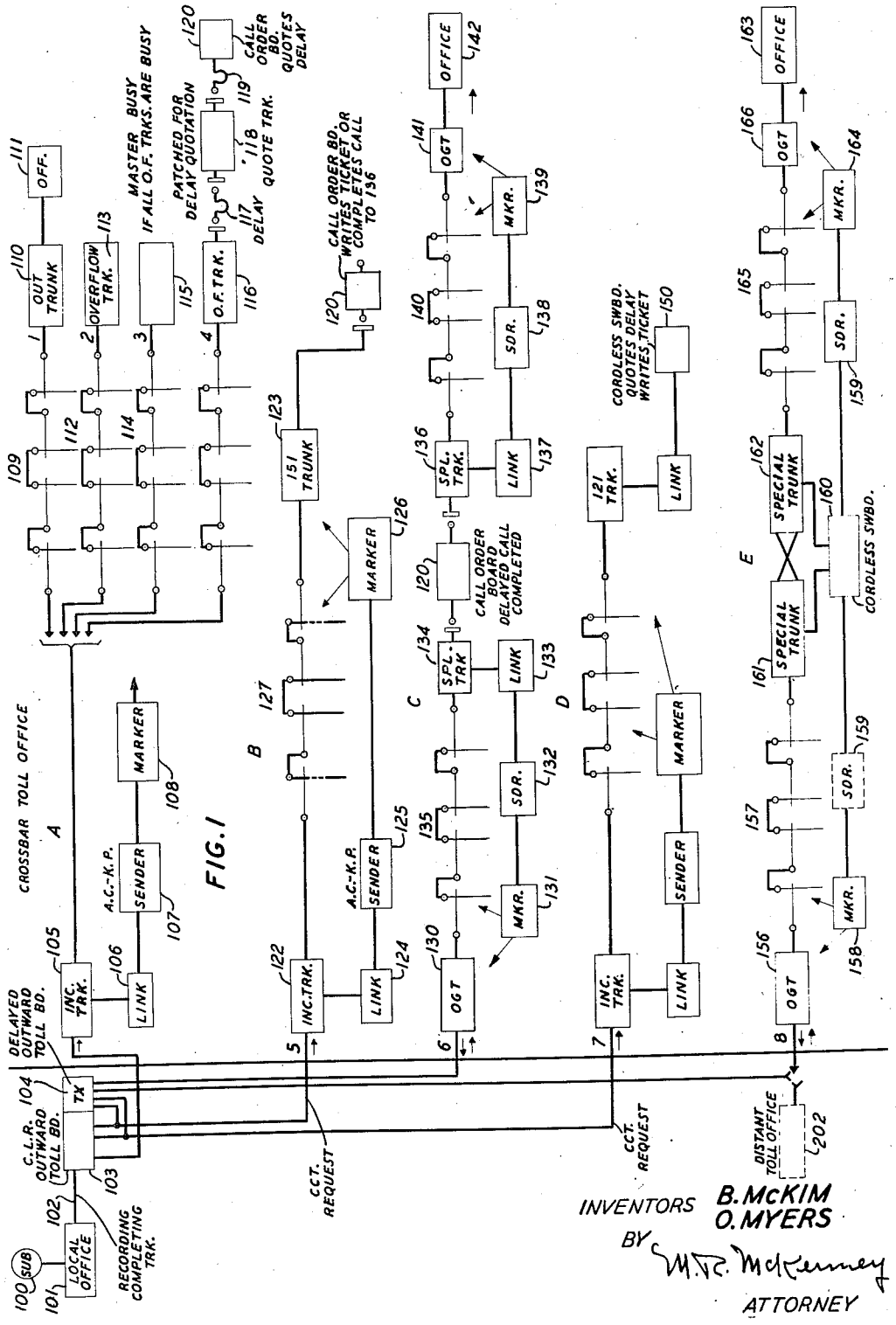
Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 1



INVENTORS B. McKIM
O. MYERS

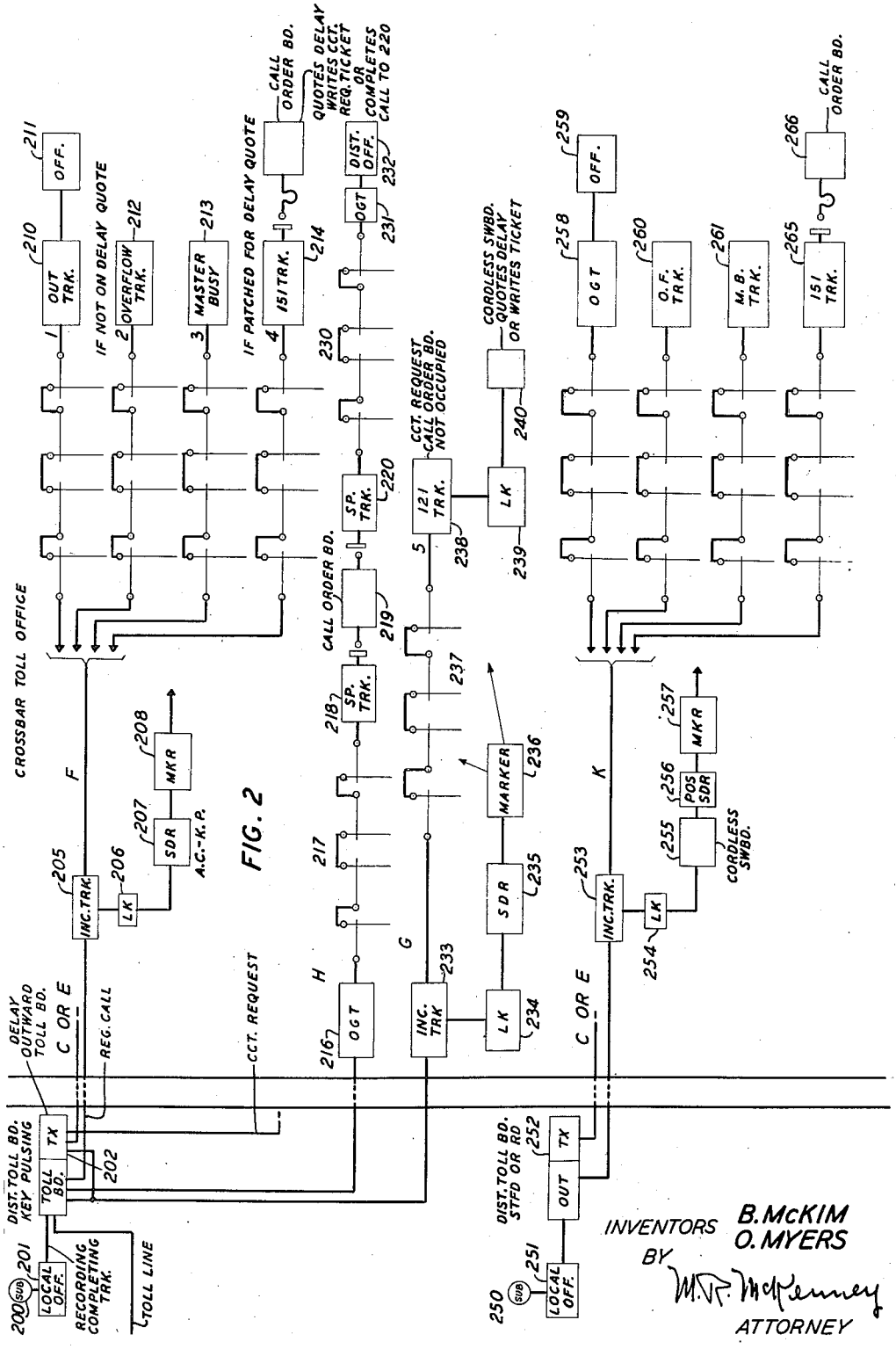
BY M. T. McTierney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 2



Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 3

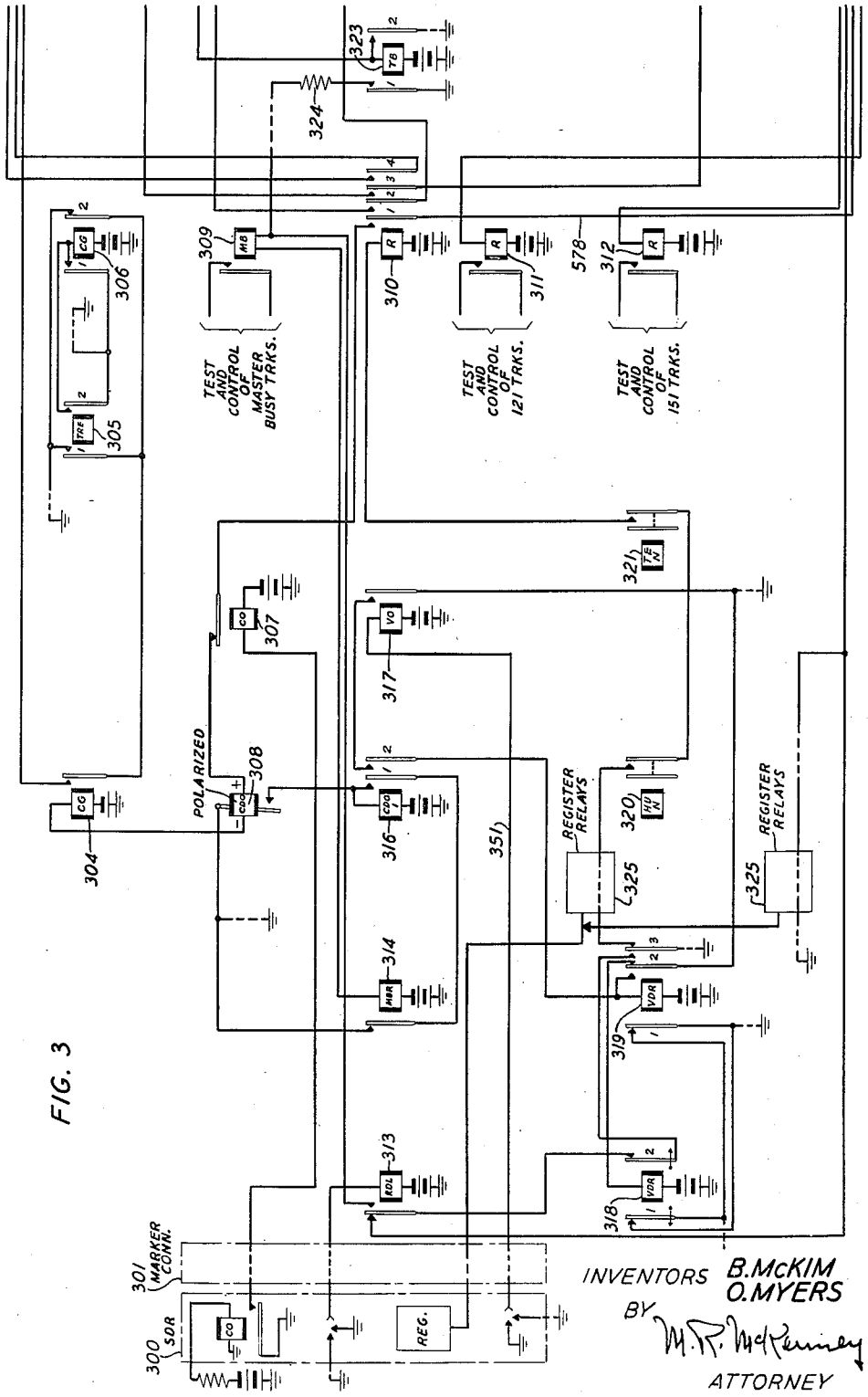


FIG. 3

INVENTORS B. McKIM
O. MYERS

BY M. P. McKenney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 4

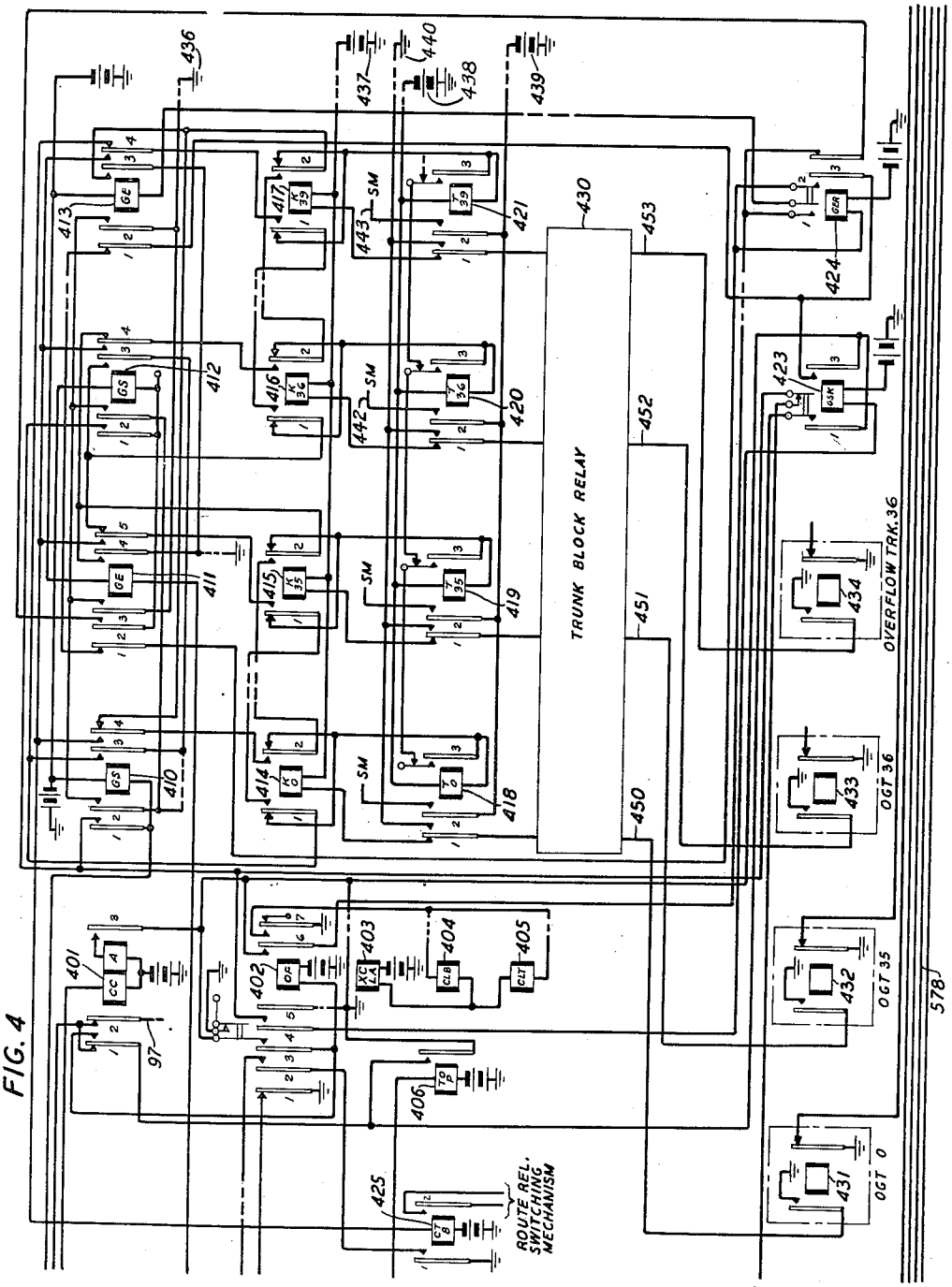


FIG. 4

INVENTORS B. McKIM
O. MYERS
BY
ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 5

