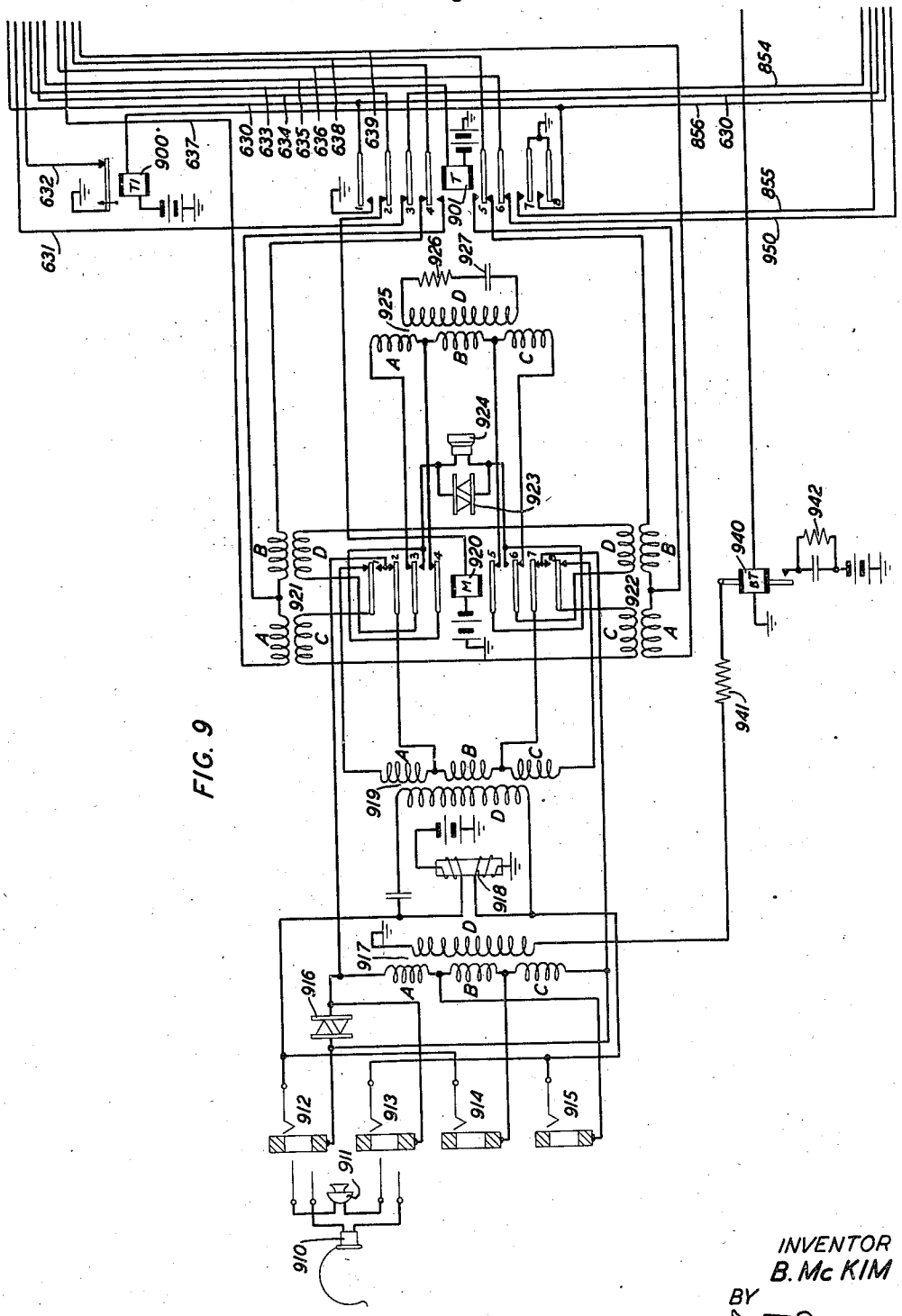


FIG. 9

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TELEPHONE SYSTEM

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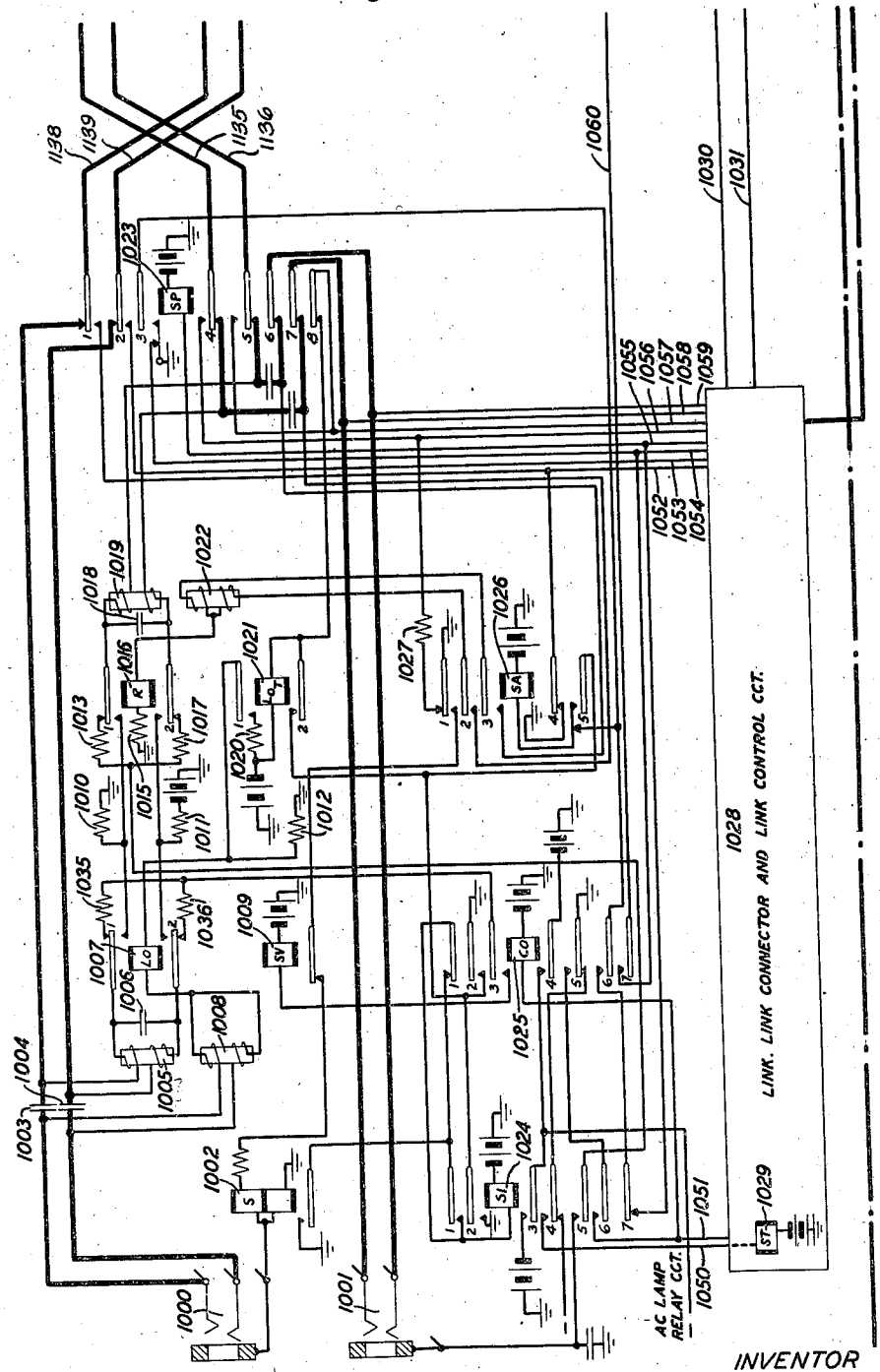


FIG. 10

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TELEPHONE SYSTEM

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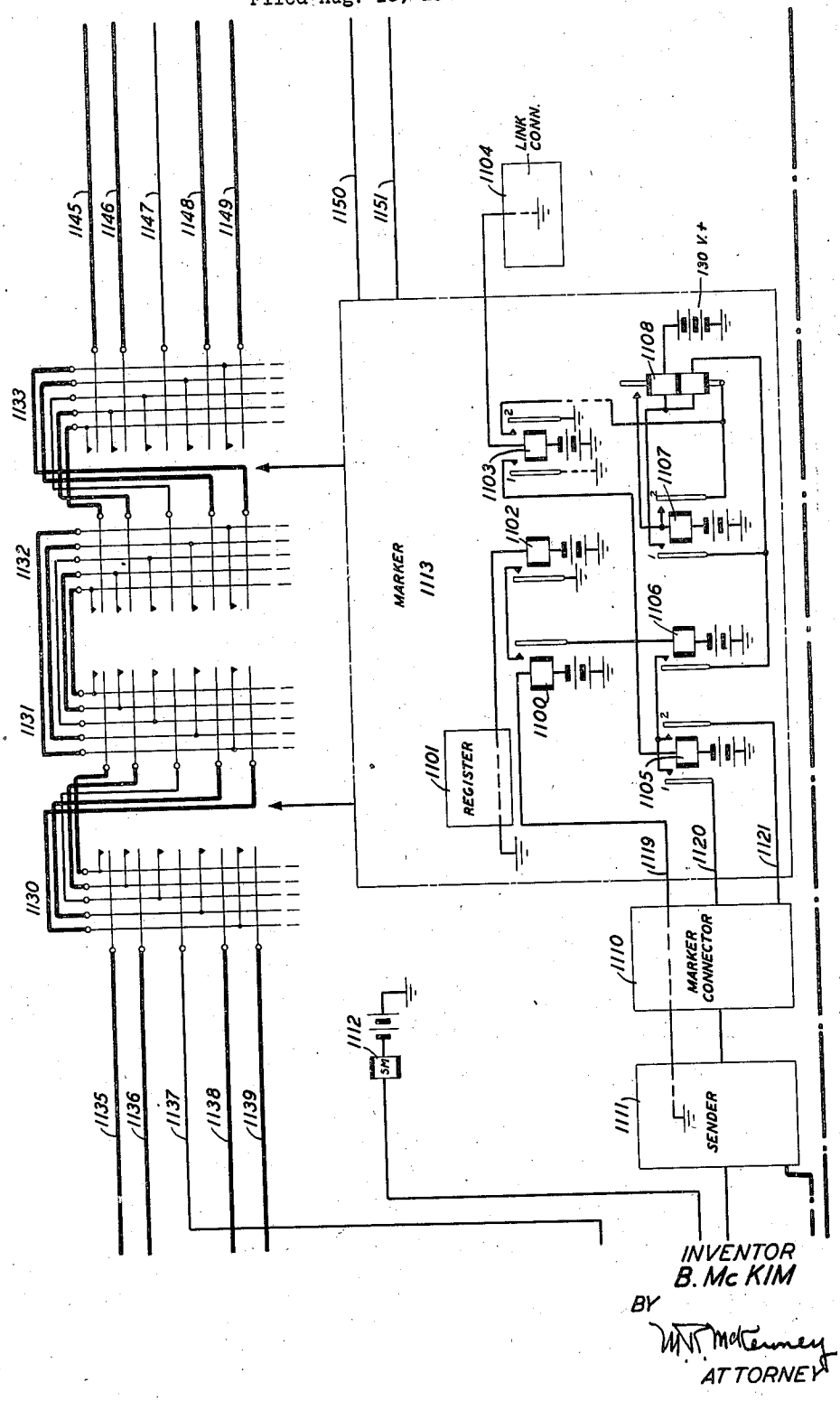


FIG. 11

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TELEPHONE SYSTEM

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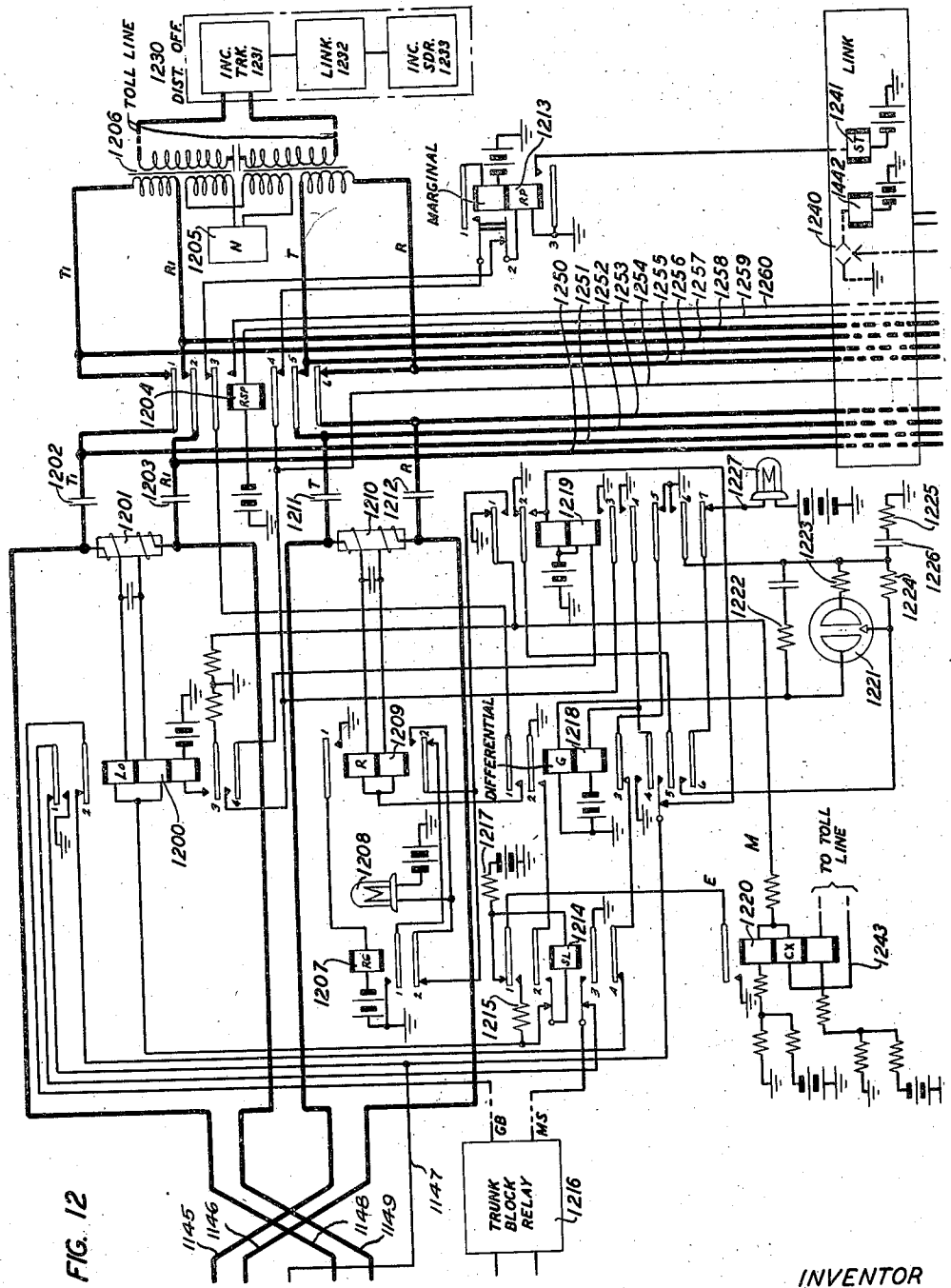