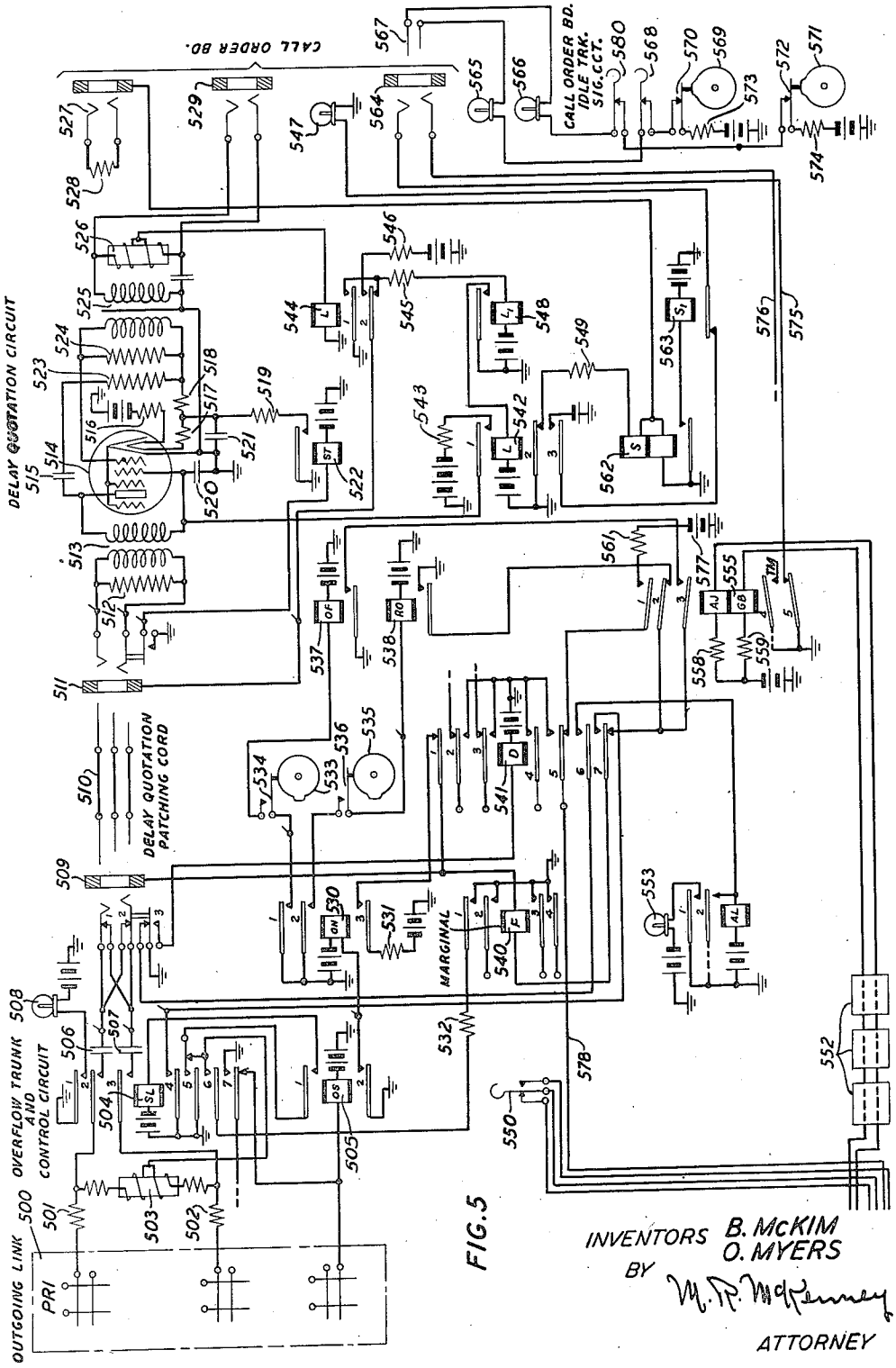


FIG. 5

INVENTORS B. McKIM
O. MYERS
BY
ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 6

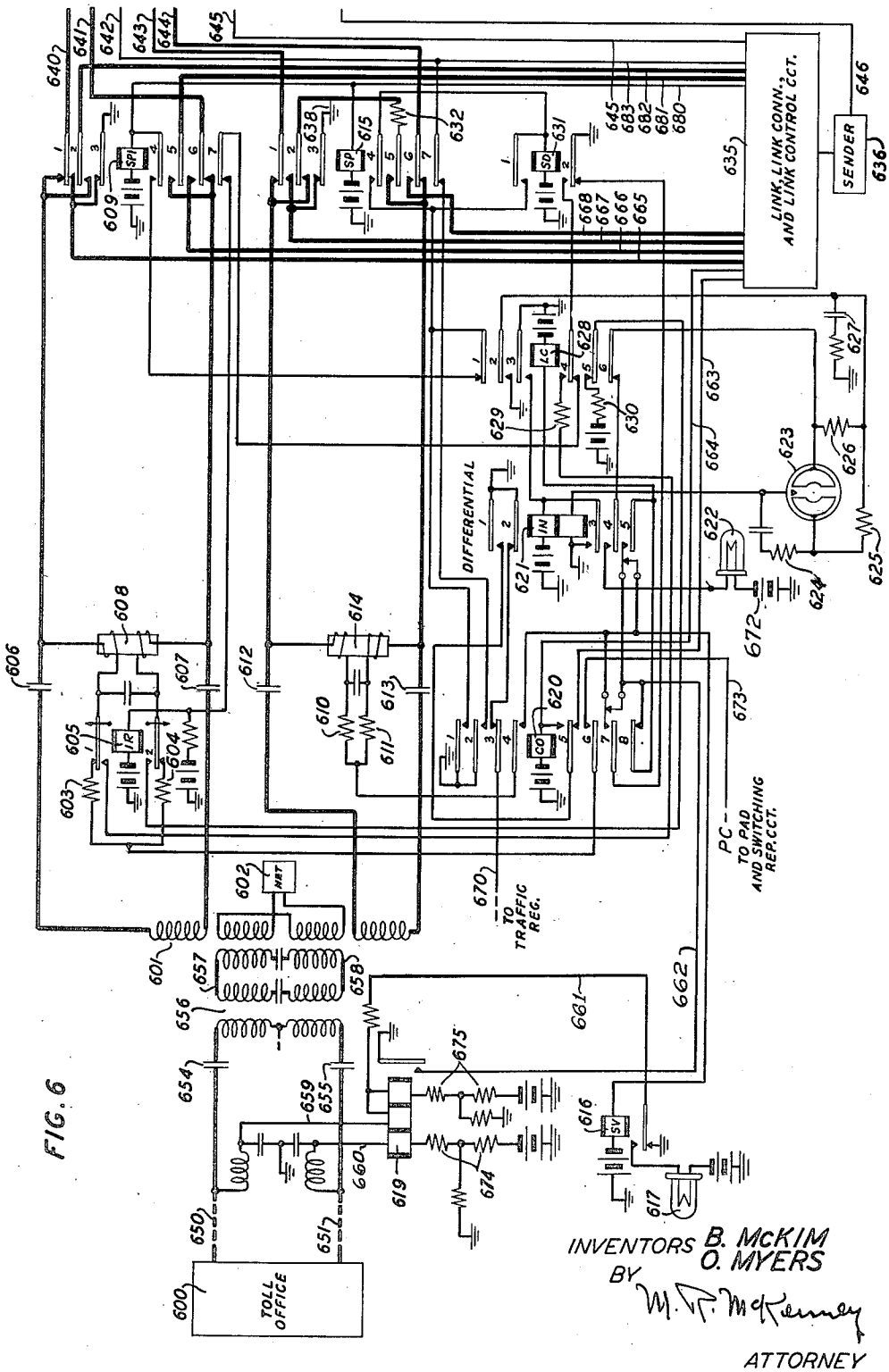


FIG. 6

INVENTORS B. McKIM O. MYERS

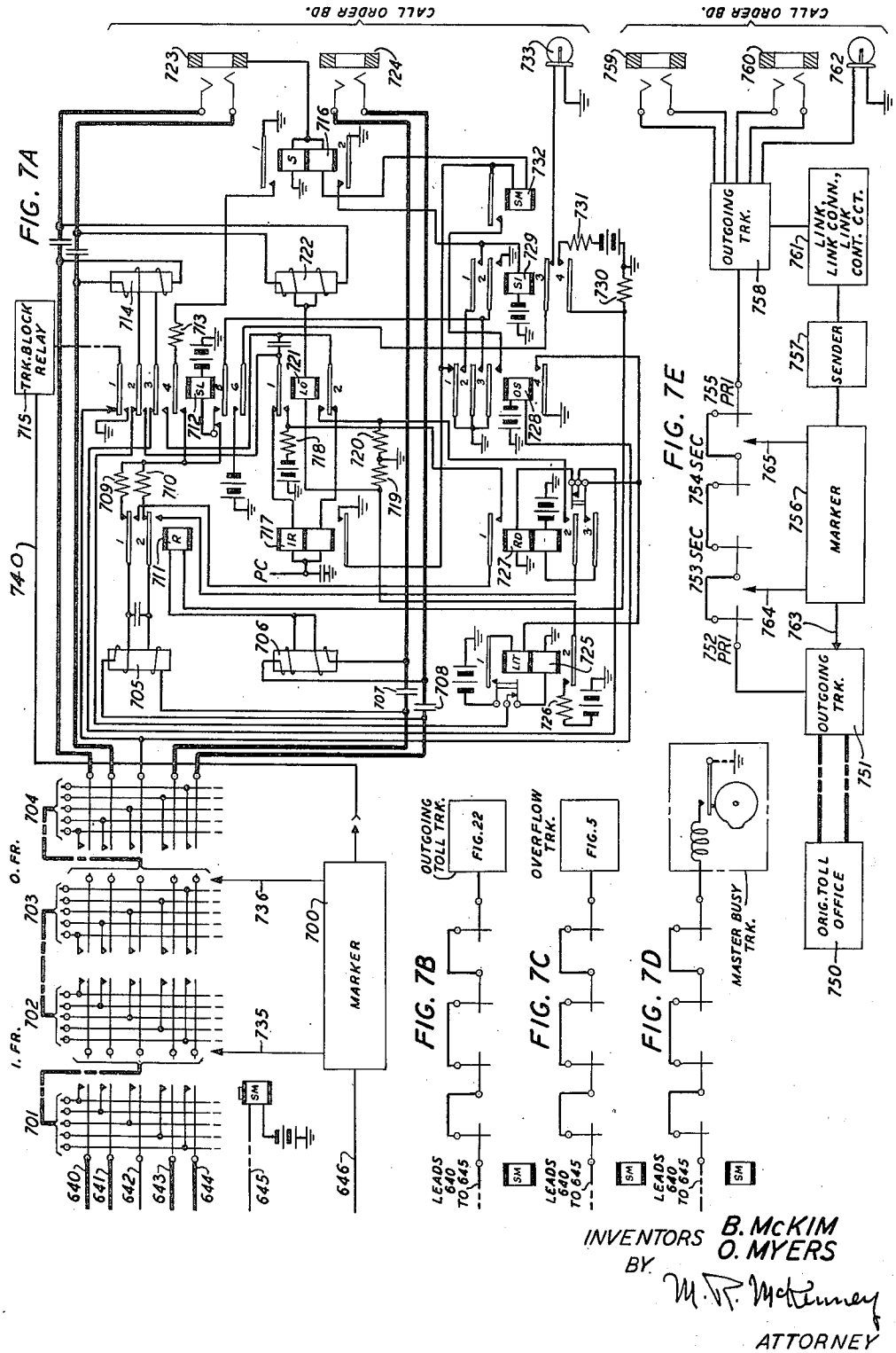
BY W. P. McKenney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 7



INVENTORS B. McKIM
O. MYERS
BY M. P. McKinney
ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 8