FIG. 12

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TELEPHONE SYSTEM

Filed Aug. 18, 1944 18 Sheets-Sheet 13

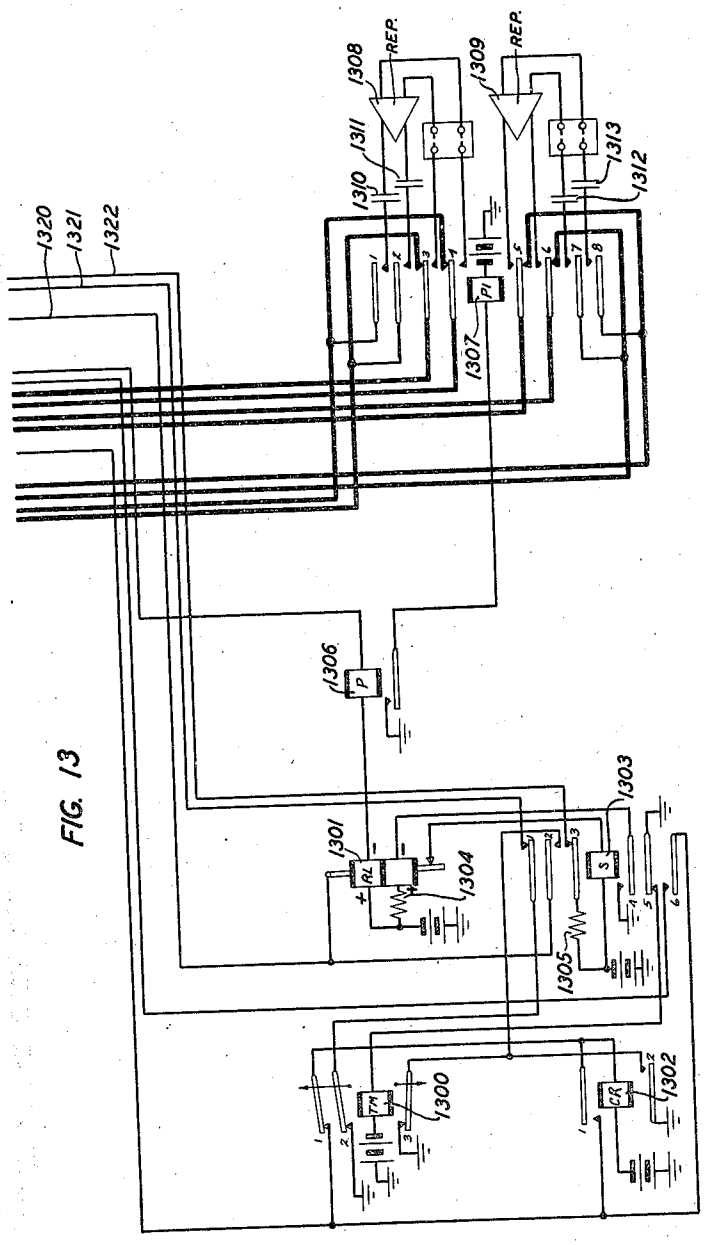


FIG. 13

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TELEPHONE SYSTEM

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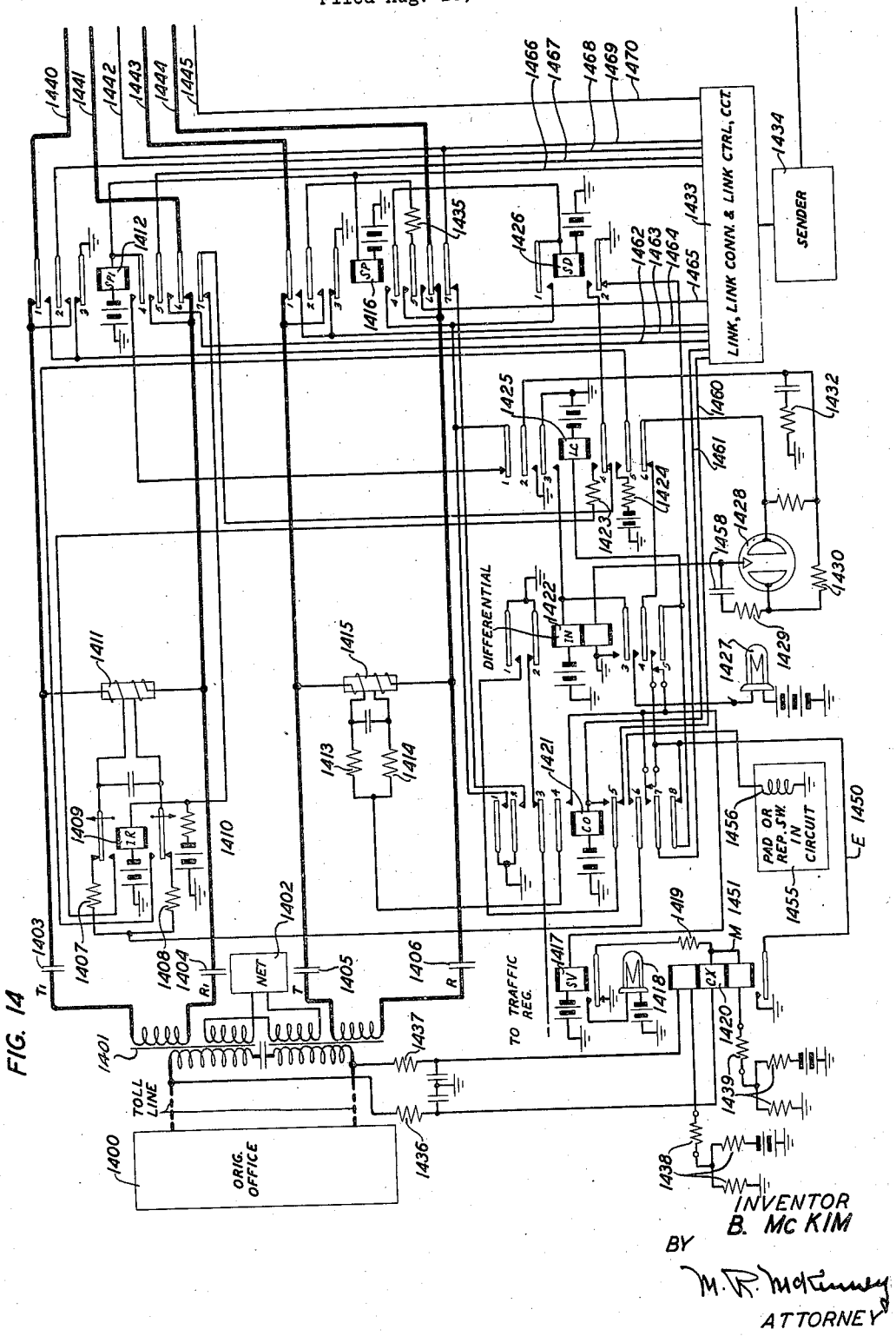


FIG. 14

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TELEPHONE SYSTEM

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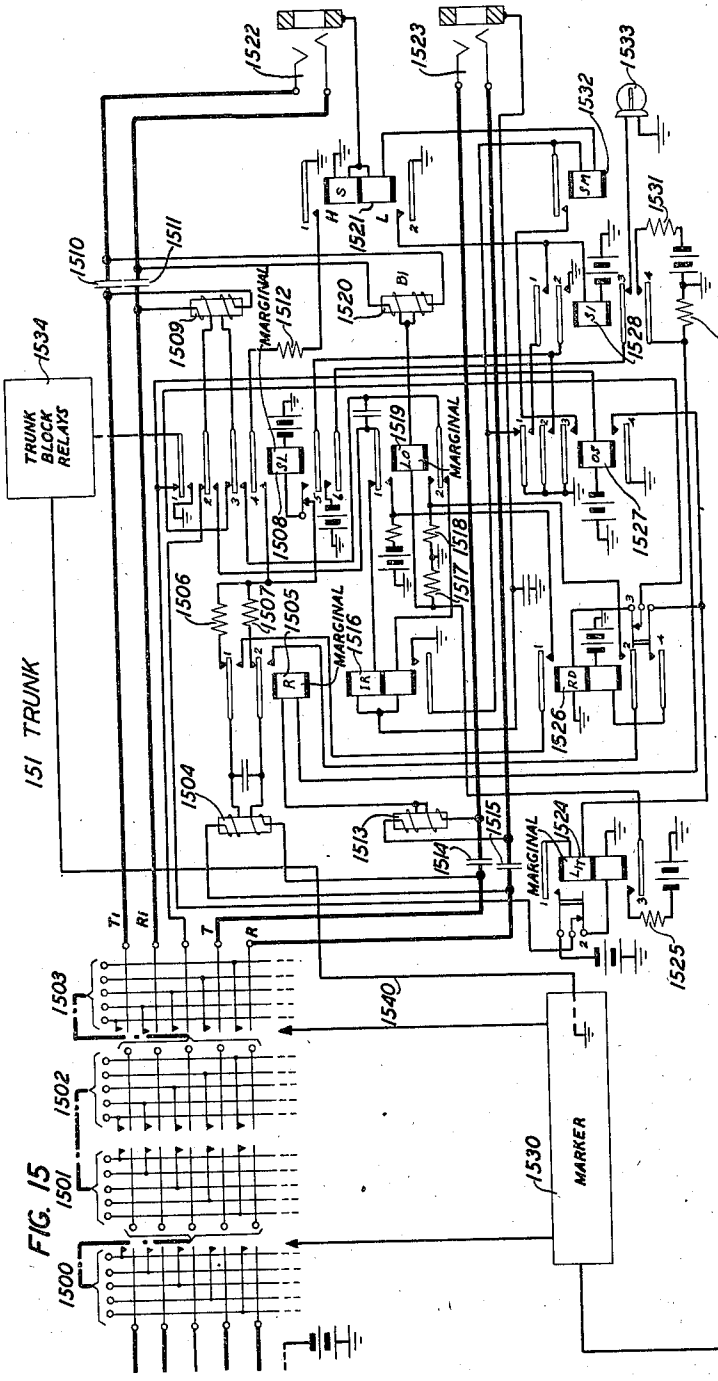


FIG. 15

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TELEPHONE SYSTEM

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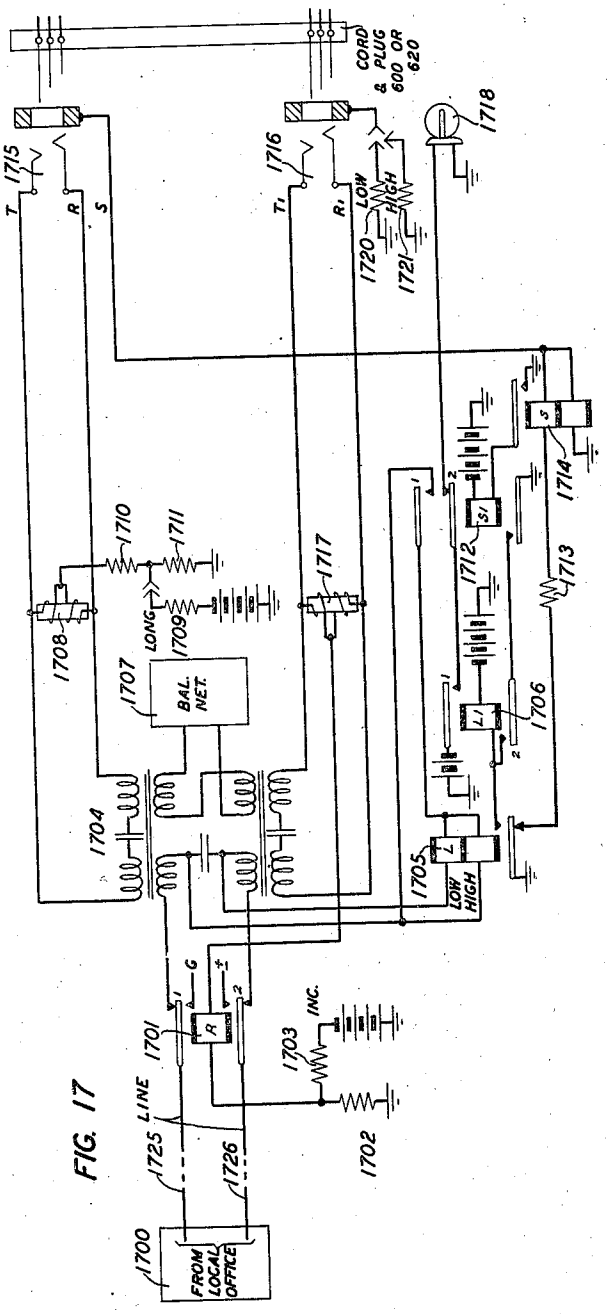


FIG. 17

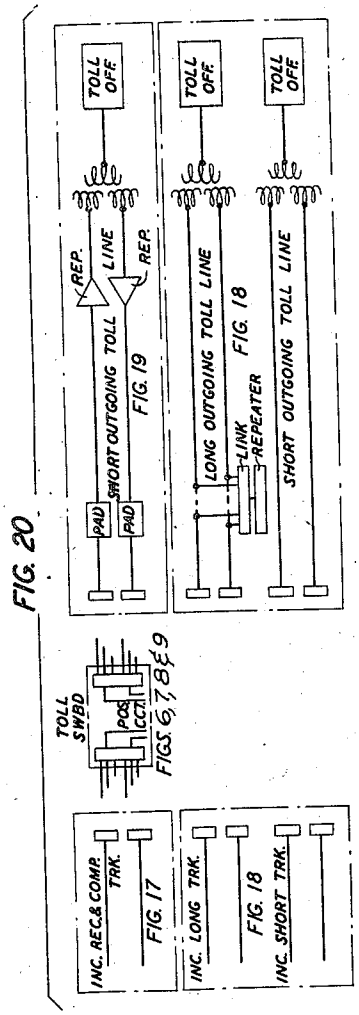


FIG. 20

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TELEPHONE SYSTEM

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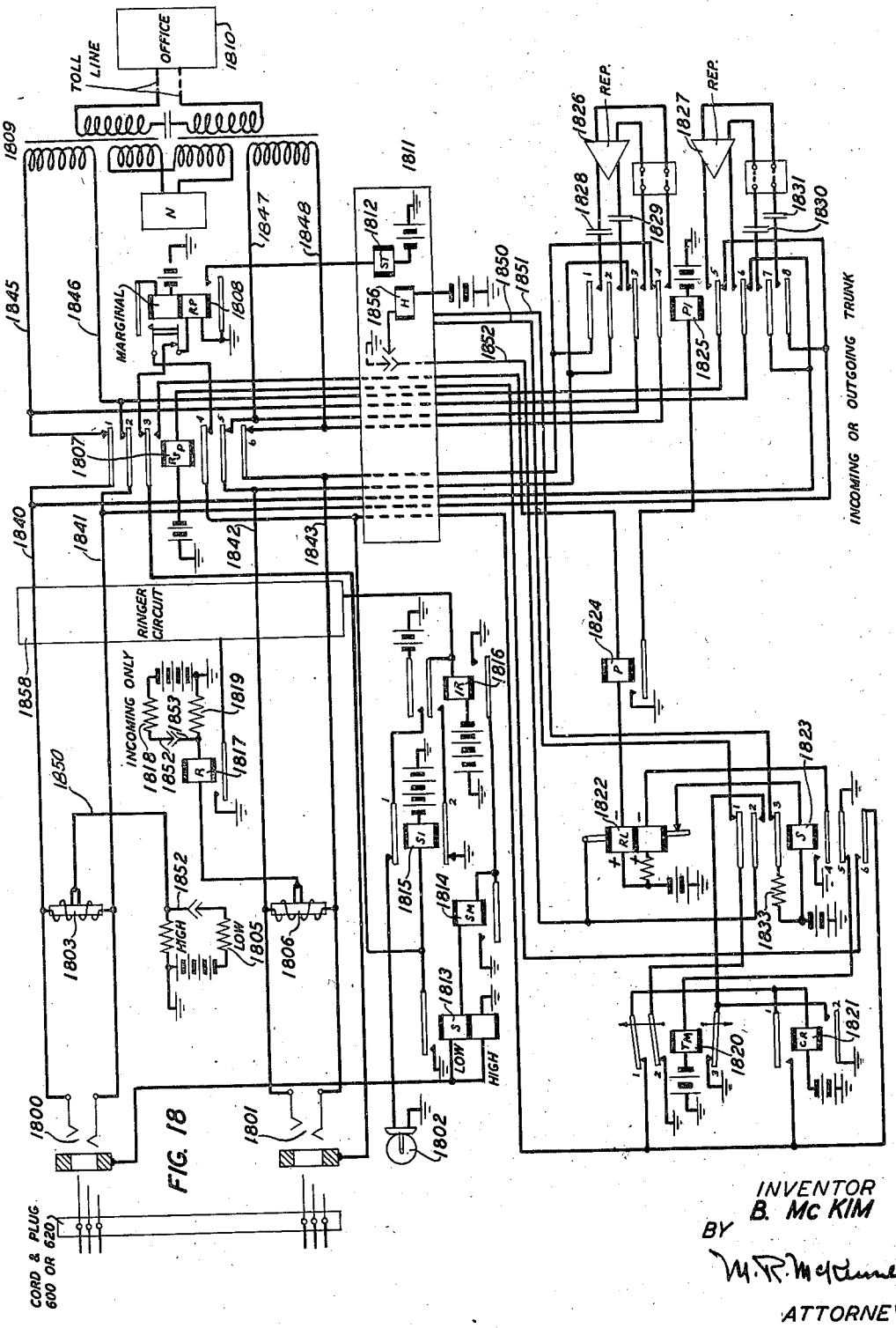


FIG. 18

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TELEPHONE SYSTEM

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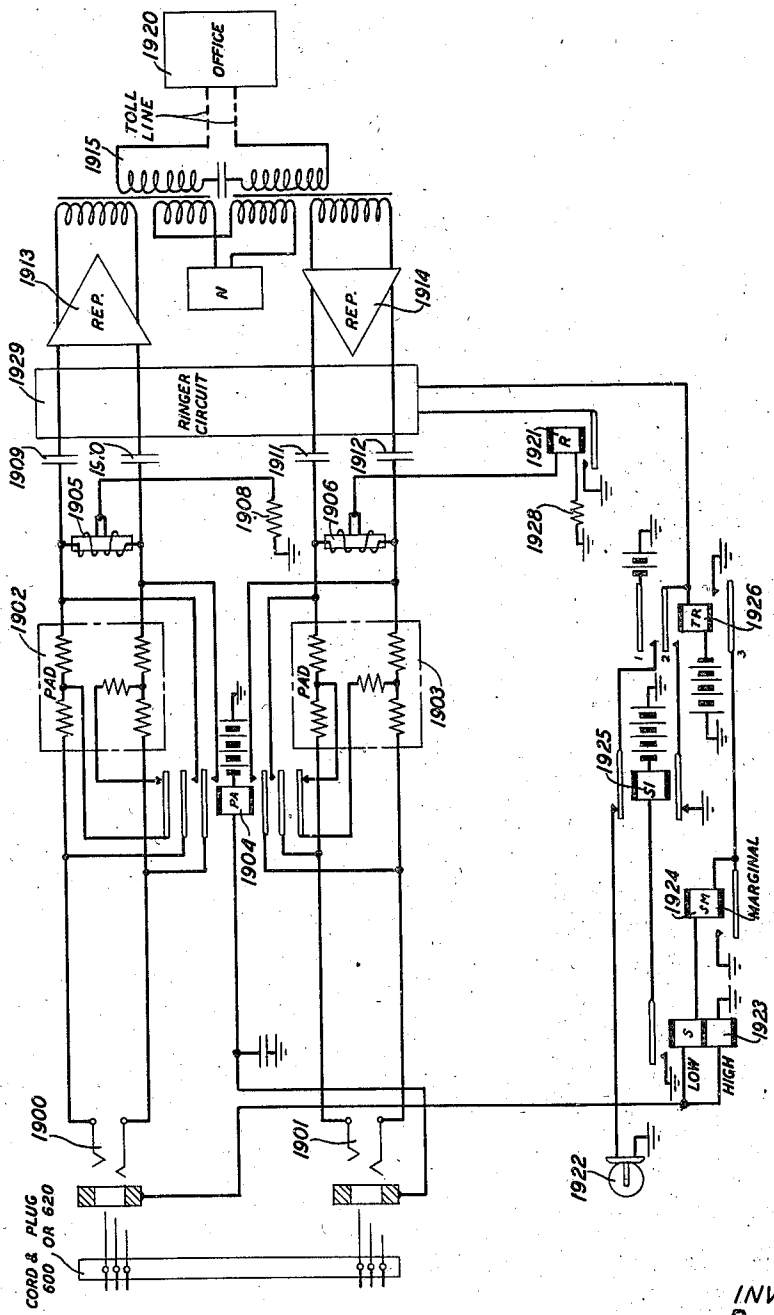


FIG. 19

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Patented May 27, 1947 2,421,034

UNITED STATES PATENT OFFICE

2,421,034

TELEPHONE SYSTEM

Burton McKim, East Orange, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application August 18, 1944, Serial No. 550,071

21 Claims. (Cl. 179—27)

1

This invention relates to telephone systems and more particularly to such systems with four-wire transmission circuits.