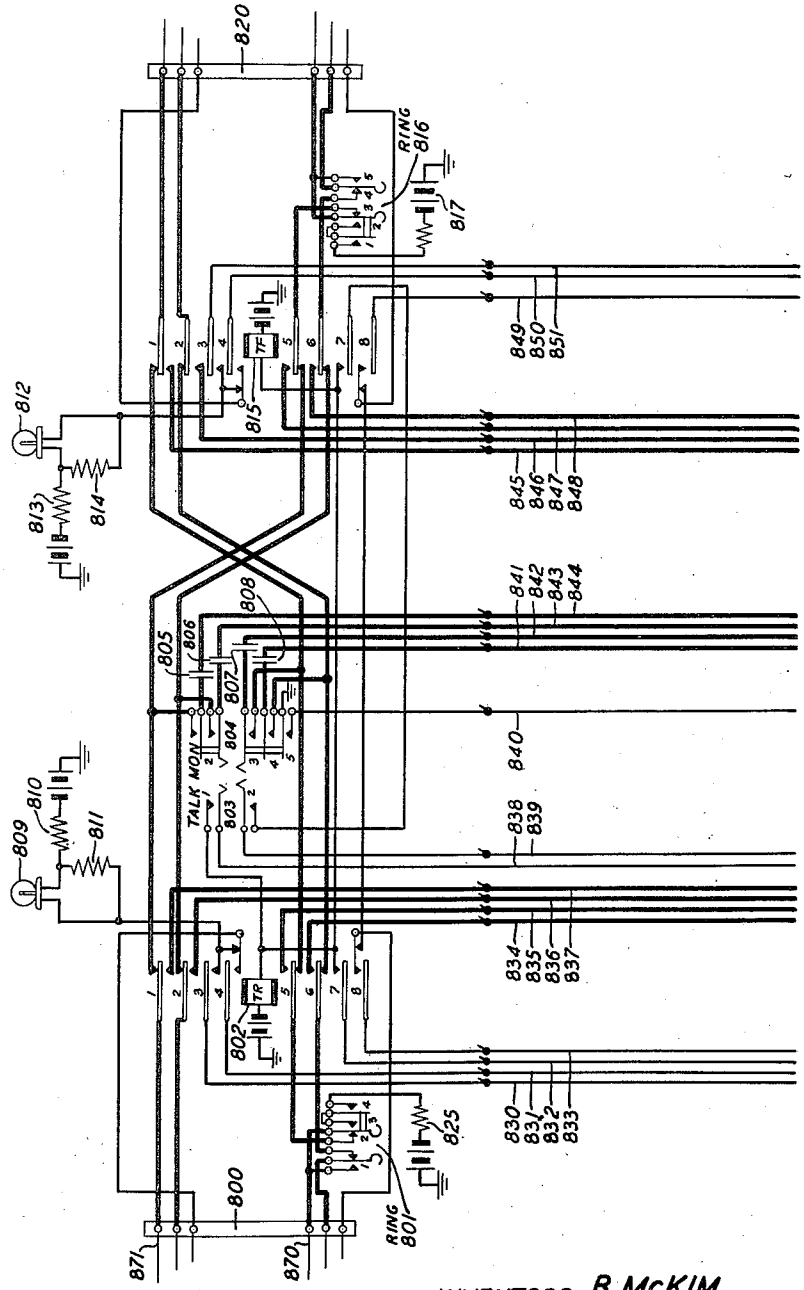


FIG. 8

INVENTORS B. McKIM
O. MYERS
BY M. R. McKinney
ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 9