The object of the present invention resides in the improvement of facilities for controlling transmission quality over trunks and lines from a manually operable switchboard.

A feature of the invention consists in a manually operable switchboard having cord circuits with multicontact plugs for connecting the two channels of one jack terminating four-wire trunk to the two channels of another jack terminating four-wire trunk.

Another and related feature consists in mechanism in this manually operable switchboard for registering the transmission characteristics of the line and trunks connected to a cord circuit for automatically inserting voice amplifying repeaters in each of the two transmission channels or disconnecting voice amplifying repeaters from each of the two transmission channels, according to the trunk and line characteristics indicated in the switchboard mechanism.

Another and related feature consists in repeated use of trunks and a line connected to one twin plug of a cord circuit without removing the plug from said trunk connection and connecting the other plug of the cord circuit to a plurality of different trunks to different lines with means in said switchboard to register the characteristics of each trunk connection and automatically insert voice amplifying repeaters in the transmission channels or remove voice amplifying repeaters from the transmission channels, which were previously inserted therein.

The foregoing and other features of the invention will be described more fully in the following specification which should be taken in connection with the accompanying drawings and appended claims.

Referring to the drawings:

Figs. 6, 7, 8 and 9 illustrate a manually operable toll switchboard;

Fig. 1 illustrates a four-wire outgoing trunk to a toll office over a low loss toll line;

Figs. 2 and 12 each illustrates a four-wire outgoing trunk to a toll office over a high loss toll line;

Figs. 3 and 13 illustrate selectable voice amplifying repeaters;

Figs. 5 and 10 illustrate special four-wire trunks outgoing from the toll switchboard;

Figs. 4 and 11 diagrammatically illustrate senders and markers and cross bar switches operable under the control of the switchboard for

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selecting the outgoing trunks and for connecting them to the special trunks, Figs. 5 and 10;

Fig. 14 illustrates an incoming trunk from either a high loss toll line or a low loss toll line and diagrammatically illustrates a sender operable over said lines;

Fig. 15 illustrates a special trunk incoming to the toll switchboard from the incoming trunk, Fig. 14, and diagrammatically illustrates a marker and cross bar switch for connecting the trunk, Fig. 14 to the trunk, Fig. 15;

Figs. 17, 18 and 19 illustrate four-wire trunks incoming to and outgoing from the manually operable toll switchboard, Figs. 6, 7, 8 and 9; and

Figs. 16 and 20 show the manner of assembling the drawings to illustrate the invention.

The sender diagrammatically disclosed herein and the manner of operating this sender may be as disclosed in the copending application of B. McKim and O. Myers, Serial No. 550,070, filed August 18, 1944, which issued as Patent No. 2,382,893 on August 14, 1945. The marker, link connector, and the trunk block relays diagrammatically disclosed herein may be of the type disclosed in Patent 2,236,246 to G. V. King, J. B. McKim and O. Myers, March 25, 1941, and Patent 2,293,191 to A. J. Busch and F. J. Scudder, August 18, 1942. The marker-connector may be of the type disclosed in Patent 2,241,016 to G. V. King, F. A. Korn and R. K. McAlpine, May 6, 1941.

General description

It is shown in Patent No. 2,382,893 to McKim and Myers, that there are occasions when toll trunk groups outgoing from an automatic toll switching office become overloaded either for a short duration of time or for several hours. Under such conditions calls from nearby or distant toll offices encounter delay in obtaining an idle trunk in these groups for completing tool telephone connections. In order to facilitate the completing of toll connections over trunks in such groups, a call order switchboard is provided to which incoming calls may be routed which have encountered delay in obtaining an idle toll trunk to a desired destination. The call order switchboard has a number of operators' positions for handling delayed calls and announcing the amount of delay expected in completing calls to toll trunks in groups to particular offices. This switchboard is supervised by a supervisory operator who in combination with a group of persons, observes signals which indicate the overloading of trunk groups which if severely overloaded are made unavailable to incoming calls from other

offices and are made only available to the operators in the call order switchboard. A special arrangement is provided for making groups of trunks unavailable to incoming calls so that the calling operator is immediately appraised of the delay anticipated in obtaining an idle trunk for completing the desired connection. A ticket is written by a call order board operator covering the information for each call, including the originating toll operator's number and the trunk connection desired and these tickets are filed or stacked in a particular order so that the delayed calls may be completed substantially in the order received. The responsibility of completing these delayed telephone connections then rests upon the call order switchboard operators instead of the various calling operators from other toll offices and the time of these calling operators which would otherwise be required in making numerous attempts to complete the delayed connections is saved since only one call to the call order board operator is necessary.

Each group of toll trunks outgoing to other offices has one or more overflow trunks associated therewith which are connected by automatically operable mechanisms, along with the trunks of the group, with a trunk testing unit when the code of this trunk group is transmitted to the automatic switching office. The testing unit tests the trunks in the outgoing group of trunks and when no idle trunk is found it tests the overflow trunks and if an idle overflow trunk is found the incoming trunk is automatically routed thereto. The overflow trunk has two types of signals, one which flashes an indication over the incoming trunk that all trunks in the group are busy. This signal may be altered to a different flashing signal if a trunk in the group becomes idle while the calling operator holds the incoming line, hoping to receive this second flashing signal. Whenever a call is routed to an overflow trunk, a signal is operated which may be observed by the supervisory staff. If the calling operator does not receive a second flash after a given time, the connection is released and this operator then has the choice of making another attempt to obtain an idle trunk in this group a few minutes later or she may pulse a circuit request call which requires a special code to connect her through the mechanism of the automatic switching office with a trunk extending to the call order switchboard. Each call order switchboard position has a cord and telephone circuit for connection to this trunk and also has means to observe whether there is an idle trunk in the desired outgoing group. If the group is overloaded, this operator refers to a bulletin handed to her by the supervisory group. This bulletin posts all groups which are overloaded and on which there is a time delay in completing calls. The call order board operator advises the calling operator the condition of the group and writes a ticket to complete the call later if it cannot be immediately completed.

The supervisory staff observes the overflow signals if they are constantly operated and investigates the number of circuit request calls for which tickets have been written by the call order board operators for any group of trunks which are gaining in demand. If the trunks of a group are constantly busy and a given number of circuit request tickets have been written, a delay announcing circuit is patched to the overflow trunks of the group and thereafter the calling incoming trunks which are routed to an overflow circuit receive an announcement of the time period of delay in completing toll connections to the trunks of this group, instead of receiving the aforementioned flashing signals. The patching of the overflow trunks of a trunk group to the delay quotation circuit also operates mechanism to automatically make this group of trunks unavailable to incoming calls, even though there are idle trunks in the group. As these trunks become idle they are taken for use by the call order board operators for completing circuit request calls from tickets previously written.

The circuits and mechanisms disclosed herein deal with the completion of the toll telephone calls by the call order board operators and automatic signaling arrangements between trunks and the operator's position mechanism for inserting and removing voice amplifying repeaters according to characteristics required for good transmission over low-loss and high-loss toll lines. The low-loss toll line and the trunk mechanism with which it is connected will herein be called a short toll line and is one in which the loss because of resistance of the line conductors and other mechanisms connected therewith is low enough to provide good transmission characteristics. A high-loss toll line and the trunk mechanism with which it is connected will herein be called a long line and is one having a line and associated mechanism of sufficient resistance to require voice amplifying repeaters to give it substantially the equivalent transmission of the low-loss or short toll line. Under normal conditions in the automatic switching toll office, the trunks connected to long and short lines operate mechanism in the sender and marker which are automatically connected thereto to indicate to the marker where and when a voice amplifying repeater is required and the marker may operate mechanism in the selected outgoing trunk which causes the insertion of repeaters in the transmission channels. These functions are somewhat different when calls are completed through the call order board, since the same trunk outgoing or incoming may be used for a number of telephone connections.

The arrangement disclosed in this application includes an incoming trunk, Fig. 14, which may be incoming over a short toll line from a nearby CLR toll office 1499 or over a long toll line to a toll office in a distant city 1490, which assumes that the toll office 1400 may be in two different locations in order to economize in the drawings of this application. The trunk, Fig. 14, may be used for incoming calls for completing toll telephone connections over outgoing trunks, as described in the aforementioned Patent 2,382,893, to McKim and Myers, but the use herein described will be for making circuit request calls to the call order switchboard. This assumes that a call was previously made by an operator in office 1400 who was advised by signals that all of the outgoing trunks to the desired office were busy or by an announcement that there would be a given delay in obtaining an outgoing trunk to complete the connection. The operator in office 1400 may make a circuit request call by sending circuit request code pulses over the incoming toll line which are recorded by a sender and marker and the marker selects an idle trunk in a group of circuit request trunks shown in Fig. 15 which terminates in twin jacks and a lamp in the call order switchboard. As explained in the aforementioned patent, a call from a distant office over a long toll line is automatically routed

to a special circuit request trunk, Fig. 15, when code pulses have been transmitted over this long line designating the selection of a trunk in a group which has been patched for delayed quotation and also made unavailable to the calling incoming trunks. In either case the trunk call is answered by a call order board operator, who inserts a four-wire twin plug into the four-wire twin jacks of the trunk, Fig. 15, and operates the call order position talking key which connects the four-wire telephone circuit with the trunk transmission conductors extending to the calling operator. The call order board operator explains the overloaded condition of the desired outgoing trunk group to the calling operator and will ordinarily write a ticket for completing the toll connections and place this ticket with other tickets for calls to this trunk group. Special consideration may be given to urgent calls, particularly from distant cities having considerable toll line mechanisms already set in operating condition. Therefore, some calls may be completed directly from the circuit request incoming trunk Figs 14 and 15 to the desired outgoing trunk, if the call order board operator observes that an idle trunk in the group is at the time available.

A majority of the delayed calls are completed by the call order board operators from the tickets previously written. Special four-wire trunks, such as those shown in Figs. 5 and 10, have twin jacks in the call order board. These trunks are outgoing from the switchboard, but operate in the manner of an incoming trunk in that they select a sender through a link when the cord circuit plugs are inserted in the jacks. The special trunk, Fig. 5, is shown connectable with the two-way trunk, Fig. 1, for an outgoing call from the call order board over a short toll line to a nearby CLR toll board or connectable to the two-way trunk, Fig. 2, extending over a long toll line to a distant office. The offices, Figs. 1 and 2, are offices from which circuit request calls were received and tickets written covering the code of the calling office and the number of the operator who will handle the call. For the sake of efficiency the delayed calls from an originating office are handled by a delay through toll operator, termed a TX operator, after the ticket is written in the originating office by the regular through-toll operator. The number of this TX operator is placed on the ticket written by the call order board operator so that the latter operator can register the TX operator's number in the sender after the office code. These trunks, Figs. 5, 1 and 2 are therefore typical of the trunks used between the toll call order board and the office originating a toll call for a subscriber.

The trunk, Fig. 10, operates in the same manner as the trunk, Fig. 5, and is shown for making connections with outgoing trunks of overloaded groups to offices over short or long toll lines. Upon observing that there is an idle trunk in an overloaded group, the call order board operator may connect a rear cord 600 into jacks 1522 and 1523 for (1) setting up a connection to the TX operator and (2) place the front cord 620 into jacks 1000 and 1001 to set up the connection over an idle outgoing trunk to the office written on a ticket. The length of each toll line is automatically indicated to the call order board position mechanism, which automatically inserts voice amplifying repeaters where required if the repeaters have not already been inserted by the marker which selected the idle trunk, as explained later in detail. For good quality transmission, a voice amplifying repeater is required in each channel of a four-wire outgoing trunk when two long lines or trunks are connected together by the switches or cord circuits of a telephone office. When a short trunk is connected to a long trunk, no repeater is required for good transmission and if a repeater is inserted there would be too much gain. If repeaters are inserted in each of two long trunks which are connected together there would also be too much gain.

After the first connection is made with an idle outgoing trunk the call order board operator may use the same trunk for connection with different toll boards which have made circuit request calls. This is done by the call order board which may pulse any code into different senders which may be connected with the rear cord. It may be seen that one connection may have two long toll lines connected together and other connections may have a long and a short toll line connected together. In order to always provide correct transmission between the toll lines connected together through the call order switchboard, an automatically operable device is placed in the call order board position circuit for automatically removing or inserting voice amplifying repeaters as required, according to the indications signaled thereto by the trunks connected. This repeater removing and inserting mechanism is shown in Fig. 8 and is operated, as stated, by the signals from the trunks which are connected to the lines. The position mechanism after being operated by the trunks, remains in this status until the operator restores the talking key and at this time repeaters are either removed from or inserted in the channels of the four-wire transmission circuits as shown.

A second arrangement is included in the disclosure to illustrate the use of the call order switchboard as an independent toll office for handling incoming and outgoing calls on a four-wire basis.

Detail description

For making a circuit request call the toll operator in office 1400 seizes a toll line and trunk of the type as shown in Fig. 14. The seizure of the trunk closes a signal over its transmission wires for operating the composite signaling relay 1420, which may be referred to as the CX signaling circuit. The operation of relay 1420 associated ground with its E lead 1450 to actuate the incoming trunk Fig. 14. The ground from the contact of relay 1420 extends through contact 8 of relay 1421, winding of relay 1425 to battery and also extends through contact 7 of relay 1421, winding of relay 1417 to battery. Relay 1417 in operating disconnects ground from the composite signaling circuit and connects battery through lamp 1418 to its composite signaling M lead 1451. Office 1400 has a composite signaling relay therein substantially the same as relay 1420 which is operated when battery is associated through lamp 1418 with the M lead 1451. This does not cause the release of relay 1420 but transmits a signal to the office 1400 which is maintained until an incoming sender is associated with the incoming trunk Fig. 14. The signal is altered when a sender 1434 is associated with the trunk in order that the operator in office 1400 may become aware that she may transmit code pulses into the sender. Relay 1425 in operating connects ground to the timing circuit comprising condenser and resistance 1432 which is discharged if any charge remains in the condenser and the tube 1428 with

its associated network. Relay 1425 associated ground with the upper winding of relay 1422, operating the latter relay. Relay 1422 in operating locks through its contact 3 to ground on contact 3 of relay 1422. Relay 1422 also prepares a circuit through its contact 4 for connecting battery through lamp 1427 to the ionic tube 1428 when relay 1425 is later released. Ground is also connected to the link start lead 1460 from ground on contact 1 of relay 1422, contact 5 of relay 1421 through the winding of the link start relay to battery. This link may be of the character fully described in Patent 2,293,191 to A. J. Busch and F. J. Scudder, August 18, 1942. This type of link has a control circuit associated therewith for selecting the type of sender indicated therein by the trunk circuit. In this instance the trunk circuit indicates the selection of an incoming sender arranged to receive alternating current pulses and consequently a sender 1434 is selected by the link. This sender may be of the character shown in Figs. 23 to 35 of Patent No. 2,382,893 to McKim and Myers, which was filed on the same date as this application. After the sender is selected by the link control circuit, the trunk is connected thereto over leads 1461 to 1470, which establishes cooperating circuit paths between the sender and the trunk Fig. 14. A number of relays in the sender are operated by the link control circuit before the sender is connected through the link switch contacts to the trunk Fig. 14 and thus ground is connected by the sender to lead 1461 for operating relay 1421 and also high resistance ground is connected to lead 1466 through the windings of relays 1412 and 1416. The circuit extending to relays 1412 and 1416 establishes an operator's circuit for a sender relay, which is high in resistance and does not operate relays 1412 and 1416 until after the sender has received class signals. The class signals extend over the leads to the sender, as related in the McKim-Myers patent to establish in the sender the type of trunk connected thereto. Relay 1421 in operating establishes a locking circuit for itself through contact 1 of relay 1422 to ground and removes ground from the link start lead 1460. Relay 1421 also opens the original operating circuit for relay 1417 but this relay remains operated through contact 7 of relay 1421 to ground on contact 2 of relay 1426. Relay 1421 also connects ground to lead 1469 and lead 1442 which operates a relay in the sender and is later used for the hold magnets of the cross bar switches. A class signal is transmitted to the sender from ground on contact 3 of relay 1412 over lead 1462, which indicates to the sender the type of trunk connected thereto. Since in this instance the sender registers are to be set by alternating current pulses, a relay is also operated in the sender for associating pulse leads with an alternating current receiving circuit associated with the sender. Other relays are operated at this time for arranging the sender to receive alternating current pulses and after this sender adjustment has been made a low resistance is connected with lead 1466 to operate relays 1412 and 1416. The operation of relay 1416 establishes a circuit through its contact 4 for operating relay 1426. The operation of relay 1426 causes the release of relay 1417 since at this time no circuit remains established for the latter relay. The release of relay 1417 disconnects battery from the composite signaling M lead 1451, which signals the originating operator in toll office 1400 to proceed with the transmission of alternating current pulses.

The switchboard positions in toll office 1400 each have a set of keys therein substantially the same as shown in the call order board Fig. 7 which extends to an alternating current supply circuit for transmitting currents of two frequencies over the tip and ring trunk line conductors for each digit. A special code, such as 151, is used by the originating toll operator to make a circuit request call extending to the call order switchboard operator in a cross bar toll system. This code is set up by the toll operator on her keys and is transmitted through the hybrid coil 1401, then through contacts 2 and 5 of relay 1412, over the tip and ring conductors 1467 and 1468 to the registers of the sender. In order to balance the circuit, the currents are also extended through contacts 2 and 5 of relay 1416 to the bridge consisting of resistance 1435. In all cases arrangements are made for balancing the two channels of a four-wire system, such as shown in this patent. The digit pulses from the originating office operate three registers in the sender designating the selection of a special trunk to the call order board, such as shown in Fig. 15. As soon as the sender 1434 has registered the pulses and received the class of trunk indications, the code registration is automatically transferred to the marker 1530 as fully described in Patent 2,236,246, issued to King, McKim and Myers, March 25, 1941, or as shown in Patent 2,283,395 to W. B. Strickler, issued May 19, 1942.

In response to the setting of the marker registers, a route relay is operated for associating the desired group of trunks with the marker trunk testing mechanism. The group of 151 trunks such as shown in Fig. 15 is thus associated with the marker testing mechanism when trunk block relay 1534 is operated by the route relay. The manner of finding an idle trunk in the group of 151 trunks may be the same as fully disclosed in Patent No. 2,382,893 to B. McKim and O. Myers. When a marker finds an idle 151 trunk, the select magnet associated with the cross bar switch 1503 is energized and relay 1527 is operated by ground from the marker over lead 1540, which extends through a contact of the trunk block relay 1534, contact 1 of relay 1508, winding of relay 1527 to battery. An idle trunk is thus taken for use and the marker energizes the hold magnets of the cross bar switches 1500, 1501, 1502 and 1503 which associates the idle 151 trunk with the incoming trunk Fig. 14. Relay 1527 supplies ground for other relays operated in a sequential order. The marker then operates relays in trunk circuit Fig. 15 to indicate the character of trunk circuit which has been connected thereto, for example, if the office 1400 is a distant office connected to the cross bar switch over a long trunk known as a high-loss trunk, this would have been indicated to the sender and marker by the trunk Fig. 14 and the marker responsively connects battery over lead 1463, contact 6 of relay 1412, lead 1441, upper winding of retardation coil 1509, contact 2 of relay 1508, contact 2 and lower winding of relay 1524 to ground, operating relay 1524. The operation of relay 1524 is being described at this time since there are occasions when this trunk is connected by the call order board operator to an outgoing trunk if it so happens that a trunk has become idle between the time that the calling operator attempted to get an idle trunk and the time that she has made this circuit request call to the call order board operator. The operation of re-

lay 1524 establishes a locking circuit for itself from battery through its contact, and upper winding to ground on contact 4 of relay 1527 and remains thus locked for transmitting the long trunk indication to the call order board mechanism. If, on the other hand, the call is over a short toll line, such as from a local CLR toll board, relay 1524 is not operated since a long trunk indication was not given to the associated sender and marker and the marker therefore does not connect the battery with the lead extending to the lower winding of relay 1524.

A 151 trunk Fig. 15 is used by different toll offices having different types of trunk circuits outgoing from the toll switchboards. The trunk circuits may be of the key pulsing type ringdown type or straightforward type. When a call is from a ringdown toll trunk, an indication is given to the sender and marker by the incoming ringdown toll trunk similar to Fig. 14 but which is arranged in a different manner for ringdown signaling. This ringdown trunk operates a relay in the marker, causing the marker to connect battery to the incoming trunk lead 1462, which extends through contact 1 of relay 1412, thence over lead 1440, contacts of the cross bar switches, lower winding of retardation coil 1509, contact 3 of relay 1508, contact 2 and upper winding of ringdown relay 1526 to ground, operating relay 1526. This relay in operating connects battery through its lower winding and its contact 4 to ground on contact 4 of relay 1527 and thus remains operated during the operation of this trunk. The operation of relay 1526 controls the signaling path to the originating office, since ringing current must be associated with a ringdown trunk in order to operate the signal in the originating toll office.

At this time the marker 1530 having served its purpose may release but the sender is held connected to the trunk of Fig. 14 until such time as other mechanism in the trunk Fig. 15 is operated and relays 1412 and 1416 are released for connecting the toll operator over the four-wire transmission circuit of the trunk Fig. 15. The marker previous to its release energized relays in the sender for connecting a relay through a high resistance over leads 1464 and 1465 which extend through contacts 1 and 6 of relay 1416, thence over leads 1443 and 1444, through the contacts of the cross bar switches, upper and lower windings of retardation coil 1504, resistances 1506 and 1507, contact 5 and winding of relay 1508 to battery. The sender relay associated therewith is operated as a signal to the marker when the outgoing toll trunk is connected through the cross bar switches and this relay operates other relays which associate a low resistance with the leads 1464 and 1465, causing the operation of relay 1503. This causes a progressive operation in the sender and a check of the trunk connection before operating relay 1508. The operation of relay 1508 establishes a locking circuit through its contact 5 to ground on contact 2 of relay 1527 and establishes a circuit from battery, through its contact 6 and contact 3 of relay 1528, lamp 1533 to ground, lighting the lamp. Lamp 1533 is in the call order switchboard and designates an incoming call to the call order board operator. At this time lead 1466 is opened in the sender, causing the release of relays 1412 and 1416, thus preparing the connection of the originating toll operator with the call order board operator as soon as the latter operator answers the call by inserting twin plug 600 into jacks 1522 and 1523. Relay 1508 further disconnects relay 1527 from its contact 1 and associates ground with lead 1540 extending to the marker. The ground extending to the trunk block relay 1534 indicates to any other marker attempting to seize this trunk that the trunk is busy and cannot be taken for use at this time. Relay 1527 is now held operated by ground on contact 2 of relay 1421, which extends through contact 7 of relay 1416 over lead 1442, contacts of the cross bar switches, winding of relay 1527 to battery.

Call order operator answers request call

The call is answered in the call order switchboard by actuating the talking key 607 and inserting twin plug 600 constituting plugs 601 and 602 in the respective jacks 1522 and 1523 of the four-wire trunk Fig. 15. The twin plugs 600 and 620 are considered as a single six conductor plug for use with four-wire (two transmission channel) jack terminating trunks. A circuit is now established for trunk relay 1521 from ground, through its upper winding, sleeve of jack 1522, sleeve of plug 601, contact 4 of relay 603, lamp 604 and its associated resistances 605 and 606 to battery. The resistance of the upper winding of relay 1521 is high enough to prevent the lighting of lamp 604. The operation of relay 1521 establishes an operating circuit for relay 1528 which locks to ground on contact 1 of relay 1527 and opens the circuit for lamp 1533. Relay 1521 also connects ground through resistance 1512, contact 4 of relay 1508, resistances 1506 and 1507, retardation coil 1504, thence through the cross bar switch contacts and leads 1443 and 1444, contacts 1 and 6 of relay 1416, retardation coil 1415, resistances 1413 and 1414, contact 4 of relay 1421, winding of relay 1417 to battery, operating relay 1417. The operation of relay 1417 connects battery through lamp 1418 to the composite signaling M lead 1451 for operating a signal in the originating toll office to indicate to the operator in that office that the call order operator has answered the call. The actuation of the talking key 607, energizes relays 603 and 613. The circuit for these relays may be traced from battery, through their windings, contact 1 of key 607, thence over lead 632 to ground on the contact of relay 900.

The operation of relay 613 establishes a circuit for the telephone circuit relay 901 from battery through the winding of the latter relay, over lead 633, contact 2 of talking key 607, contact 7 of relay 613, contact 1 of the talking key thence over lead 632 to ground on the contact of relay 900. The operation of relay 901 establishes a locking circuit for relay 603 and 613 to ground, through its contact 1, lead 630, contact 7, winding of relay 603 and winding of relay 613, both extending to battery through these windings. The operation of relays 603 and 613 splits the cord circuit and transfers the talking and control conductors into the position circuit, Figs. 7, 8 and 9. The operation of relay 603 alters the circuit extending from ground through the upper winding of relay 1521 over the sleeve conductor which now passes through contact 4 of relay 603 to lead 642, thence through the upper winding of relay 822, winding of relay 805 to battery. Relay 805 operates in the circuit traced but relay 822 does not operate at this time since it is biased for marginal operation and does not operate through the high resistance upper winding of relay 1521.

Fig. 9 is the operator's telephone circuit for talking and monitoring on four-wire transmis-

sion circuits. The operation of relay 901 connects the A winding of coil 921 to leads 636 and 637 which for talking purposes extend over leads 850 and 851, contacts 3 and 4 of key 806, contacts 3 and 4 of relay 805, leads 745 and 746, contacts 4 and 5 of relay 700, leads 645 and 646, contacts 5 and 6 of relay 603, to the lower channel of the four-wire transmission trunk circuit. A winding of coil 922 is connected to leads 638 and 639 which, for talking purposes, extend over leads 852 and 853, contacts 1 and 2 of key 806, contacts of key 800, contacts 1 and 2 of relay 805, leads 643 and 644, contacts 1 and 2 of relay 603, to the upper channel of the four-wire transmission trunk circuit. The upper and lower channels extend through the trunk Fig. 15, cross bar switches 1500 to 1503, trunk Fig. 14 and the windings of coils 1401 to the calling toll line. The operation of relay 901 therefore connects both transmission channels by induction with the coils C and D of the telephone circuit hybrid comprising coils 921 and 922. The coils D are connected to the telephone circuit balancing network for talking and the coils C are connected to the telephone circuit transmitter 911 and receiver 910 through coil 919. The busy test relay 940 is shown connected to winding D of coil 917. Relay 920 is operated by monitoring key 608 for monitoring on both channels of the transmission circuits after the telephone connection has been established as later described. The operation of key 608 connects windings A and B of the hybrid 921 and 922 over conductors 636 to 639 directly through contacts of key 608 to the transmission channels. The arrangement of this four-wire telephone circuit and the direction of current flow through the circuit windings is substantially the same as fully disclosed in Patent 2,294,237 to J. B. McKim, August 25, 1942.

The call order board operator converses with the calling operator in a nearby or distant telephone office and may write a ticket or complete the telephone connection by inserting a plug of the front cord 620 into the jacks of the trunk Fig. 10, depending upon the character of the call and the condition of the trunk group over which the connection is desired. Before proceeding further with the connection, a description will be given of the indications recorded by the position mechanism responsive to the insertion of plug 600 into the jacks of the trunk Fig. 15.

A mechanism is shown in the lower portion of Fig. 8 for recording whether the connected trunk is an incoming trunk or an outgoing trunk and whether it is a short or a long trunk. It will later be shown that the mechanism operated in the lower portion of Fig. 8 is used to insert or remove voice amplifying repeaters as required. In this instance an incoming trunk is connected to the call order board cord circuit and this is indicated through the mechanism of Fig. 8 by the operation of relay 825. Since the special circuit request trunk Fig. 15 is always connected to an incoming trunk, it is arranged to give this indication to the call order board mechanism. The operation of trunk relay 1528 establishes a circuit for relay 825 by connecting battery through its contact 4, winding of relay 1505, upper and lower windings of retardation coil 1513, thence over the tip and ring conductors of the lower channel, jack 1523 and plug 602, through contacts of key 617, contacts 5 and 6 of relay 603, leads 645 and 646, contacts 4 and 5 of relay 700, leads 745 and 746, contacts 3 and 4 of relay 805, left and right windings of retardation coil 808, winding of relay 825, resistance 840, to ground. Relay 825 in operating establishes a circuit for relay 826 which now remains operated. Relay 1505 does not operate in the circuit traced since the resistance of relay 825 is high enough to prevent its operation. It was earlier described that when the incoming trunk is a long trunk, an indication is given to the sender and marker by the trunk Fig. 14 and in response to this indication, relay 1524 is operated by the marker to show the mechanism in the lower portion of Fig. 8 that the call order board is connected to a long trunk. This indication is established by battery through resistance 1525 and contact 3 of relay 1524, thence through the winding of relay 1519, upper and lower windings of retardation coil 1520, tip and ring conductors of the upper channel of jack 1522 and plug 601, contacts 1 and 2 of relay 603, leads 643 and 644, contacts 1 and 2 of relay 805, contacts 1 and 2 of key 800, both windings of retardation coil 802, winding of relay 829, resistance 830, to ground which operates relay 829. The trunk lock-out relay 1519 is not operated in the circuit traced. The operation of relay 829 establishes an operating circuit for relay 831 which is obvious. Relay 829 also connects ground through its contact 2 to lead 741 which is effective only after the operation of relay 705 at the beginning of the key pulsing period over a trunk connected with the front cord 620 as later described. The operation of relays 826 and 831 indicate to the call order board position mechanism that it is connected with a long incoming trunk. If it were connected with a short incoming trunk, relays 829 and 831 would not be operated since the trunk relay 1524 would not have been operated by the marker which selected this trunk. The operation of relays 825 and 826 would thus indicate a connection to a short incoming trunk. These indications remain in the circuit Fig. 8 until they are either used as later described or the plug 600 is removed from jacks 1522 and 1523. The trunk which may be connected with plug 620 will either operate relays 836 and 835 or permit these relays to remain normal. Relay 836 is operated when a long trunk is connected with plug 620. If plug 620 on another connection is associated with an incoming trunk relay 827 is operated by relay 823.

An incoming ringdown trunk has not been disclosed, but in toll practice such trunks are used and therefore the ringdown relay 1526 is included in Fig. 15 because this trunk may either be associated with a ringdown incoming trunk using ringing current for signaling or a trunk from an office using composite signaling as shown in Fig. 14. The mechanism for operating the composite signaling relay 1420 has been described and it was set forth that an incoming call from a ringdown trunk would be indicated to the marker which selects the trunk Fig. 15. The marker would then extend a circuit over leads 1440 and 1441 for operating relay 1526 to indicate that the incoming trunk is a ring-down trunk. The operation of relay 1526 connects battery through its contact 1 and ground through its contact 2 to the inner contacts 1 and 2 of the ringing relay 1505. The ringing relay 1505 is operated by the actuation of the call order board position key 617. The operation of the latter key connects battery through low resistance 623 over both the tip and ring conductors of the lower channel, upper and lower windings of retardation coil 1513, winding of the ringing relay 1505, resistance 1529 to ground. This momentarily operates the ringing relay

which connects battery and ground through the retardation coil 1504, thence through the cross bar switches, conductors 1443 and 1444 to mechanism in the ringdown trunk circuit which applies a signal to the toll line for signaling the distant operator. In the circuit as disclosed the operation of key 617, operates relay 1505 in the same manner as described but since the trunk Fig. 14 is not a ringdown trunk, relay 1526 would not have been operated. The result of the operation of relay 1505 is to open its contacts extending through resistance 1506 and 1507, contact 4 of relay 1508, resistance 1512 to ground. It will be remembered that the lower channel extends through the windings of retardation coil 1415, contact 4 of relay 1421, winding of relay 1417 to battery as previously traced. Consequently, when relay 1505 is operated it releases relay 1417 which associates ground with the composite signaling lead 1451 instead of battery through lamp 1418 and thus transmits a signal to the originating toll office.

If the circuit request call just described is deemed sufficiently important and there is an idle trunk available in the desired group, the telephone connection can be completed by the insertion of plug 620 into jacks 1000 and 1001. The insertion of plug 620 into the trunk jacks of Fig. 10 energizes relay 814 from battery through its winding, upper winding of marginal relay 823, lead 651, contact 4 of relay 613, thence over the sleeve conductor and lower winding of relay 1002 to ground, which operates relays 814 and 1002 but does not operate relay 823 because of the high resistance of the lower winding of relay 1002. Relay 1002 in operating establishes a circuit through contact 1 of relay 1025, winding of relay 1024 to battery, operating the latter relay which establishes a start circuit for the link 1028. This start circuit extends from ground on contact 5 of relay 1025, contact 4 of relay 1024 through the link start relay 1029 to battery. This link automatically connects a sender with the trunk circuit Fig. 10 in the manner disclosed in the aforementioned Patent 2,382,893 to McKim and Myers. The call order board operator has a set of keys 730, the same as disclosed in this patent and by depressing key 711 and certain of the keys 730 transmits code pulses to the sender for setting the sender registers. The sender selects a marker after a certain number of registers have been set and the marker selects the idle outgoing trunk in the desired group. For selecting the outgoing trunk a marker route relay is operated by the code registers which are set in the marker and this route relay indicates to the marker whether the trunks of the group are long or short trunks. The marker thus uses this information and information regarding the length of the incoming trunk as later described for signaling the outgoing trunk whether a repeater shall be selected for the telephone connection. This signaling for the connection of the repeater will be given in detail in the following description. A signal is also transmitted by the marker, through the sender, to the trunk Fig. 10 for indicating to the mechanism in the lower portion of Fig. 8 what character of outgoing trunk has been connected to the position cord circuit. The operation of the sender and marker and the selection of the outgoing trunk Fig. 12 is substantially the same as fully described in the aforementioned Patent 2,382,893 to McKim and Myers, and for the present this will suffice for continuing the description of the operation of the mechanism of Fig. 8.

After the selection of the outgoing trunk and the interconnection between the outgoing trunk mechanism and the mechanism in the sender relay 1023 is released for connecting the call order switchboard to the outgoing trunk. At this time and before the sender is released, ground is connected from the marker to the sender to lead 1057, if the outgoing trunk is connected to a long line. Lead 1057 extends through contact 8 of relay 123, winding of relay 1021 to battery, operating the latter relay. Relay 1021 is locked through its contact 2 to ground on contact 2 on relay 1025 and connects battery through resistance 1020 and its contact 1, winding of relay 1007, upper and lower windings of retardation coil 1008, thence over the tip and ring conductors of jack 1000 and plug 621, contacts 1 and 2 of relay 613, conductors 650 and 652, contacts 1 and 2 of relay 814, contacts 1 and 2 of key 820, both windings of retardation coil 813, winding of relay 836, resistance 837 to ground. Relay 836 establishes an obvious operating circuit for relay 835 which indicates to the call order board mechanism that plug 620 is connected to a long outgoing trunk. The call order board operator may converse over the outgoing trunk and the toll line with the distant operator and then release the talking key 607. When this key was operated it will be remembered that relay 901 followed its operation. The operation of relay 901 connected ground from its contact 7 to contact 3 of relay 831 and also to contact 3 of relay 835. Therefore the operation of relay 831 indicating a long trunk establishes a circuit through contact 2 of relay 826, winding of relay 832 to battery. If relay 826 is operated, which indicates that the long trunk is an incoming trunk, the circuit for relay 832 is not established. When the outgoing trunk indicates that it is a long trunk, relay 835 is operated which also establishes a circuit for relay 832 if relay 827 is not operated. This circuit extends from ground on contact 7 of relay 901 through contact 3 of relay 835, contact 2 of relay 827, winding of relay 832 to battery. Relay 832 is operated when two trunks are connected together if one of the trunks is a long outgoing trunk line. Relay 832 is slow in releasing and consequently after the talking key 607 is released, relay 901 is first released and relay 832 remains operated causing circuits to be established through the contacts of relay 901 released and through the contacts of relay 832 operated for removing or inserting repeaters in the trunk circuits. Relay 832 also connects ground from its contact 3 for holding relays 603 and 613 operated and connects ground through its contact 4 for holding relay 900 operated. These three relays release after the release of relay 832.