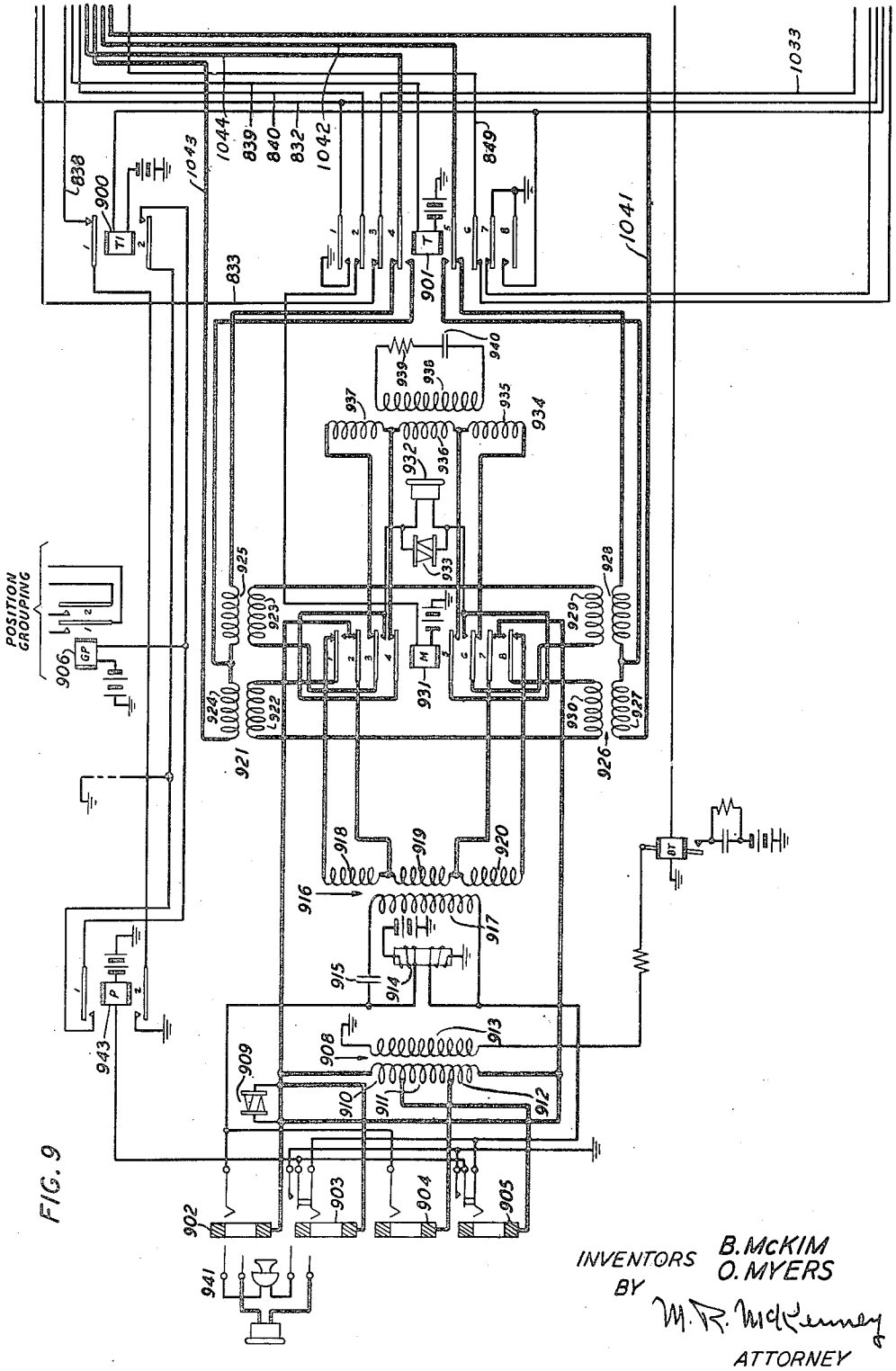


FIG. 9

INVENTORS B. McKIM
O. MYERS

BY M. R. McKinney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 10

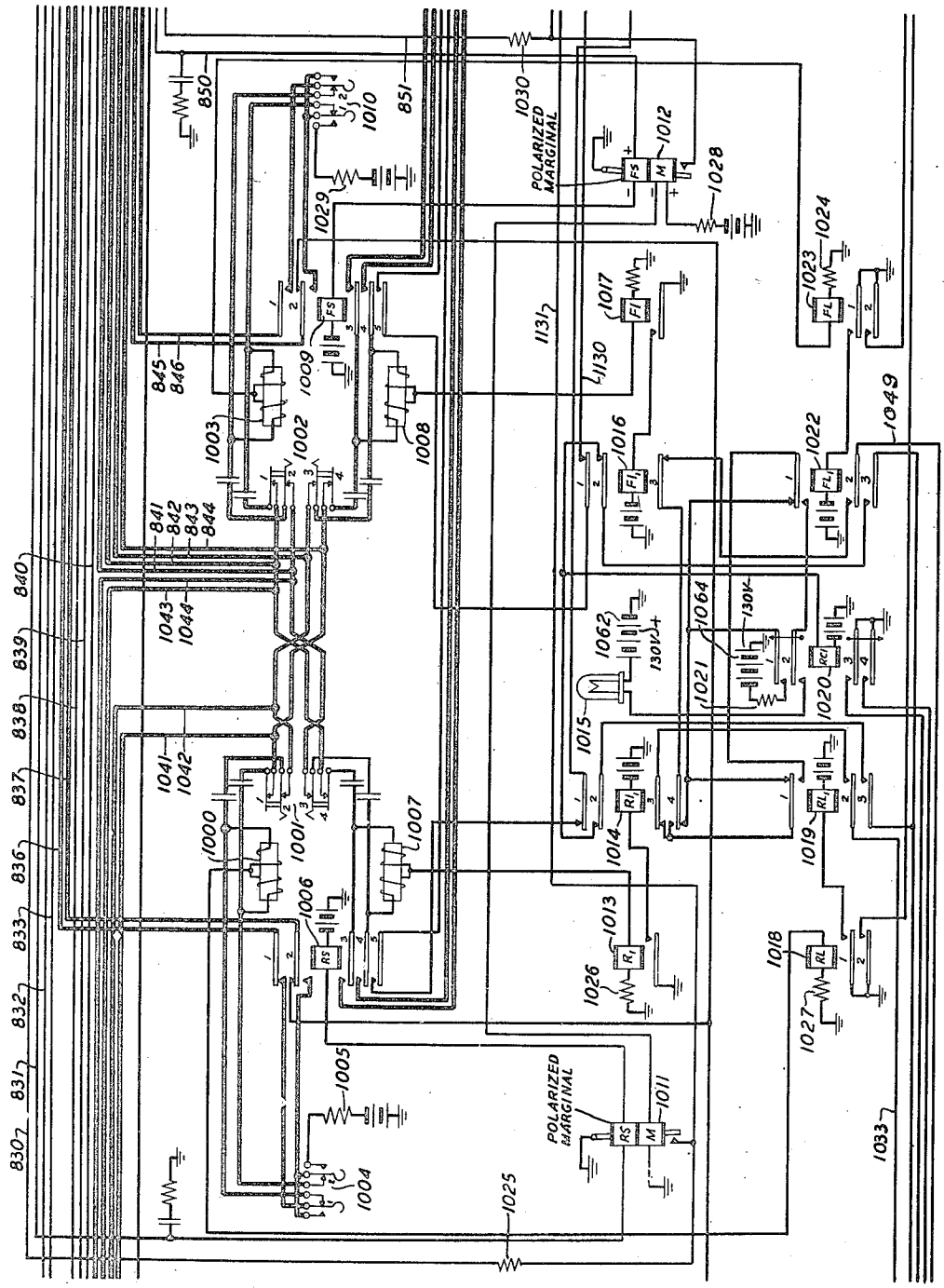


FIG. 10

INVENTORS B. McKIM
O. MYERS

BY M. W. McElroy

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 11

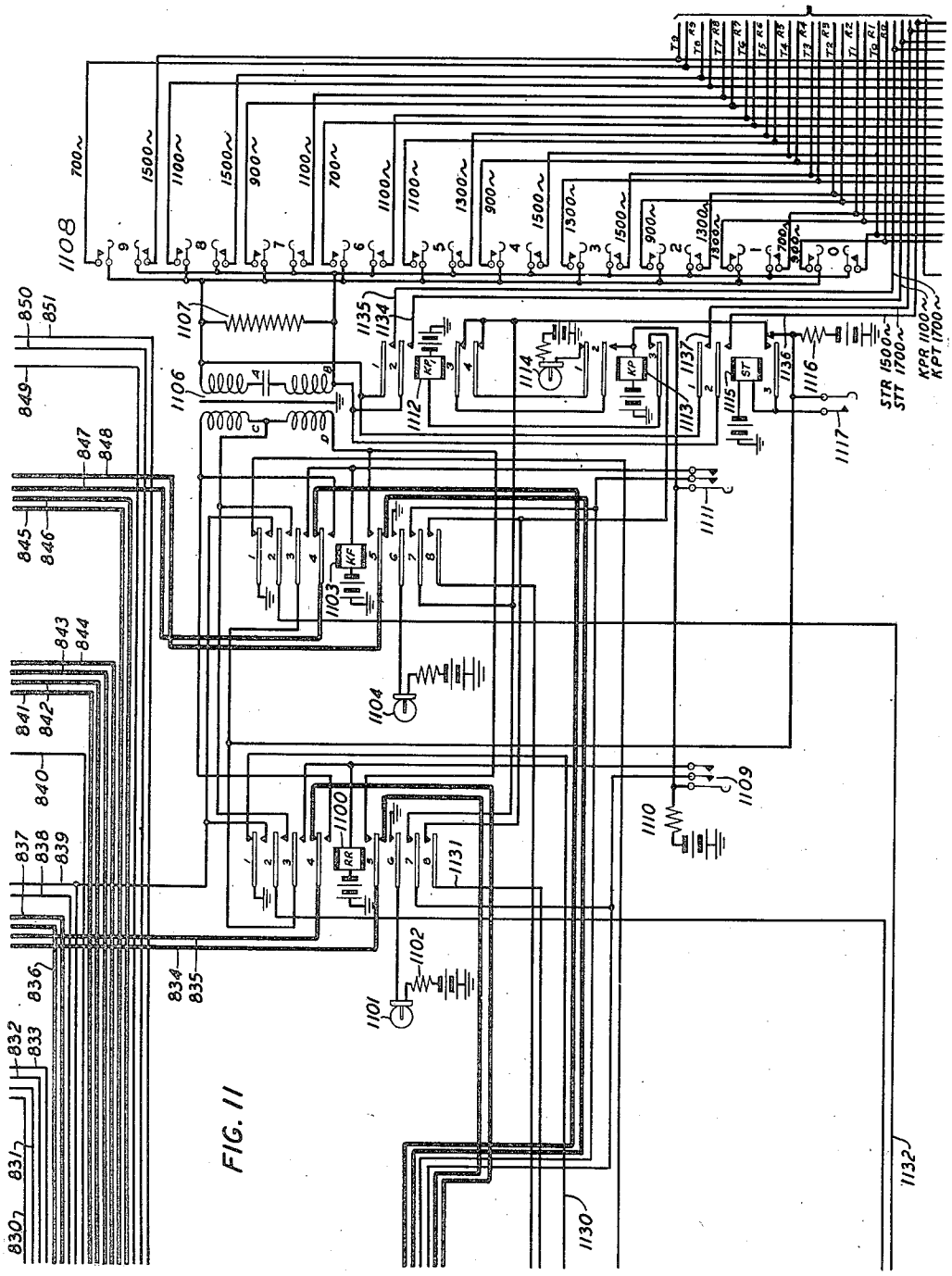