The foregoing operation of the mechanism in Fig. 8 along with the following table is given at this time to show how it is operated when connected to any of the trunk circuits through the cords and plugs of the call order board cord circuit. It provides a means for handling trunk calls rapidly from the call order board after the call order board operator has made connections with a trunk to an office for which she has a number of waiting calls for which tickets have been written. For example, the call order board operator may insert plug 620 into jacks of trunk Fig. 10 and operate sender registers for selecting a trunk Fig. 12 to a particular office. The first connection over this trunk may be used for completing

the circuit request call described from a distant toll operator over a long incoming toll line to trunk Fig. 14 which was connected to the special call order board trunk Fig. 15, the rear cord 600 being inserted in the jack of the trunk Fig. 15. Let it be assumed that the toll line between the trunk Fig. 12 and the office 1230 is a long outgoing line. According to the table this would comprise condition 6 and relays 831, 826 and 835 are operated over the circuits previously traced. Assume this connection as the first connection to the outgoing trunk Fig. 12 extending to office 1230 and also assume that the call order board operator has a number of tickets waiting for calls over this trunk which may be extended to different subscribers available from the office 1230 and that the call order board operator will keep plug 620 in the trunk Fig. 10 and maintain connection with the trunk Fig. 12 and office 1230 for completing all of these calls which are waiting.

First connection

For the first connection a ground signal is passed from contact 2 of relay 829 through the trunk Fig. 10 to the sender and the marker which are automatically connected to trunk Fig. 10 to indicate to the marker that a long trunk is connected to the cord and plug 600. When the marker route relay operates after its registers have been set according to code signals from the call order board, this route relay indicates to the marker mechanism that the toll line connected to the trunk Fig. 12 is also a long line and therefore a repeater should be inserted in each channel of the transmission circuit of the outgoing trunk Fig. 12. The marker therefore establishes a circuit for relay 1213 which automatically inserts voice amplifying repeaters for this telephone connection in a manner later described. Upon the termination of conversation over this first toll connection, the call order board operator gets a disconnect signal but since she wishes to make another toll connection to toll office 1230, she will only remove the cord and plug 600 from the jacks of the associated trunk Fig. 15.

Second connection

The second connection over the rear cord and plug 600 may be made to a nearby toll office over a short toll line. In this case repeaters should not be used in the outgoing trunk transmission channels. Since repeaters were inserted by the action of the marker in the transmission channels of the trunk Fig. 12, they must be removed for the second connection as shown in the condition 2 of the table. 130-volts negative potential is sent over the trunk conductors by the mechanism of Fig. 8 to cause the removal of this repeater. If the rear cord and plug 600 is connected to a short trunk, there would not be a circuit established for relay 829 and therefore relay 831 would not be operated. Relays 836 and 835 remain operated from battery connected to contact 1 of relay 1021. After setting up the connection, the operator restores talking key 607 which causes the release of relay 900 but relay 832 remains operated long enough to transmit 130 volts negative potential for removing the repeater from this circuit. This circuit may be traced from 130-volt negative battery through resistance 833, contact 1 of relay 832, contact 4 of relay 826, contact 3 of relay 827, contact 2 of relay 835, lead 950, contact 6 of relay 901, lead 635, contact 8 of relay 613, sleeve of plug 622 and jack 1001, contact 5 of relay 1024, resistances 1013 and 1017, contacts 1 and 2 of relay 1016, upper and lower windings of retardation coil 1019, contacts 4 and 5 of relay 1023, conductors 1135 and 1136, thence through the cross bar switches to conductors 1145 and 1146, upper and lower windings of retardation coil 1210, upper and lower windings of relay 1209, contact 1 of relay 1218, contact 3 of relay 1204, thence over conductor 1260 to the repeater circuit which will be described later.

Third connection

When, after this conversation is completed, the call order board operator again removes plug 600 and leaves plug 620 in the jacks 1000 and 1001 and inserts plug 600 in a trunk connected to a long line, there would again be two long lines connected together. Consequently, a repeater should be inserted in one of these lines. This would correspond to condition 7 in the following table. In this condition relays 831 and 835 are operated by the trunks and a circuit is established to remove the repeater from one trunk and insert a repeater in the other trunk. With the above two relays operated, a circuit is established from 130-volts positive battery through lamp 834, contact 2 of relay 832, contact 1 of relay 835, contact 1 of relay 831, contact 3 of relay 826, contact 2 of relay 831, lead 854, contact 3 of relay 901, lead 631, contact 8 of relay 603, over the sleeve of plug 602, which would cause repeaters to be inserted in the channels of the outgoing trunk associated with plug 600. 130-volts negative battery is connected through contact 1 of relay 832, contact 4 of relay 826, contact 3 of relay 827, contact 2 of relay 835, lead 950 contact 6 of relay 901, lead 635 to the sleeve of plug 622 for removing a repeater in the outgoing trunk connection to plug 622.

The following table illustrates the various conditions and relays operated in Fig. 8 by the connected trunks for causing the removal of repeaters from the transmission channels when they are not required and the insertion of repeaters in the transmission channels when they are required for any character of connection which may be established by a call order board operator.

	Trk. Conn. To Plug 600	Trk. Conn. to Plug 620	Relays Operated	Repeater Control Signal	
				Over Plug 602	Over Plug 622
				Volts	*Volts*
1	Long Outgoing..	Short Outgoing..	831	130—	
2	Short Outgoing..	Long Outgoing..	835		130—
3	Long Outgoing..	Short Incoming..	831 827	130—	
4	Short Incoming..	Long Outgoing..	826—835		130—
5	Long Outgoing..	Long Incoming..	831 835—827	130+	
6	Long Incoming..	Long Outgoing..	831—826—835		130+
7	Long Outgoing..	Long Outgoing..	831 835	130+	130—

130-volts positive, inserts repeater.
130-volts negative, removes repeater.

Completing connection to outgoing trunk

A detailed description was given in the aforementioned patent to McKim and Myers to the effect that the outgoing trunks of a trunk group which are patched for delay quotation are not available to the outlying toll operators who register code pulses for this trunk group and that the operation of the trunk group route relay immediately actuates other relays which prevent the test of the trunks in this group and the routing of an incoming toll line over a trunk of this group. It was brought out that the trunks of the

group or groups patched for delay quotation are made available to the call order board operators for completing delayed calls in the order received. Special trunks as shown in Figs. 5 and 10 terminating in twin jacks in the call order switchboard are used by the operators for completing calls over trunks which are patched for such call order board control. It was also brought out that the call order board operator has means for placing a special plug into a jack which is individual to a trunk group for observing whether there is an idle trunk in the group. If there is an idle trunk a connection is completed by inserting the twin plugs of the cord circuit into the twin jacks of a special trunk shown in Figs. 5 and 10. The insertion of the plug into the trunk jacks causes the selection of a sender followed by the establishment of circuits between the trunk and the sender mechanism and also followed by the transmission of code pulses by the call order board operator for selecting an idle trunk in the patched trunk group. These code pulses are transmitted by operating the keys 730 in the call order board position for setting the registers of the sender after the operation of key 709 or key 711 depending upon whether the pulses are to be sent over plug 609 or plug 620 into an associated sender. One of the circuits established with the trunk, Fig. 10, over lead 1057 causes the operation of a call order relay in the sender which connects ground to a call order lead. After the code pulses are registered in the sender the sender selects an idle marker and this grounded call order lead is connected to the winding of the call order relay in the marker substantially at the same time as the code registration is transferred from the sender register relay to the registers of the marker. The marker call order relay operates before the marker route relay which is operated responsive to the code registered in the marker. This call order relay arranges the marker trunk testing mechanism so that instead of refusing to test the trunks of the trunk group it proceeds in a normal manner to find the idle trunk which the call order board operator knows exists at the time. An idle trunk in this group is selected in the manner described in the aforementioned McKim-Myers patent by the operation of a trunk group relay which connects the trunks of a group with the marker testing mechanism. This idle trunk which may be an outgoing toll trunk as shown in Figs. 1, 2 or 12 is connected by cross bar switches under the control of the marker with the trunk, Fig. 5 or Fig. 10, whichever is used by the call order board. The other end of the cord may or may not have already been connected to a toll line such as the calling toll line previously described.

The following description of the operation of Figs. 10, 11 and 13 will be given at this time. Assume that the call order board operator completes a connection with the incoming calling trunk, Fig. 14, just described and that plug 609 is inserted in the jacks 1522 and 1523 and that now the call order board operator has inserted plug 620 into jacks 1000 and 1001 to select an idle trunk for completing a telephone connection for a calling operator who has called over a long incoming trunk. This connection will be described as a first connection over the outgoing trunk, Fig. 12, to the telephone office 1230 and the marker will be used for inserting the repeater. The insertion of plugs 621 and 622 into the trunk circuit jacks 1000 and 1001 causes a circuit to be established from battery through the winding of relay 614, upper winding of relay 823, lead 651, contact 4 of relay 613, sleeve of plug 621, sleeve of jack 1000, lower winding of relay 1002 to ground as previously described. The operation of relay 1002 establishes a circuit for relay 1024 which is locked through its contact 1 to the operating ground. Relay 1024 in operating establishes a circuit for link start relay 1029. The other connections established by relay 1024 will be described in the order in which they are used. The link energized by the trunk circuit, Fig. 10, for selecting an idle sender may be the same as fully disclosed in Patent 2,236,246, issued to G. V. King, J. B. McKim and O. Myers, March 25, 1941. This patent illustrates the link switches in Fig. 22, a link connector in Figs. 42 and 43 and a link control circuit in Figs. 52, 53, 54, 62, 63 and 64. Fig. 22 of this patent illustrates the manner of selecting a sender diagrammatically illustrated as sender 2214 connected to the secondary cross bar switch 2210. In general, the link 1028, disclosed herein diagrammatically, selects an idle sender of the type indicated by the trunk, Fig. 10, and connects this sender to cross bar link switches through leads 1051 to 1059, inclusive.

The connection of the sender to the trunk, Fig. 10, establishes a circuit for relay 1025 by connecting ground to lead 1051. Relay 1025 removes ground from the start lead 1050, thus releasing relay 1029 and also opens the operating path for relay 1024. The latter relay is locked to ground on relay 1002. Relay 1025 also connects ground to lead 1060 from contact 3 on relay 1023. A ground is also connected to lead 1060 from the sender over lead 1054 and the ground from the sender is held thereon until such time as relay 1023 is operated and again released. Relay 1025 also closes the supervisory simplex circuit through its contact 3 and winding of relay 1009. Class signals are now transmitted to the sender from ground through contact 1 of relay 1026 and resistance 1027 over lead 1056, also from battery through the winding of relay 1021 which is connected through contact 8 of relay 1023, thence to the sender over lead 1057 as previously mentioned. Battery through relay 1021 is used at this time as a signal to the sender but relay 1021 does not operate over this signaling circuit. After class determination is made by the sender, the sender operates relay 1023 by placing a low resistance ground on lead 1055. Relay 1023 opens the lead to relay 1021 and splits the talking conductors and connects the tip and ring leads from jack 1001 into the sender over leads 1058 and 1059. With the splitting relay operated the sender is in condition to receive pulses from the call order board position for setting the sender registers. The operation of relay 1023 establishes a circuit for operating relay 1026 and the latter relay locks to ground on contact 2 of relay 1025. The operation of relay 1026 connects ground through its contact 1 with the low resistance upper winding of sleeve relay 1002 which extends through the sleeve of the jack and plug, contact 4 of relay 613, thence over lead 651 through the upper winding of relay 823, winding of relay 814 to battery which reduces the resistance through the winding of relay 823 causing its operation. The operation of relay 823 connects ground through its contact over lead 640, resistance 625, contact 3 of relay 613, lamp 614 and resistances 615 and 616 to battery causing the lamp 614 to light as an indication to

the call order board operator that the sender is in readiness to receive pulses.

The call order board operator operates key 711 before operating the key-set 730 in the left portion of Fig. 7 as disclosed in the aforementioned copending application for setting the registers of the sender according to the desired outgoing trunk group over which the call is to be made. As previously set forth when a long trunk is connected to cord 600, relay 831 is operated by relay 829 and the latter relay is operated over a simplex circuit as traced from battery on contact 3 of relay 1524 or a similar relay in another trunk circuit connected to a long toll line. This indication is passed along to the sender which is connected to the trunk, Fig. 10, just before the call order board operator sets the keys for transmitting pulses into the sender. The operation of key 711 connects ground from contact 1 of relay 700 over lead 743 through contact 1 of relay 827, contact 5 of relay 814, contact of key 711, winding of relay 705 to battery and winding of key pulsing relay 713 to battery which operates both relays 705 and 713. Relay 705 in operating connects ground from contact 2 of the long trunk indicating relay 829 over lead 741, contact 2 of relay 705, upper winding of coil 706, contact 4 of relay 705, lead 649, contact 5 of relay 513, contact of key 618, tip of plug 622, tip of jack 1001, thence over lead 1058 to the sender. At this time relay 1023 is operated. A relay in the sender is operated to indicate that a long incoming trunk is connected to plug 600 of the call order board. The relay which is operated in the sender connects a ground over lead 1119 through the winding of marker relay 1100 operating the latter relay to indicate to the marker a long incoming trunk is connected to the call order switchboard from another toll office. Subsequently the registers of the marker are operated according to the registrations transmitted to the sender from the call order board operator and a route relay the same as relay 1102 is operated for selecting the outgoing trunk. The route relay selected indicates the character of the outgoing trunk by either establishing a circuit for relay 1106 through the contact of relay 1105 or by leaving the circuit open. Since the character of both trunks is indicated to the marker and since two long trunks require the insertion of a repeater the operation of relay 1100 and relay 1106 indicate to the marker that a repeater is required in the transmission channels of the outgoing trunk. Until such time as an idle outgoing trunk has been found and seized by the marker and paths created for its proper operation, certain circuits of the marker are maintained open. As shown in Fig. 11 one such circuit extends between the outgoing link 1104 to which is known as an outgoing frame relay 1103. This circuit is however established as soon as an idle outgoing trunk is found and connected to the trunk, Fig. 10, and the sender by the cross bar switches 1130, 1131, 1132 and 1133. A circuit is thus established for relay 1105 since two long trunks are to be used for this telephone connection. The marker thus automatically creates a start circuit for the selection of a repeater. The circuit for operating relay 1213 for selecting a repeater will be traced after certain relays have been operated in the outgoing trunk circuit.

Upon the selection of the outgoing trunk circuit, Fig. 12, a ground is connected to lead 1151 by the marker which operates relay 1219 and relay 1219 operates relay 1218 which locks through its operating winding. The marker then operates the cross bar switches 1130 and 1131, 1132 and 1133 as fully described in Patent 2,236,246 to G. V. King, J. B. McKim and O. Myers, March 25, 1941. Relay 1214 is thus connected to the sender from battery through resistance 1217 and the winding of relay 1214, upper two windings of relay 1209, upper and lower windings of retardation coil 1201, leads 1148 and 1149, thence through the contacts of the cross bar switches to leads 1138 and 1139, inner contacts 1 and 2 of relay 1023, leads 1052 and 1053 to the sender. These leads extend through a high resistance relay to ground which operates, conditioning the sender for further operations and for connecting a low resistance relay in the circuit just traced to battery through the winding of relay 1214 which operates relay 1214. Relay 1214 locks through its contact 2 to ground on contact 2 of relay 1218 and connects ground through a contact of the trunk block relay to lead 1151 so that any marker attempting to seize this trunk will recognize it as a busy trunk.

The marker now has a clear path through the sender and the trunk, Fig. 10, to the trunk, Fig. 12, for operating relay 1213 so that a repeater will be connected in the transmission circuit when it is fully established. The circuit for operating relay 1213 may be traced from 130-volt positive battery through both windings of relay 1108, contact of relay 1106, both contacts of relay 1105, thence over conductors 1120 and 1121 through the sender and to conductors 1056 and 1057 of the trunk circuit. This circuit extends through contacts 4 and 5 of relay 1023, conductors 1135 and 1136, through the cross bar switches to conductors 1145 and 1146, thence through the upper and lower windings of retardation coil 1210, upper and lower windings of relay 1209, contact 1 of relay 1218, contact 3 of relay 1204, lower winding of relay 1213 to ground. Relay 1213 does not operate over the circuit traced in view of the high resistance of the upper winding of relay 1108. Relay 1108 however operates in the circuit traced and associates an operating circuit with relay 1107 from battery through the winding of the latter relay, contact 1 of relay 1108 to ground on contact 2 of relay 1103. The operation of relay 1107 establishes a locking circuit for itself through its contact 2 and short-circuits the lower winding of relay 1108 through its contact 1. A circuit is thus created from 130-volt positive battery through the upper winding of relay 1108, contact 1 of relay 1107, thence over the path traced through the lower winding of relay 1213 which operates relay 1213. Relay 1213 in operating establishes a locking circuit for itself through contact 4 of relay 1204 to ground on contact 3 of relay 1219. Relay 1213 in operating establishes a start circuit for a link similar to the one previously described which causes the selection of a repeater shown in Fig. 13. This repeater is not immediately connected into the transmission circuit but is connected after all mechanism has been set for the transmission circuit. After the sender and marker have operated the outgoing trunk it removes the ground from lead 1055, releasing relay 1023. The release of relay 1023 connects ground through contact 7 of relay 1025 to lead 1060 which extends through the contacts of the cross bar switches through the hold magnets for maintaining the switches operated and also extends over lead 1147 through contact 5 of relay 1208, contact 2 and winding of relay 1219 to battery for holding ground on relay 1219 for the duration of the connection. The

sender also connects direct ground to lead 1057 for operating relay 1021. The operation of relay 1021 connects battery through resistance 1020, winding of relay 1007, upper and lower windings of relay 1008, tip and ring of jack 1000 and plug 621, contacts 1 and 2 of relay 613, thence over conductors 650 and 652 as previously traced for operating relays 836 and 835 to indicate to the call order board position mechanism that a long outgoing toll line is connected to the trunk, Fig. 10.

Repeater circuit

The operation of the link start relay 1241 by the repeater relay 1213 causes the selection of an idle repeater circuit, Fig. 13. An idle repeater is indicated by ground on lead 1321 from contact 2 of the normally operated timing control relay 1300 and battery on lead 1322 extended through resistance 1305 and contact 3 of relay 1303. The operation of link start relay 1241 causes the association of a link connector and link control circuit with the trunk, Fig. 12, and the link control circuit test leads 1321 and 1322 to associate the trunk circuit, Fig. 12, with the idle repeater circuit, Fig. 13, as fully described in Patent 2,293,191 to A. J. Busch and F. J. Scudder, August 18, 1942. After the idle repeater is found the link control circuit operates link cross bar switches to connect leads 1250 to 1259 from the trunk circuit to the repeater circuit. The control circuit also connects ground through the link switch cross-points to lead 1320 which extends through the polarized relay 1301, winding of relay 1303 to battery operating relay 1303. The closing of the link switch contacts also establishes a circuit for relay 1302 from battery through its winding, contact 1 of relay 1300, lead 1254 to ground on contact 3 of relay 1219. It will be remembered that relay 1219 is locked to ground on contact 3 of relay 1023 and remains locked throughout the telephone connection. Relay 1303 is locked from battery through its winding, contact of relay 1301, contact 2 of relay 1303 to ground on contact 2 of relay 1302. The operation of relay 1303 disconnects ground from lead 1321 and battery from lead 1322 to indicate to the link control circuit that an idle repeater has been taken for use. The operation of relays 1303 and 1302 connects ground from contact 2 of relay 1302 through contact 2 of relay 1303, lead 1320 through the switch cross-points to the switch hold magnets 1442. Relay 1204 is operated from battery through its winding, lead 1259, contact 6 of relay 1303, thence over lead 1254 to ground on contact 3 of relay 1219. Relay 1303 opens the operating circuit for the timing relay 1300 which is slow to release in order that the aforementioned circuits are established before the release of this relay. The operation of relay 1204 extends the transmission circuit leads through the normal contacts of relay 1307. Relay 1307 is used to cut in the repeaters after all other operations have been completed for the toll connection.

After the call order board operator has talked to the operator in office 1230 or otherwise set up the toll connection by automatically operating mechanism, she releases her talking key 607. The release of the talking key 607 causes the release of relay 901 and as hereinbefore described will cause circuits to be established through relay 832. The circuits established through relay 832 are of consequence when repeaters are to be inserted or removed by the mechanism of Fig. 8. However, in the circuit described, the repeater inserted in the transmission conductors of Fig. 12 is required and, therefore, if the automatically operable mechanism in Fig. 8 should transmit 130 volts positive current after the talking key is released, it would have no effect since the repeater has already been selected by the action of the marker circuit. Relays 603 and 613 are released after the release of relay 832 and at this time a circuit is established for repeater cut-in relays 1306 and 1307. The operating circuit for relay 1306 extends to ground in the pad or repeater control relay in the incoming trunk circuit, Fig. 14. If the plug 600 is associated with an outgoing trunk to another toll office the circuit for relay 1306 would be the same and extend to ground in the pad or repeater control relay in the outgoing trunk. This circuit may be traced over the trunk simplex circuits as follows:

Battery through the upper winding of relay 1301 which does not operate, thence through the winding of repeater control relay 1306, lead 1260, contact 3 of relay 1204, contact 1 of relay 1218, upper and lower windings of relay 1209, upper and lower windings of retardation coil 1210, leads 1145 and 1146, cross-points of the cross bar switches 1130, 1131, 1132 and 1133, conductors 1135 and 1136, contacts 4 and 5 of relay 1023, upper and lower windings of retardation coil 1019, contacts 1 and 2 of relay 1016, resistances 1013 and 1017, contact 5 of relay 1024, sleeve of jack 1001, sleeve of plug 622, contact 8 of relay 613, contact 8 of relay 603, sleeve of plug 602, sleeve of jack 1523, upper and lower windings of relay 1516, contacts 1 and 2 of relay 1519, contacts 2 and 3 of relay 1508, upper and lower windings of retardation coil 1509, thence through cross-points of cross bar switches 1500, 1501, 1502 and 1503, conductors 1440 and 1441, contacts 1 and 6 of relay 1412, upper and lower windings of retardation coil 1411, contacts 1 and 2 of relay 1409, resistances 1407 and 1408, contact 6 of relay 1421, coil 1456 to ground. The coil 1456 illustrates a coil in a balancing pad circuit or repeater switch-in circuit which is the same as the lower winding of relay 1213 connected to ground. It will be remembered that it requires 130 volts through the lower winding of relay 1213 for its operation and consequently the circuit traced from 48-volt battery through the winding of relay 1306 over the simplex circuit to the repeater control relay, Fig. 14, would not operate the repeater control relay, Fig. 14, since it requires 130 volts to operate the latter relay. The operation of relay 1306 establishes an obvious circuit for relay 1307 which causes the insertion of repeater 1308 in the upper transmission channel and repeater 1309 in the lower transmission channel.

The call order board operator may now monitor upon the transmission circuit by operating key 608 which connects the monitoring windings A and B of coils 921 and 922 in the telephone circuit as previously described. The cord circuit supervisory lamps 604 and 614 are extinguished when a connection has been established to a subscriber who has answered the call or under some conditions when the connection reaches a toll switchboard which does not provide through supervision. These lamps are extinguished by the operation of relays in the trunks such, for example, as relays 516 and 1009 in trunk circuits, Figs. 5 and 10. Relays 516 and 1009 are operated by respective composite signaling relays 229 and 1229 as explained. Until the relays 516 and 1009 are operated the lamps 604 and 614 remain lighted since these lamps are connected through the

windings of relays 517 and 1002, through the contact of relays 516 and 1009 to ground on contact 1 of relays 518 and 1026 both of which are operated. The upper windings of relays 517 and 1002 are the low resistance windings which cause the illumination of the cord circuit supervisory lamps 604 and 614. The operator in toll office 1230 may signal the call order board operator by causing the release of the composite signaling relay 1220 in the manner already described. For extinguishing lamp 614 the composite signaling relay 1220 connects ground through contact 1 of relay 1214, resistance 1215, upper and middle windings of relay 1200, upper and lower windings of retardation coil 1201, thence over conductors 1148 and 1149, contacts of the cross bar switches to conductors 1138 and 1139, contacts 1 and 2 of relay 1023, upper and lower windings of retardation coil 1003, contacts 1 and 2 of relay 1007, resistances 1035 and 1036, contact 3 of relay 1025, winding of relay 1009 to battery. The operation of relay 1009 opens the circuit through the upper winding of relay 1002, contact 4 of relay 613, lamp 614 and associated resistances to battery which extinguishes lamp 614. Since the trunks, Figs. 2 and 5, are the same as trunks, Figs. 12 and 10, respectively, the circuit for extinguishing and lighting supervisory lamp 604 may be traced in the same manner as for lamp 614. The supervisory lamp 614 is therefore lighted by the release of the composite signaling relay 1220. The call order board operator then operates her talking key which associates the talking windings A of telephone circuit coils 921 and 922 with the transmission circuit as previously described and the call order board operator converses with the operator in office 1230. For good transmission between operators, the repeaters 1308 and 1309 are eliminated from the transmission circuit during the conversation between operators. This is accomplished by releasing relay 1306 when the talking key 607 is operated. It will be remembered that the operation of the talking key 607 causes the operation of relays 603 and 613. The operation of these relays opens the circuit for relay 1306 since it will be remembered that the circuit for relay 1306 extends to ground in the pad or repeater circuit associated with the trunk, Fig. 14. When this conversation between operators has ceased and the talking key is restored to normal, relays 603 and 613 are also restored to normal which again establishes the circuit for repeater cut-in relays 1306 and 1307 as previously described.

Repeater release

A repeater is released or removed in two different manners. If plug 620 is removed from jack 1001 the trunk circuit, Fig. 10, is restored to normal. The cross bar switches 1130, 1131, 1132 and 1133 are restored to normal since the hold magnets of the switches are no longer held operated over lead 1060 which is opened by the release of relay 1025. The release of the cross bar switches opens the locking circuit for relay 1219 and the cold cathode tube 1221 is actuated from battery through lamp 1227, contact 6 of relay 1218 and from ground through the upper winding of relay 1218. The tube 1221 and associated circuit causes the release of relay 1218. The release of the relays, Fig. 12, removed ground from lead 1254 which opens the holding circuit for relay 1302. The release of relay 1302 opens the locking circuit for relay 1303 which causes the release of the trunk relay 1204. It will be apparent that relays 1306 and 1307 were released as soon as the plug 620 was removed from the jacks of the trunk, Fig. 10. Thus the repeater is restored to normal by the release of the trunk circuits.

The removal of the repeater from the transmission leads may also be caused by the automatically operable mechanism in the lower portion of Fig. 8 which is arranged to connect 130 volts negative battery with the repeater circuit when the repeater should not be included in the transmission channels for good transmission. For the release of the repeater under this condition reference may be had to the table included in this application which shows in item No. 4 a short incoming trunk associated with a long outgoing trunk causing the application of 130 volts negative battery from the call order board mechanism. Under this condition relays 826 and 835 are operated since relay 826 indicates a short incoming trunk and relay 835 indicates a long outgoing trunk. For this description, it should be assumed that conversation has ceased over the connection just described from the toll office 1400 over a long incoming trunk to toll office 1230 over a long outgoing trunk and that the operator has removed the plug 600 from the jacks of the trunk, Fig. 15, and inserted it in a trunk extending to a nearby toll office over a short trunk. This trunk may be a short outgoing trunk as shown in the table, item No. 2, or a short incoming trunk shown in the table, item No. 4. In either case the repeater which was previously inserted by the marker should be removed from the transmission channels of the outgoing trunk, Fig. 12. This, of course, assumes that the plug 620 was not removed from the jacks 1000 and 1001 so that the call order board operator can use the trunk connection, Figs. 10 and 12, for a second connection to the office 1230. Under this condition, the call order board operator operates the talking key 607 for conversing with a toll operator over the short incoming or outgoing trunk to tell this operator that she is prepared to extend the connection to the toll office 1230. Under this condition, relay 835 is operated and when the talking key 607 is restored to normal relay 901 is released but relay 832 remains operated since it is slow to release. Consequently, at this time negative 130-volt battery is transmitted through resistance 833, contact 1 of relay 832, contact 4 of relay 826, contact 3 of relay 823, contact 2 of relay 835, lead 950, contact 6 of relay 901, lead 635, contact 8 of relay 613 which is held operated by relay 832, thence over the sleeve of plug 622, sleeve of jack 1001, contact 5 of relay 1024, resistances 1013 and 1017, contacts 1 and 2 of relay 1016, upper and lower windings of retardation coil 1019, contacts 4 and 5 of relay 1023, conductors 1135 and 1136, contacts of cross bar switches, conductors 1145, 1146, upper and lower windings of retardation coil 1210, upper and lower windings of relay 1209, contact 1 of relay 1218, contact 3 of relay 1204 which is operated, thence over lead 1260, winding of relay 1306, winding of relay 1301 to 48-volt battery which causes the operation of relay 1301. The operation of relay 1301 opens the circuit for relay 1303 which releases and cannot again operate except by the application of a 130-volt positive battery to relay 1213 as later described. The release of relay 1303 disconnects ground from the link switch hold magnets 1442 which opens the link switch contacts between the repeater circuit and the trunk circuit, Fig. 12, disconnecting

the repeater from the trunk circuit. Relay 1204 is released upon the release of relay 1303 causing the transmission circuit to extend through its contacts to the office 1230 without the repeater in the transmission channels.

Repeater insertion by call order switchboard circuit

It was previously set forth that the call order board operator may hold the trunk connection between the call order board and the trunk, Fig. 12, by causing plug 620 to remain in the jacks 1000 and 1001 for completing a number of telephone connections to the toll office 1230. If the repeater has been removed from the transmission channel of the trunk, Fig. 12, and it should again be required by the connection of plug 600 with a long incoming trunk, as shown in item No. 6 of the table, the mechanism in Fig. 8 is automatically set for transmitting 130 volts positive potential to the trunk, Fig. 12. When a long incoming trunk is connected with the plug 600, relays 826 and 831 are operated in the manner described. The long outgoing trunk connected with plug 620 operates relay 835.

The operation of these relays establishes a circuit for relay 832 from battery through its winding, contact 2 of relay 827, contact 3 of relay 835 to ground on contact 7 of relay 901. When the call order board operator has completed the connection from the toll operator over the long incoming trunk to the toll operator over the long outgoing trunk the talking key 607 is restored to normal which releases relay 901. At this time positive 130-volt potential extends through lamp 834, contact 2 of the slow release relay 832, contact 1 of relay 835, contact 1 of relay 831, contact 4 of relay 826, contact 3 of relay 827, contact 2 of relay 835, over lead 950, contact 6 of relay 901, lead 635 which, as previously traced, extends over talking conductors 1145 and 1146 through retardation coil 1210, upper and lower winding of relay 1209, contact 1 of relay 1218, contact 3 of relay 1204 which under this condition is released. The circuit from 130-volt positive potential thus extends through contact 3 of relay 1204, lower winding of repeater selecting relay 1213 to ground operating relay 1213 as previously described, the operation of relay 1213 connects ground with the link start relay 1241 causing the link to select an idle repeater and insert this repeater in the upper and lower transmission channels of the outgoing trunk circuit, Fig. 12 as previously described.

Outgoing calls from call order switchboard

In the foregoing description, incoming request calls were completed between a toll operator who initiated a call over the trunks, Figs. 14 and 15, through the call order switchboard and outgoing over trunks, Figs. 10, 11 and 12. The connection of repeater, Fig. 13, to the outgoing trunk, Fig. 12, was described. A general description was given showing the operation of repeater insertion and removal mechanism in Fig. 8 for all incoming and outgoing trunk connections. A description will now be given in which the call order board operator establishes connections in both directions from information which has been written on a circuit request ticket. By reference to the ticket, the call order board operator may find that the operator in office 200 requires connection to office 1230. She may then insert plug 600 into jacks 521 and 522 which operate the trunk, Fig. 5, in the same manner as described for the trunk, Fig. 10. The trunk, Fig. 5, thus associates a sender with the position mechanism through the trunk, Fig. 5, and the call order board operator sets the registers of the sender according to the code of office 200. The sender sets the registers of the marker 430 and the marker selects the idle trunk, Fig. 2, which is then operated by the marker and the sender in the manner described for the trunk, Fig. 12. Assuming that the trunk, Fig. 2, is connected to a distant toll office 200 over a long line, relay 406 is operated in the marker by the marker route relay 402, and relay 504 is operated in the trunk, Fig. 5. The operation of relay 504 operates relay 829 in the call order board position circuit over a simplex circuit as previously described and relay 829 establishes an obvious circuit for relay 831. The marker sets the cross bar switches 410, 411, 412 and 413 for connecting the trunk, Fig. 2, with the trunk, Fig. 5, and to the call order board. Since Figs. 2, 3, 4 and 5 are the same as Figs. 10, 11, 12 and 13, a general explanation of the first-mentioned circuits only will be given, as reference can be made to the explanation of Figs. 10, 11, 12 and 13 for a detailed description of the circuits traced for operating the mechanism. The call order board operator may now converse with the operator in office 200 and explain to her that there is an idle trunk to office 1230 available and that the operator in office 200 may now make connection with the calling subscriber.

The call order board operator then places plug 620 in the jacks 1100 and 1101 which, as previously explained, causes the association of a sender with the call order switchboard mechanism. Code pulses are transmitted into the sender by the call order board operator for setting the registers of the sender, which registration is later transferred to the marker 1113 and the marker seizes the idle trunk, Fig. 12, to office 1230. The trunk, Fig. 12, is connected to the trunk, Fig. 10, by the operation of cross bar switches 1130, 1131, 1132 and 1133. Assuming that the line between the trunk, Fig. 12, and office 1230 is a long line, the marker relay 1106 is operated since route relay 1102 and relay 1100 are operated. Relay 1100 is operated by a circuit previously explained indicating that a long trunk is connected from office 200 to the toll operator's position. Relay 1021 in the trunk, Fig. 10, is operated by the marker to indicate to the call order board position mechanism that a long trunk has been connected to plug 620. This indication associates battery with the winding of relay 836 for operating relay 836. The operation of relay 836 establishes an obvious circuit for relay 835 and the operation of relay 829 by the trunk, Fig. 5, establishes an obvious circuit for relay 831. Since they are both outgoing trunks, neither relays 826 nor 827 are operated.

Under the conditions where two long trunks are connected together in the manner described, the second marker operates in such a manner that a repeater is inserted in outgoing trunk, Fig. 12, in the manner described for trunk, Fig. 12, and the repeater circuit, Fig. 13. It will be remembered that the repeaters are prepared for insertion by the marker and inserted after the transmission circuits have been established between the two trunk circuits. The maker mechanism shown in Fig. 4 prepares the inserting of a repeater in the same manner as described for the marker mechanism in Fig. 11 and therefore does not require further description.

If the operator removes plug 600 from the above

connected long trunk and inserts this plug in another long trunk and thereafter sets the registers of a sender and a marker, a second repeater will be connected with an outgoing trunk, Fig. 2, in the manner described for the trunk, Fig. 12. Since only one repeater is required for good transmission in the connection of two long lines, one of the repeaters inserted by the markers must be removed. By reference to the table showing the operation of the mechanism in the call order board position, Fig. 8, it will be noted in item No. 7 that when two long outgoing trunks are connected together and relays 831 and 835 are operated in Fig. 8, 130-volt positive potential is transmitted over plug 602 and 130-volt negative potential is transmitted over plug 622. Since in this case relay 216 has already been operated in the trunk, Fig. 2, the 130-volt positive potential transmitted by the call order board mechanism only insures that this relay was operated and insures that a repeater will be connected with the trunk, Fig. 2. The 130-volt negative potential transmitted over plug 622 operates relay 1301 in the manner described for dismissing the repeater connected to the trunk, Fig. 12. Thus when the transmission circuits are established between the subscriber connected to the toll office 200 and the subscriber connected to the toll office 1230, only one repeater is connected in the upper and the lower channel of the trunk, Fig. 2. With relays 831, 832 and 835 operated, after the talking key 607 has been restored to normal, the positive 130-volt potential is transmitted through lamp 834, contact 2 of relay 832, contact 1 of relay 835, contact 1 of relay 831, contact 3 of relay 826, contact 2 of relay 831, thence over lead 854 through contact 3 of relay 901, leads 631, contact 8 of relay 603, and thence to trunk, Fig. 2, over circuits previously described and over conductor 340 through the winding of relay 309, the winding of relay 310 to battery. Relay 310 is polarized in such direction that it does not operate when 130-volt positive potential is connected to its winding. Relay 309 operates and consequently the repeaters 300 and 304 are inserted in at transmission channels of the trunk, Fig. 2, by the operation of relay 308. 130-volt negative potential is transmitted through resistance 833, contact 1 of relay 832, contact 4 of relay 826, contact 3 of relay 827, contact 2 of relay 835, thence over lead 950, contact 6 of relay 901, leads 635, contact 8 of relay 613, thence over plug 622 to the trunk, Fig. 12, where it is connected with lead 1260, winding of relay 1306, upper winding of polarized relay 1301, to battery. In this circuit the 130-volt negative potential operates relay 1301 which, as previously described, causes the release of relay 1303 to disconnect the repeater and the link switch from the trunk, Fig. 12.