FIG. 11

INVENTORS B. McKIM
O. MYERS

BY W. R. McKinney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 12

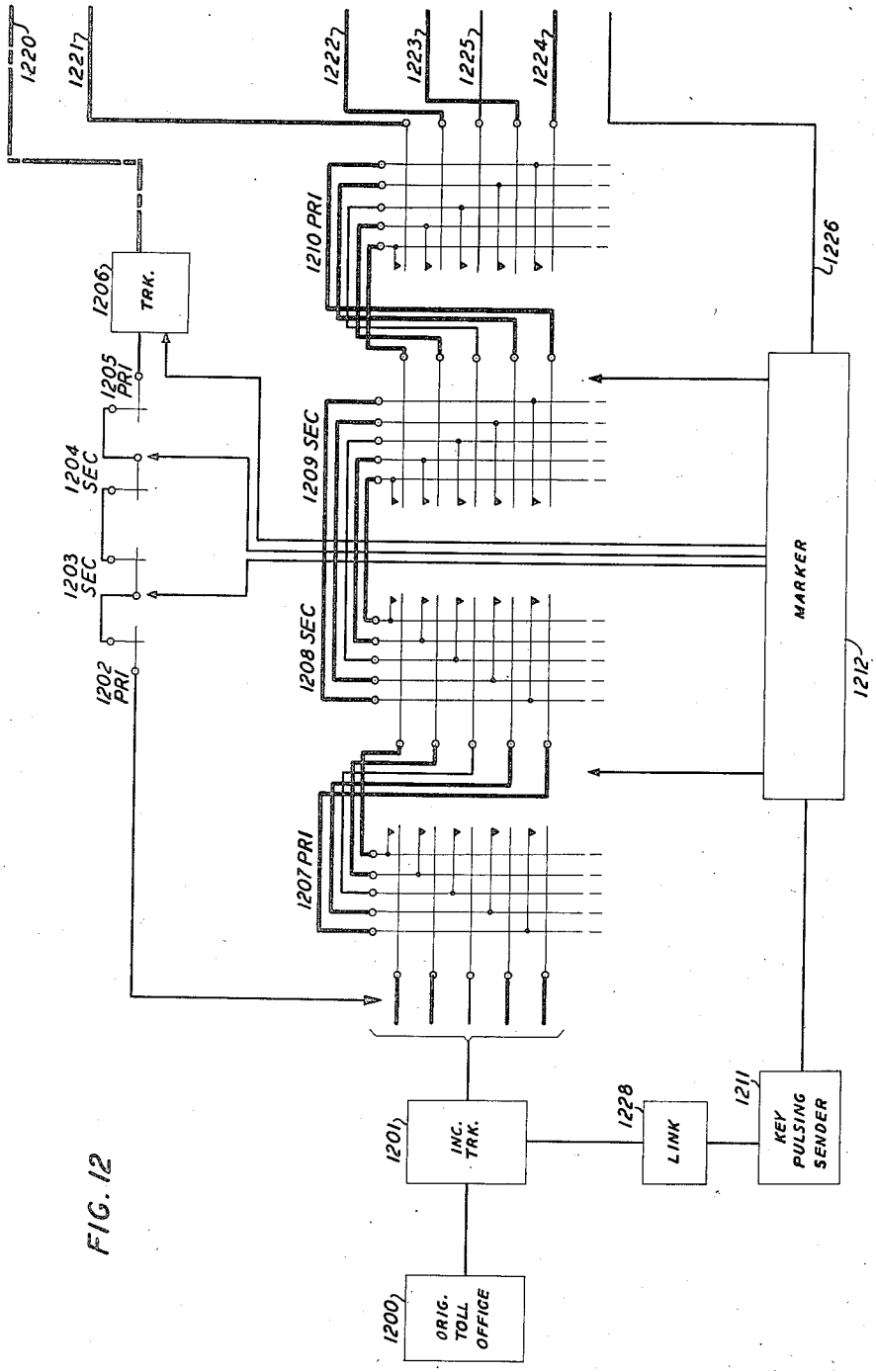


FIG. 12

INVENTORS B. McKIM
O. MYERS

BY M. P. McKinney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 13

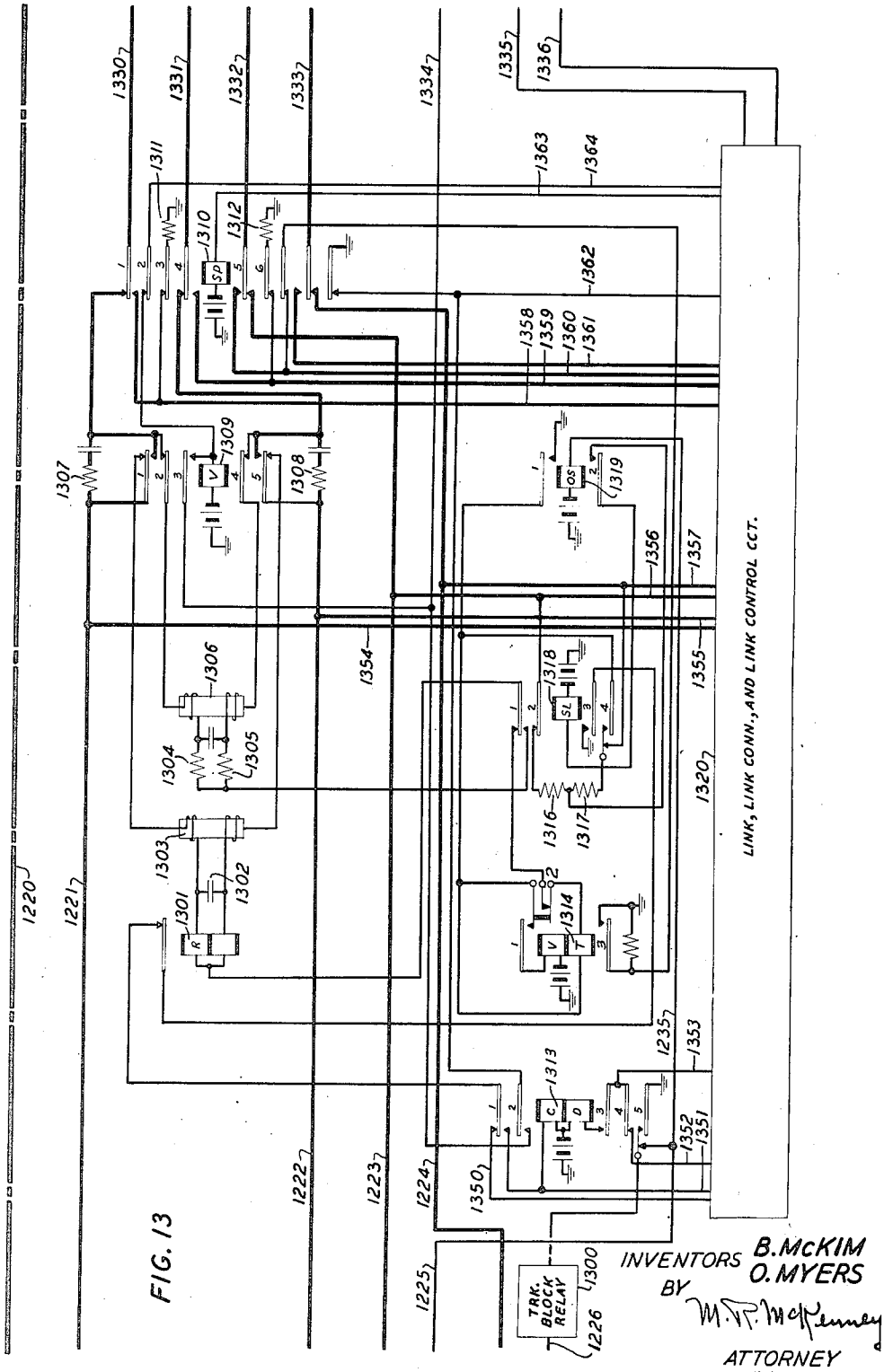


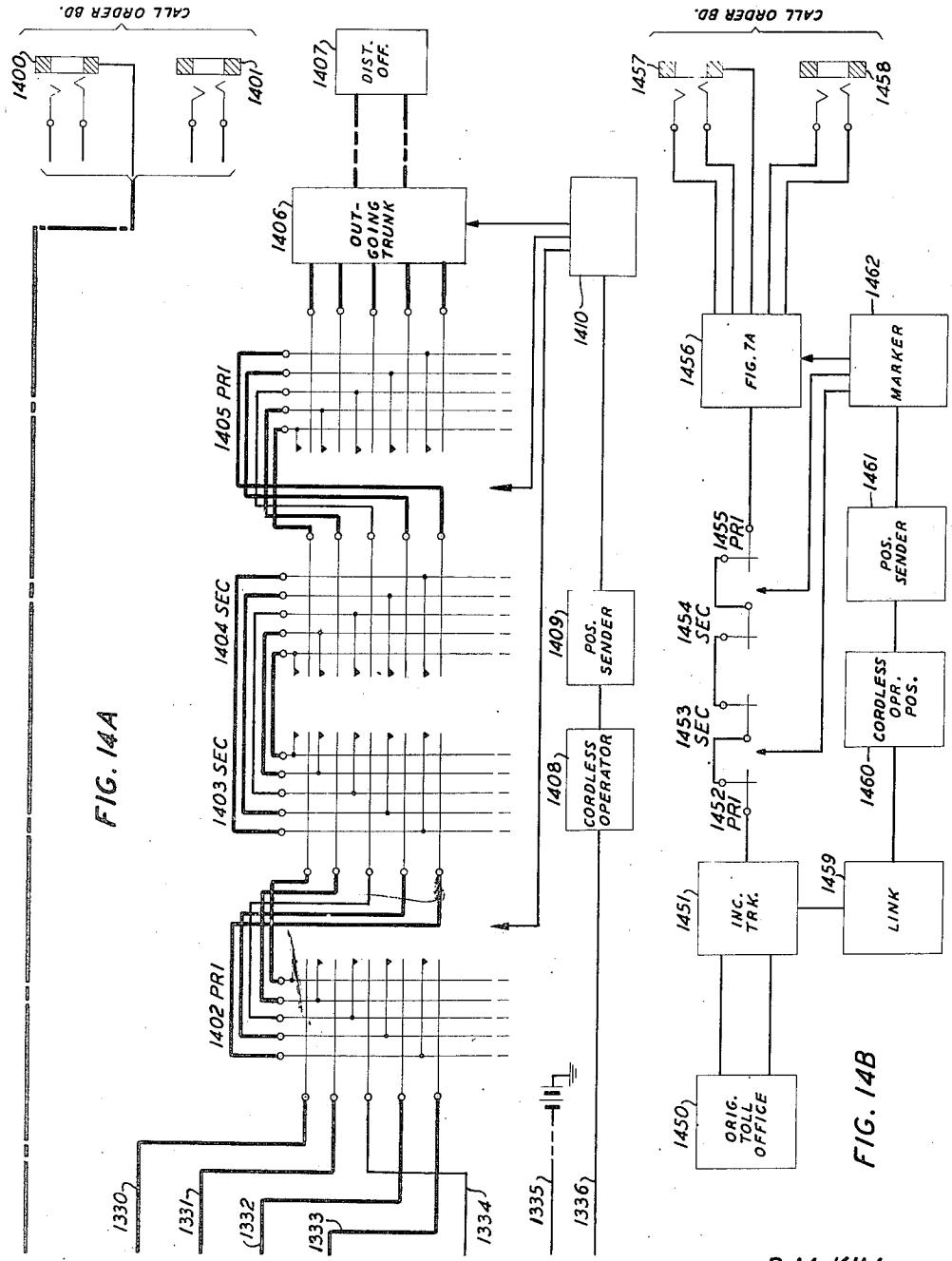