Outgoing calls to nearby toll office

The call order board operator initiates a call to a nearby toll office in the same manner as to a distant office and the code pulses which the call order board operator transmits to the sender selects a trunk arranged for short toll lines such as the trunk shown in Fig. 1. Thus, the call order board operator connects plug 600 with the trunk, Fig. 5, which associates a sender and marker therewith in the manner described. The code registration pulsed by the call order board operator and transferred from the sender to the marker causes the selection of the trunk, Fig. 1, by operating a route relay individual to the group of trunks, Fig. 1, and then operates the cross bar switches 420, 411, 412 and 413 for connecting the trunk, Fig. 1, to the trunk, Fig. 5, and the call order board position mechanism. When the marker seizes the trunk, Fig. 1, relay 101 is operated from battery through its winding, contact 4 of relay 102, thence to a contact of the trunk block relay over lead 140 to ground in the marker. Relay 101 prepares various locking circuits and maintains these locking circuits throughout the holding time of the trunk. After the operation of the cross bar switches and the release of relay 500, relay 101 is held operated to ground at contact 3 of relay 500.

Relay 102 is connected through contact 6 of relay 101, resistances 113 and 114, contacts 1 and 2 of relay 107, upper and lower windings of retardation coil 115, thence over leads 141 and 142, contacts 1 and 2 of relay 500 to ground through the winding of a relay in the sender circuit. This circuit first operates a relay in the sender which, by its operation lowers the resistance of the circuit in series with the winding of relay 102 which causes the operation of relay 102. Relay 102 locks through contact 6 of relay 101 to ground on its own contact 3. Relay 102 in operating closes a circuit through its contact 5 for transmitting a signal to the operator in the toll office 130. The closure of this circuit connects the winding of relay 100 to the toll board 130. This circuit may be traced from battery through the upper winding of relay 100, resistance 109, winding 120 of the line hybrid coil, winding 122, contact 5 of relay 102, contact 1 of relay 104, thence over lead 128 to a relay in the office 130. A ground is connected through the lower winding of relay 100, resistance 108, windings 121 and 123 of the line hybrid coil, thence over lead 129 to the relay in office 130. This operates what is known as a high-low supervisory relay in the TX operator's trunk position. The latter relay has its high resistance winding in the circuit at this time and operates to signal the TX operator that a call is incoming to her position. The relay 100 does not operate until after the high-low relay lowers the resistance of the circuit. Relay 100 then operates to connect a supervisory path to the call order board position. The operation of relay 100 connects ground through contact 2 of relay 102, resistances 113 and 114, contacts 1 and 2 of relay 107, upper and lower windings of retardation coil 115, thence over leads 141 and 142 which extend through the cross-bar switches and through contacts 1 and 2 of relay 500 released, upper and lower windings of retardation coil 514, contacts 1 and 2 of relay 500, contacts 1 and 2 of relay 512, resistances 510 and 511, contact 3 of relay 519, winding of relay 516 to battery. The operation of relay 516 opens the circuit to the upper winding of relay 517, contact 4 of relay 603, conductor 642 to the windings of relays 822 and 805. Relay 822 disconnects the ground connected through supervisory lamp 604 and associated resistances to battery. Thus the lamp 604 is extinguished which indicates to the call order board operator that the TX operator has answered the call.

Talking may now take place between the call order board operator and the TX operator in switchboard 120. The arrows 126 and 127 associated with leads 141 and 142 and also leads 143 and 144 indicate the direction of transmission over the two channels of the talking circuit. The windings of the coils in the hybrid are designed

and connected in such a way that the induced energy in the outgoing transmission channel is divided equally between the trunk and the balancing network, the network being an approximate counterpart of the trunk itself. No energy, however, is transferred to the incoming channel with transmission conductors 141 and 142 because the two hybrid windings included in the incoming path balance each other at this time. The incoming talking currents traverse windings 124 and 125 respectively on the two separate coils of the hybrid combination and these currents induce energy into both the outgoing circuits embracing leads 143 and 144 and the incoming circuits embracing leads 141 and 142. The network circuit which is located opposite the trunk in the hybrid combination received no energy at this time.

Flashing from the TX operator in toll board 130 causes variations in the loop resistance through the high-low supervisory relay so that relay 100 in the trunk alternately releases and reoperates. The circuit from ground on the contact of relay 100 has already been traced through the winding of relay 516 to battery. Therefore, the operation and release of relay 100 causes the release and operation of relay 516 to light and extinguish the supervisory lamp 604 in the call order board position. The call order board may signal the TX operator by operating key 617 which associates battery through resistance 623 with both the tip and ring conductors of the plug 602. This battery extends through contacts 6 and 7 of relay 500, contacts 2 and 3 of relay 510, upper and lower windings of retardation coil 502, winding of relay 503, resistance 506 to ground, operating relay 503. The operation of relay 503 associates battery and ground through resistances 508 and 509 and through contacts 4 and 5 of relay 500 with the upper channel of the talking circuit. This circuit extends through the upper and lower windings of retardation coil 103, contacts 1 and 6 of relay 102 to the windings of relay 104, causing the operation of relay 104 which opens the circuit over lead 128 to the toll office 130, causing a signal to operate in the TX operator's position of toll office 130.

Since the operation of key 617 may be of short duration, a timing circuit is associated with relay 104 to cause a flash of considerable extent for attracting the attention of the TX operator. When the TX operator disconnects, relay 100 restores to normal and removes ground from the circuit extending to relay 516 to light the lamp 604 for indicating to the call order board operator that the TX operator has disconnected from the circuit.

The connection to a short outgoing line such as that connected to the trunk, Fig. 1, would not operate the long trunk indication relay in the trunk, Fig. 5, and therefore, neither incoming trunk relay 826 nor the long trunk relay 831 would have been operated in the call order board position circuit. Indications are, therefore, recorded in the call order board position that a short trunk and a long trunk are connected together, or that two short trunks are connected together, and consequently, no repeater is required for good transmission.

Manual toll switchboard

The toll switchboard shown in Figs. 6, 7, 8 and 9 is not only adapted for use as a call order switchboard but may be used as a manual toll office which does not have automatic switching mechanism with the exception of links for selecting repeater circuits. The manually operable trunk circuits, Figs. 17, 18 and 19, are shown in Fig. 20 associated with a toll position comprising Figs. 6, 7, 8 and 9. The mechanism of the toll position, Figs. 6, 7, 8 and 9 operates with the manual trunk circuits, Figs. 17, 18 and 19 for a four-wire manual office in the same manner as herein described for the call order switchboard position. The pulsing keys shown in Fig. 7 can be used for operating senders in a distant office. In Fig. 20 the manual four-wire trunk circuits are shown associated with the toll switchboard, Figs. 6, 7, 8 and 9 as they may be combined for toll telephone connections and reference may be had to the following table to indicate how these circuits may be connected together for toll telephone connections.

Trunks may be connected together as follows:

1	Incoming trunk Fig. 17.	Toll switchboard.	To long outgoing trunk Fig. 18.
2	Incoming trunk Fig. 17.	Toll switchboard.	To short outgoing trunk Fig. 18.
3	Incoming trunk Fig. 17.	Toll switchboard.	To short outgoing trunk Fig. 19.
4	Incoming trunk long—Fig. 18.	Toll switchboard.	To long outgoing trunk Fig. 18.
5	Incoming trunk long—Fig. 18.	Toll switchboard.	To short outgoing trunk Fig. 18.
6	Incoming trunk long—Fig. 18.	Toll switchboard.	To short outgoing trunk Fig. 19.
7	Incoming trunk short—Fig. 18.	Toll switchboard.	To long outgoing trunk Fig. 18.
8	Incoming trunk short—Fig. 18.	Toll switchboard.	To short outgoing trunk Fig. 18.
9	Incoming trunk short—Fig. 18.	Toll switchboard.	To short outgoing trunk Fig. 19.

An incoming call from a local office for a subscriber who wishes to make a toll call is initiated from office 1700 over the lines 1725 and 1726 through a relay in office 1700 connected to the line conductors which extend through the upper and lower windings of the high-low relay 1705 operating relay 1705. Relay 1705 establishes an obvious circuit for relay 1706 thus causing battery to be associated through contact 1 of relay 1706, contact 2 of relay 1712, with lamp 1718 and ground. The jacks 1715 and 1716 and the lamp 1718 are in the face of the toll switchboard, Figs. 6, 7, 8 and 9. The toll operator in this switchboard observing the lamp, answers the incoming call by operating the talking key 607 and inserting twin plug 609 into the jacks 1715 and 1716 of the four-wire trunk circuit, Fig. 17. The talking key 607 and relays 603 and 613 should have been operated before the plug is inserted in the jack and thus the normal circuit for relay 1714 extends through the inner contact 4 of relay 603, resistance 624, lead 641, upper winding of relay 822, winding of relay 805 to battery. As previously explained the operation of the talking key 607 causes the operation of relays 603, 613 and the telephone relay 991. The operation of relay 1714 establishes an obvious circuit for relay 1712 which extinguishes lamp 1718 and connects ground through contact 2 and the winding of relay 1706 for locking relay 1706. Relay 1712 also short-circuits the high resistance lower winding of relay 1705 which causes the operation of the relay in the switchboard 1700 for indicating to the operator in switchboard 1700 that the call has been answered. Conversation may now take place between the operator in the switchboard of office

1700 and the operator in the toll switchboard, Figs. 6, 7, 8 and 9, the latter operator making a record of the toll connection required.

An indication is registered in the toll switchboard, Fig. 8, that an incoming trunk has been connected to plug 600. The circuit for this registration may be traced from battery through resistance 1703, winding of relay 1701, thence over the simplex circuit comprising the upper and lower windings of retardation coil 1717, tip and ring of jack 1716 and plug 600, thence through contacts 5 and 6 of relay 603, over leads 645 and 646, contacts 4 and 5 of relay 709, leads 745 and 746, contacts 3 and 4 of relay 805, left and right windings of retardation coil 808, winding of relay 825, resistance 840 to ground. Relay 825 is operated in the circuit traced and operates relay 826 over an obvious circuit to indicate that an incoming trunk is connected with plug 600. If the incoming trunk is a long incoming trunk, battery is connected through resistance 1709 and resistance 1710 through the mid-point of the simplex circuit comprising the upper and lower windings of retardation coil 1708. If the incoming trunk is a short incoming trunk, the resistance 1709 is not connected to resistance 1710. The long incoming trunk gives an indication to the mechanism in Fig. 8 by associating battery through resistance 1709, thence through the windings of retardation coil 1708, tip and ring of jack 1715 and plug 600, contacts 1 and 2 of relay 603, leads 643 and 644, contacts 1 and 2 of relay 805, contacts of key 800, left and right windings of retardation coil 802, winding of relay 829, resistance 830 to ground. Relay 829 operates in the circuit traced establishing an obvious circuit for relay 831. If a short trunk is connected to plug 600, relays 829 and 831 would not have been operated.

The operator in office 1700 may request connection with a subscriber extending from either office 1810 or office 1920 through trunks, Fig. 13 or Fig. 19. The trunk, Fig. 18, illustrates a trunk in a toll office having sufficient long lines extending therefrom to require a group of repeaters which may be either switched into the four-wire transmission circuits, omitted or disconnected. When two long lines are connected together, repeaters are inserted in the transmission conductors of the out-going trunk circuit. If a short incoming line is connected to a long outgoing trunk the repeaters are not inserted. These repeaters are inserted or removed by the mechanism of Fig. 8 in the same manner as previously described and in accordance with the table previously given.

Assuming that the calling operator in office 1700 requested a connection which would require a long trunk, Fig. 18, the toll operator, Figs. 6, 7, 8 and 9 inserts plug 620 into jacks 1800 and 1801. Relay 1813 is thus operated from ground through its high resistance lower winding, sleeve of jack 1800 and plug 621, contact 4 of relay 613, lead 651, upper winding of marginal polarized relay 823, winding of relay 814 to battery. Relays 814 and 1813 operate in the circuit traced. Relay 1813 establishes an obvious circuit for relay 1815 which in this instance opens its contacts the same as if the operator were answering an incoming call. The operator in the toll switchboard, Figs. 6, 7, 8 and 9, now operates ringing key 618 which associates battery through resistance 619, thence over the tip and ring of plug 622, upper and lower winding of retardation coil 1806, ringing relay 1817, resistance 1819 to ground which operates relay 1817. This associates ground with the ringer circuit shown diagrammatically and the ringer circuit connects ringing current to the hybrid coil 1309 for operating a relay in the office 1810 to signal the operator in the latter office. The toll operator then advises the operator in office 1810 what connection is required and releases her talking key 607. The operator in office 1810 may signal the toll operator by connecting ringing current over the toll line through the ringer circuit which actuates relay 1816. Relay 1816 in this instance connects ground to the winding of marginal relay 1814, low resistance upper winding of relay 1813, sleeve of jack 1800, sleeve of plug 620, contact 4 of relay 613, lamp 614 to battery, lighting lamp 614 and locking relay 1814. The toll operator actuates talking key 607 which operates relays 603 and 613. This extends the circuit from relay 1814 through the upper winding of relay 823, winding of relay 814 to battery increasing the resistance through marginal relay 1814 which causes its release. Marginal relay 823 is operated and associates ground through its contact with lead 640 which extends through resistance 625, contact 3 of relay 613, lamp 614 and associated resistance to battery which continues the illumination of lamp 614 until relay 1816 is released.

The trunk, Fig. 18, may be a long outgoing trunk in which case battery through resistance 1805 is connected through lead 1850, thence through the upper and lower windings of retardation coil 1803, tip and ring of jack 1800 and plug 621, contacts 1 and 2 of relay 613, leads 650 and 652, contacts 1 and 2 of relay 614, key 620, left and right windings of retardation coil 813, winding of relay 836, resistance 837 to ground which operates relay 836. Relay 836 establishes an obvious circuit for relay 835 which indicates to the automatically operable mechanism, Fig. 8, that a long outgoing trunk has been connected to plug 620. If the trunk, Fig. 18, is a short outgoing trunk, the battery through resistance 805 is not connected to lead 1850 and therefore relays 836 and 835 would not have been operated. Also if the trunk, Fig. 18, is a short outgoing trunk, relays 1807 and 1808 and the repeater are omitted and leads 1840, 1841, 1842 and 1843 are connected directly to leads 1845, 1846, 1847 and 1848, respectively.

Assuming that a long incoming trunk, Fig. 17, was connected through cords and plugs 600 and 620 to a long outgoing trunk, Fig. 18, a repeater would be required for good transmission. Since relay 831 would be operated by a long incoming trunk and relay 835 would be operated by a long outgoing trunk, a 130 volt positive potential is transmitted to the outgoing trunk for inserting a repeater in the transmission conductors. In the previous description of the mechanism, Fig. 8, it will be remembered that when the operator releases talking key 607, relay 901 is released and relay 832 remains operated since it is slow to release. Also that a circuit was established for relay 832 through contact 2 of relay 826, contact 3 of relay 831 to ground on contact 7 of relay 901 while relay 901 was operated. The circuit from the 130-volt positive potential may therefore be traced through lamp 834, contact 2 of relay 832, contact 1 of relay 835, contact 1 of relay 831, contact 4 of relay 826, contact 3 of relay 827, contact 2 of relay 835, thence over lead 950 through contact 6 of relay 901, lead 635, contact 8 of relay 613, sleeve conductor of plug 622, sleeve of jack

1801, contact 3 of relay 1807, lower winding of relay 1808 to ground operating relay 1808. Relay 1808 is the repeater insertion relay and connects ground to a link start relay 1812. The link 1811 may be the same as the link previously described or may be any character of an automatically operable link for selecting an adle repeater in a group of repeaters. An idle repeater is indicated by ground on lead 1850 and battery on lead 1851. When an idle repeater is found, ground is connected from the link over lead 1852 which extends through the contact of relay 1822, winding of relay 1823 to battery which operates relay 1823. The connection of the repeater to the trunk also establishes a circuit for relay 1821 from battery through its winding, contact 1 of relay 1820 to ground in the trunk circuit. Relay 1820 is slow to release and holds its contacts established until after the operation of relay 1821. The operation of relays 1821 and 1823 establishes a circuit for repeater relay 1807 from battery through its winding, contact 6 of relay 1823 to ground in the trunk circuit through the contacts of the link switch. The operation of relay 1807 transfers the four-wire transmission leads through the normal contacts of repeater cut-in relay 1825. The operation of relay 1807 also establishes a circuit for relay 1824 from battery through the upper winding of relay 1822, winding of relay 1824, contact 3 of relay 1807, sleeve of jack 1801, sleeve of plug 622, thence through the cord circuit over contact 8 of relay 613, contact 8 of relay 603, sleeve of plug 602, sleeve of jack 1706, resistance 1721 to ground. The operation of repeater relay 1824 establishes an obvious circuit for repeater relay 1825 which connects the repeater 1826 in the lower channel and repeater 1827 in the upper transmission channel of the four-wire outgoing trunk circuit. This repeater may be removed from the circuit if occasion arises by associating a 130-volt negative potential from the mechanism in Fig. 8 over the cord circuit to the sleeve of jack 1801 which would extend through the winding of relay 1824, upper winding of relay 1822 to 48-volt battery causing the operation of relay 1822. The operation of relay 1822 opens the circuit for relay 1823 causing its release and the release of relay 1821. Since relay 1823 is locked after its operation through its contact 2 to ground on contact 2 of relay 1821, the repeater is released by the disassociation of the link with the trunk circuit. The magnet 1856 is shown for holding the contacts of the link together after the link has selected an idle repeater and the ground disconnected from lead 1852. Ground is connected to this hold magnet through contact 2 of relay 1823 and contact 2 of relay 1821 and thus the release of relays 1821 and 1823 opens the contacts of the link switch.

The circuit, Fig 18, may be used as an incoming trunk circuit as shown combined with its use as an outgoing trunk circuit or it may be used as an incoming circuit with modifications. Such modifications would be the removal of relays 1807 and 1808 and the repeater circuit. An incoming call over the trunk, Fig. 18, is made from office 1810 by applying ringing current to the line conductors. This ringing current is transmitted to the ringer circuit which operates relay 1816. The operation of relay 1816 connects battery through the lamp 1802 to ground lighting this lamp to indicate to the toll operator that an incoming call should be answered. Relay 1826 in operating establishes a locking circuit for itself from ground on contact 2 of relay 1815. The toll operator answers the call by operating talking key 607 and inserting either plug 600 or 620 into the jacks 1800 and 1801. This causes the operation of relay 1813 over a circuit as previously described and the operation of relay 1813 establishes an obvious circuit for relay 1815 which extinguishes lamp 1802 and causes the release of the ring-up relay 1816. The toll operator then converses with the operator in office 1810 to make a record of the office to which the call should be directed. As shown in the table, an incoming trunk over Fig. 18 may be connected to a long outgoing trunk of the type shown in Fig. 18, a short outgoing trunk, Fig. 18, or to a long outgoing trunk, Fig. 19. In each case the mechanism in Fig. 8 is operated as described and as shown previously in the table for inserting or removing repeaters as required.

The trunk, Fig. 19, is for outgoing use only and has a compensating pad 1902 and 1903 and fixed repeaters 1913 and 1914 in the transmission circuits. It is used only as a short outgoing trunk. This short outgoing trunk may be connected to either the trunk, Fig. 18, when used as an incoming trunk or the incoming trunk, Fig. 17. It will be described as connected to the trunk, Fig. 17.

An incoming call operates the trunk, Fig. 17, as previously explained to light lamp 1718 in the toll switchboard. This call is answered by the toll operator who inserts plug 600 into the jacks 1715 and 1716. As previously stated, the trunk, Fig. 17, may be connected to a long or short incoming line and when connected to a long line, has resistance 1709 connected through resistance 1710 to the retardation coil 1708 for the purpose of operating relays 829 and 831 in the toll office after the toll operator has operated the talking key which operates relays 603, 613, 805 and 901. After a conversation with the calling operator in switchboard 1700, the toll operator then inserts plug 620 into jacks 1900 and 1901 and operates the ringing key 618. Key 618 associates battery with the tip and ring conductors, thence through retardation coil 1906 and the winding of relay 1921 to ground, operating relay 1921. Relay 1921 operates a relay in the ringer circuit 1929 which causes the operation of a signal in the office 1920. The insertion of plug 620 into jack 1900 causes the operation of relay 1923 which operates relay 1925. The toll operator then tells the operator in office 1920 what connection is required and releases her talking key. Since there are repeaters already in the transmission circuit of trunk, Fig. 9, the operation of the mechanism in Fig. 8 has no effect upon this trunk circuit either to add or remove repeaters from the transmission channels. The operator in office 1920 may signal the toll operator in the manner described for Fig. 18.

After the release of relays 603 and 613 a connection from battery to relay 1904 is made through contact 8 of relays 603 and 613 to either resistances 1720 or 1721, for either operating relay 1904 to remove the pads 1902 and 1903 or for causing this relay to remain normally released in which case the pads remain in the transmission channels. If the incoming trunk, Fig. 17, is a short incoming trunk, the high resistance 1721 is connected to the sleeve of jack 1716 which does not operate relay 1904 so that pads 1902 and 1903 remain in the transmission channels. If the trunk, Fig. 17, is a long incoming trunk, the low resistance 1720 is connected to the sleeve of jack

1716 so that relay 1904 is operated which removes pads 1902 and 1903 from the transmission channels. The signaling between operators is the same as described for the trunk, Fig. 18.

From the foregoing it is apparent that the switchboard disclosed in Figs. 6, 7, 8 and 9 having twin plugs for 4-wire transmission may be used universally for toll connections from any character of 4-wire trunk to another 4-wire trunk and automatically cause the insertion or removal of repeaters therein as required for good transmission.

As disclosed and described, this toll switchboard, Figs. 6, 7, 8 and 9, may be used either in a telephone office having automatic switching mechanism for completing telephone calls or in a toll office which does not use the automatic switching mechanism for establishing connections between trunks and lines.

What is claimed is:

1. In a telephone office, a manually operable switchboard, trunks having four-wire transmission circuits arranged in two transmission channels terminating in jacks in said switchboard, a telephone circuit, cord circuits in said switchboard, each cord having multicontact plugs, for extending the four wires of said transmission circuits to said telephone circuit and from one four-wire trunk to another four-wire trunk, selectable voice amplifying repeaters and mechanism in said switchboard operable according to the character of the trunks connected to each plug of a cord circuit for responsively causing the selection and insertion of repeaters in each transmission channel of a trunk.

2. In a telephone office, a manually operable switchboard, lines of different transmission characteristics connected to trunks having four-wire circuits in two transmission channels terminating in jacks in said switchboard, cord circuits in said switchboard for connecting one four-wire trunk to another four-wire trunk, a position circuit mechanism connected to said cord circuits, means in each trunk for transmitting a signal over one of the channels to said position circuit mechanism to indicate the transmission characteristic of the line connected thereto, voice amplifying repeaters selectable for each channel of a four-wire trunk circuit as required, means in said position circuit mechanism automatically responsive to signals from two trunk circuits for causing the selection of voice amplifying repeaters, and means for inserting a selected repeater in each channel of a trunk circuit.

3. In a telephone office, a manually operable switchboard, selectable voice amplifying repeaters, lines of different transmission characteristics connected to trunks having four-wire circuits in two transmission channels, the trunks connected to lines of high transmission loss having repeater selecting mechanism therein, cord circuits in said switchboard for connecting one four-wire trunk to another four-wire trunk, position circuit mechanism including line characteristic indicating mechanism connected to said cord circuit, means for connecting said trunks to said cord circuits, means in each trunk for transmitting a signal to said line characteristic indicating mechanism to indicate the transmission characteristic of the line connected thereto, means in said line characteristic indicating mechanism operated by certain signals for automatically transmitting a potential to the mechanism in a trunk circuit for causing the selection of voice amplifying repeaters, and means for inserting a selected repeater in each channel of said trunk circuit.

4. In a telephone office, a manually operable switchboard, selectable voice amplifying repeaters, lines of different transmission characteristics connected to trunks having four-wire circuits in two transmission channels, the trunks connected to lines of high transmission loss having repeater selecting mechanism therein, cord circuits in said switchboard for connecting one four-wire trunk to another four-wire trunk, position circuit mechanism including line characteristic indicating mechanism connected to said cord circuit, means for connecting said trunks to said cord circuits, means in each trunk for transmitting a signal to said line characteristic indicating mechanism to indicate the transmission characteristic of the line connected thereto, means in said line characteristic indicating mechanism operated by certain signals for automatically transmitting a potential over a trunk circuit channel to the mechanism in a trunk circuit for causing the selection of voice amplifying repeaters, and means for inserting a selected repeater in each channel of said trunk circuit.

5. In a telephone office, a manually operable switchboard, selectable voice amplifying repeaters, lines of different transmission characteristics connected to trunks having four-wire circuits in two transmission channels, the trunks connected to lines of high transmission loss having repeater selecting mechanism therein, cord circuits in said switchboard for connecting one four-wire trunk to another four-wire trunk, position circuit mechanism including line characteristic indicating mechanism connected to said cord circuit, means for connecting said trunks to said cord circuits, means in each trunk for transmitting a signal to said line characteristic indicating mechanism to indicate the transmission characteristic of the line connected thereto, means responsive to the operation of certain line characteristic indicating mechanism and the release of part of said position mechanism for automatically transmitting a potential to the mechanism of a trunk circuit for causing the selection of voice amplifying repeaters and means responsive to the release of the remainder of the mechanism of said position circuit for causing the insertion of a selected repeater in each channel of said trunk circuit.

6. In a telephone office, a manually operable switchboard, selectable voice amplifying repeaters, lines of different transmission characteristics connected to trunks having four-wire circuits in two transmission channels, the trunk connected to lines of high transmission loss having repeaters selecting mechanism therein, cord circuits in said switchboard for connecting one four-wire trunk to another four-wire trunk, position circuit mechanism including line characteristic indicating mechanism connected to said cord circuit, means for connecting said trunks to said cord circuits, means in each trunk for transmitting a signal to said line characteristic indicating mechanism to indicate the transmission characteristic of the line connected thereto, a repeater control circuit, means in said line characteristic indicating mechanism operated by certain signals for automatically transmitting a potential to the mechanism of a trunk circuit for causing the selection of voice amplifying repeaters, and means in said line characteristic indicating mechanism operated by other signals for automatically trans-

mitting a different potential to the mechanism of said voice amplifying repeater control circuit for disconnecting said repeaters from the transmission channels of a trunk circuit.

7. In a telephone office, transmission circuits, selectable voice amplifying repeater circuits, repeater selecting circuits, means for transmitting one potential for operating one of said repeater selecting circuits, means for inserting the selected repeater circuit in said transmission circuits and means for transmitting a different potential to said repeater circuit for disconnecting said repeater circuit from said transmission circuits.

8. In a telephone office, transmission circuits, selectable voice amplifying repeater circuits, repeater selecting circuits, means for transmitting a positive potential for operating a repeater selecting circuit, means for inserting the selected repeater circuit in said transmission circuits, and means for transmitting a negative potential to said repeater circuit for disconnecting said repeater circuit from said transmission circuits.

9. In a telephone office, transmission circuits, selectable voice amplifying repeater circuits, repeater selecting circuits, means for transmitting one potential for operating a repeater selecting circuit, a repeater control circuit, means for operating the control circuit of a selected repeater for inserting said repeater in said transmission circuit, and means for transmitting a different potential to said repeater control circuit for disconnecting said repeater from said transmission circuit.

10. In a telephone office, transmission circuits, selectable voice amplifying repeater circuits, repeater selecting circuits, means for transmitting a positive potential for operating said repeater selecting circuits, a repeater control circuit, means for operating the repeater control circuit of a selected repeater for inserting said repeater in said transmission circuit, and means for transmitting a negative potential to said repeater control circuit for disconnecting said repeater from said transmission circuit.

11. In a telephone office, transmission circuits of different characteristics, indicating mechanism, means for connecting said transmission circuits to said indicating mechanism, selectable voice amplifying repeater circuits, repeater selecting circuits, means in said transmission characteristic indicating mechanism for automatically transmitting one potential for operating a repeater selecting circuit, means for inserting the selected repeaters in said transmission circuits and means in said transmission characteristic indicating mechanism for automatically transmitting a different potential to said repeater circuit for disconnecting said repeater circuit from said transmission circuits.

12. In a telephone office, transmission circuits, selectable voice amplifying repeater circuits, repeater selecting circuits, means for transmitting one potential for operating one of said repeater selecting circuits, connecting means operated by said repeater selecting circuit for inserting a selected repeater circuit in said transmission circuits, means for removing said selected repeater circuit from said transmission circuits and for reinserting said selected repeater circuit therein while said connecting means remains operated, and means for transmitting a different potential to said repeater circuit for releasing said connecting means to permanently disconnect said repeater circuit from said transmission circuits.

13. In a telephone system, selectable voice amplifying repeaters, trunk circuits having transmission conductors connected to lines of different transmission characteristics, certain of said trunks having repeater selecting mechanism therein, means for making a telephone connection to a trunk having repeater selecting mechanism therein connected to a line of a given transmission characteristic, means for successively connecting other trunks to said first trunk, said other trunks being connected to lines of different transmission characteristics, transmission characteristic indicating mechanism associated with said trunk connecting means, means for variably operating said indicating mechanism to indicate the characteristics of trunks and lines connected together, and means in said indicating means as variably operated by successive connections of said first trunk to said other trunks to automatically cause the selection of repeaters for insertion in the trunk transmission conductors or the disconnection of a selected repeater from said trunk.

14. In a telephone office, leads for establishing a telephone connection, selectable devices, device selecting circuits, means for transmitting one potential for operating one of said device selecting circuits, means for associating the selected device in operative relation with said leads and means for transmitting a different potential to said selected device for disconnecting said selected device from operative relation with said leads.

15. In a telephone office, leads for establishing a telephone connection, selectable devices, device selecting circuits, means for transmitting a positive potential for operating one of said device selecting circuits, means for associating the selected device in operative relation with said leads and means for transmitting a negative potential to said selected device for disconnecting said selected device from operative relation with said leads.

16. In a telephone office, a manually operable switchboard, long and short lines connected to trunks terminating in said switchboard, cord circuits in said switchboard for connecting one trunk to another trunk, position circuit mechanism connected to said cord circuits, means in each trunk for transmitting a signal to said position mechanism to indicate the length of line connected thereto, voice amplifying repeaters selectable for said trunk circuits as required, and means in said position circuit mechanism automatically responsive to signals from two trunk circuits connected by said cord circuits for causing the disconnection of voice amplifying repeaters from transmission channels of a trunk circuit.

17. In a telephone office, a manually operable switchboard, long and short lines connected to trunks having four-wire circuits in two transmission channels terminating in said switchboard, cord circuits in said switchboard for connecting one four-wire trunk to another four-wire trunk, a position circuit mechanism connected to said cord circuits, means in each trunk for transmitting a signal to said position circuit mechanism to indicate the length of line connected thereto, voice amplifying repeaters selectable for each channel of a four-wire trunk circuit as required, means in said switchboard position mechanism for causing the selection of repeaters and the insertion of said repeaters in each transmission channel, means for causing the non-selection of repeaters and means for causing the disconnection of selected repeaters, said latter three means

being operable according to the manner of signals from said trunk circuits.

18. In a telephone office, incoming trunks, outgoing trunks, a manually operable switchboard, a group of voice amplifying repeaters selectable for the transmission conductors of said outgoing trunks, control circuits for said repeaters, cord circuits in said switchboard, means in said switchboard for connecting an incoming trunk through said cord circuit to an outgoing trunk and automatically actuating one of said repeater control circuits for causing the insertion of voice amplifying repeaters in the transmission conductors of said outgoing trunk, and means in said switchboard automatically responsive to the removal of the plug from said incoming trunk and the insertion of said plug in another trunk for applying a potential through said first outgoing trunk to said repeater control circuit for causing the disconnection of said repeaters from said first outgoing trunk.

19. In an automatic switching telephone office, incoming trunks from other offices, outgoing trunks to other offices, a manually operable switchboard, special trunks terminating in jacks and signals in said switchboard, voice amplifying repeaters, cord circuits and pulsing devices in said switchboard for making trunk connections, switching mechanism, means responsive to pulses transmitted over a cord and trunk to said switching mechanism for selecting an idle outgoing trunk, means responsive to signals from said trunks to said switching mechanism for causing the selection of idle repeaters for insertion in the transmission conductors of said trunk, mechanism in said switchboard operable for indicating the character of trunks connected to each cord of a cord circuit, and means in said switchboard mechanism for causing the selection of repeaters and the insertion of said repeaters in the transmission channels of a trunk for causing the non-selection of repeaters and for causing the disconnection of selected repeaters from the channels of a trunk according to the operation of said trunk characteristics indicating mechanism.

20. In an automatic switching telephone office, incoming trunks from other offices, outgoing trunks to other offices, a manually operable switchboard, special outgoing trunks terminating in jacks and a signal in said switchboard, means responsive to pulses transmitted over an incoming trunk for operating switches for automatically connecting said incoming trunk to an outgoing trunk to another office or to an outgoing trunk to said switchboard, cord circuits in said switchboard for answering an incoming call, a telephone circuit for connection with said cord circuit for use in conversing with the calling and called parties, mechanism connected with said cord circuit operable for indicating the character of the calling incoming trunk, means for connecting the alternate plug of a cord circuit with a special trunk outgoing from said switchboard, means in said switchboard for transmitting pulses over said special trunk according to the code of a desired outgoing trunk to another office for causing the selection of an outgoing trunk to said other office, means for operating switches to connect the latter outgoing trunk to said special outgoing trunk, switchboard mechanism connected with said alternate plug of said cord circuit operable for indicating the character of the outgoing trunk, selectable voice amplifying repeaters in a group, means in said switchboard mechanism for causing the selection of a repeater, for causing the non-selection of a repeater and for causing the disconnection of a selected repeater from the channels of a trunk according to the manner of operation of said switchboard mechanism, and means for inserting a selected repeater in the transmission conductors of said outgoing trunk circuit by the connection of said outgoing trunk through said switches and cord circuit to said incoming trunk.

21. In an automatic switching telephone office, incoming four-wire trunks from other offices having two transmission channels, outgoing four-wire trunks to other offices having two transmission channels, a manually operable switchboard, special four-wire trunks having two transmission channels terminating in jacks and signals in said switchboard, means responsive to pulses transmitted over an incoming trunk for operating switches for automatically connecting said incoming trunk to an outgoing trunk to another office or to an outgoing trunk to said switchboard, double-ended cord circuits in said switchboard, each cord having a four-wire two-channel plug, a telephone circuit for use in conversing with a calling or called party, means for connecting the plugs of a cord circuit with the jacks of special trunks in said switchboard, switchboard mechanism connected with said cord circuit operable for indicating the character of the connected trunks, means in said switchboard for transmitting pulses over said special trunks according to the code of desired trunk connections for causing the selection of particular trunks according to said codes, means for operating switches to connect the selected trunks with the special trunks in said switchboard, means in different trunks for differently operating said indicating mechanism, selectable voice amplifying repeaters arranged for insertion in both channels of a four-wire trunk, means in said switchboard indicating mechanism for causing the selection of repeaters, for causing the non-selection of repeaters and for causing the disconnection of selected repeaters from the channels of a trunk according to the manner of operation of said switchboard mechanism, and means for inserting selected repeaters in the transmission conductors of each channel of a four-wire outgoing trunk by the connection of the trunk through said switches and cord circuit to another trunk.

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