FIG. 13

INVENTORS B. McKIM
O. MYERS
BY
ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 14



INVENTORS B. McKIM
O. MYERS

BY M. R. McKinney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 15

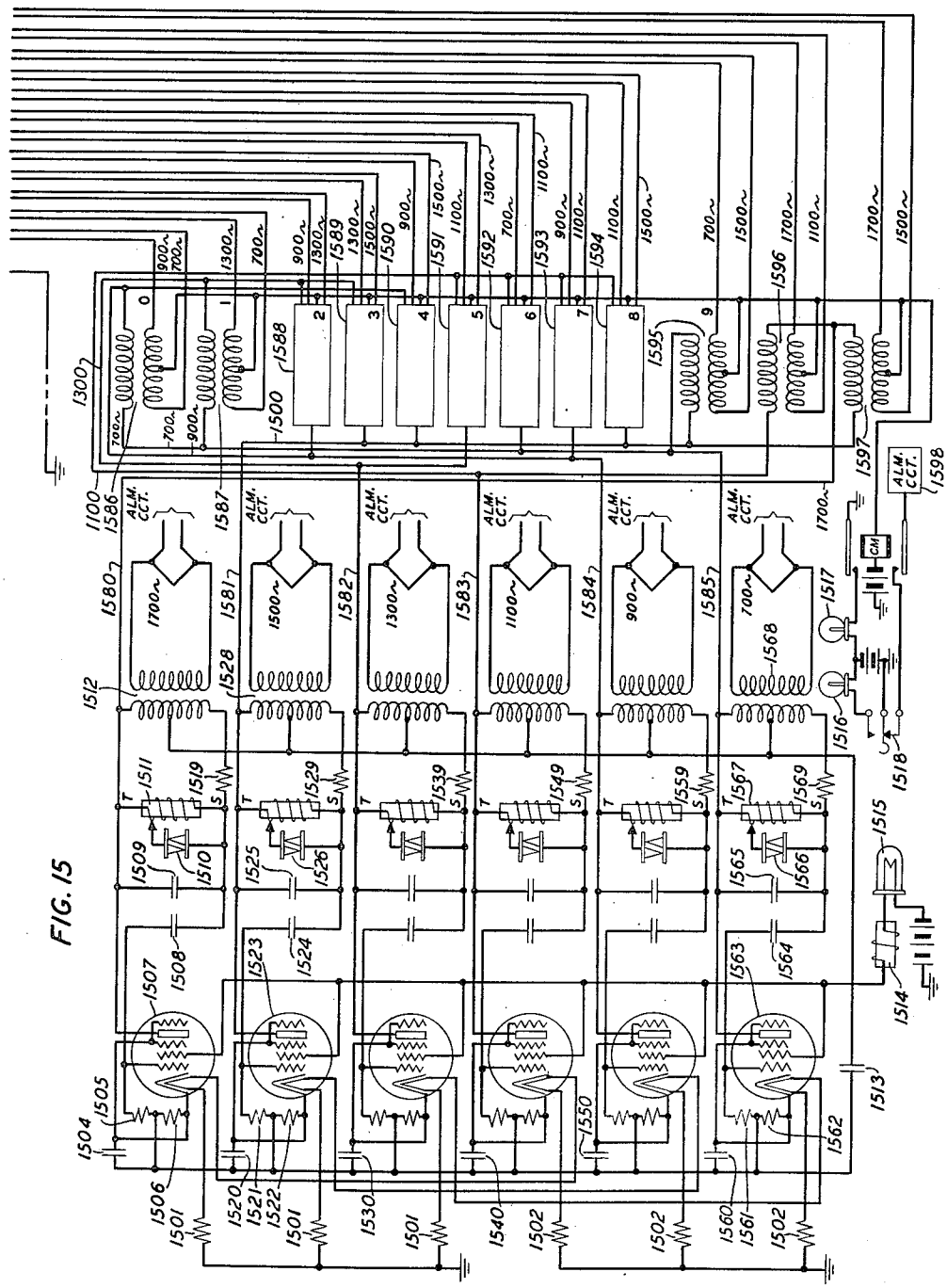


FIG. 15

INVENTORS B. McKIM
O. MYERS

BY M. P. McKinney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 16

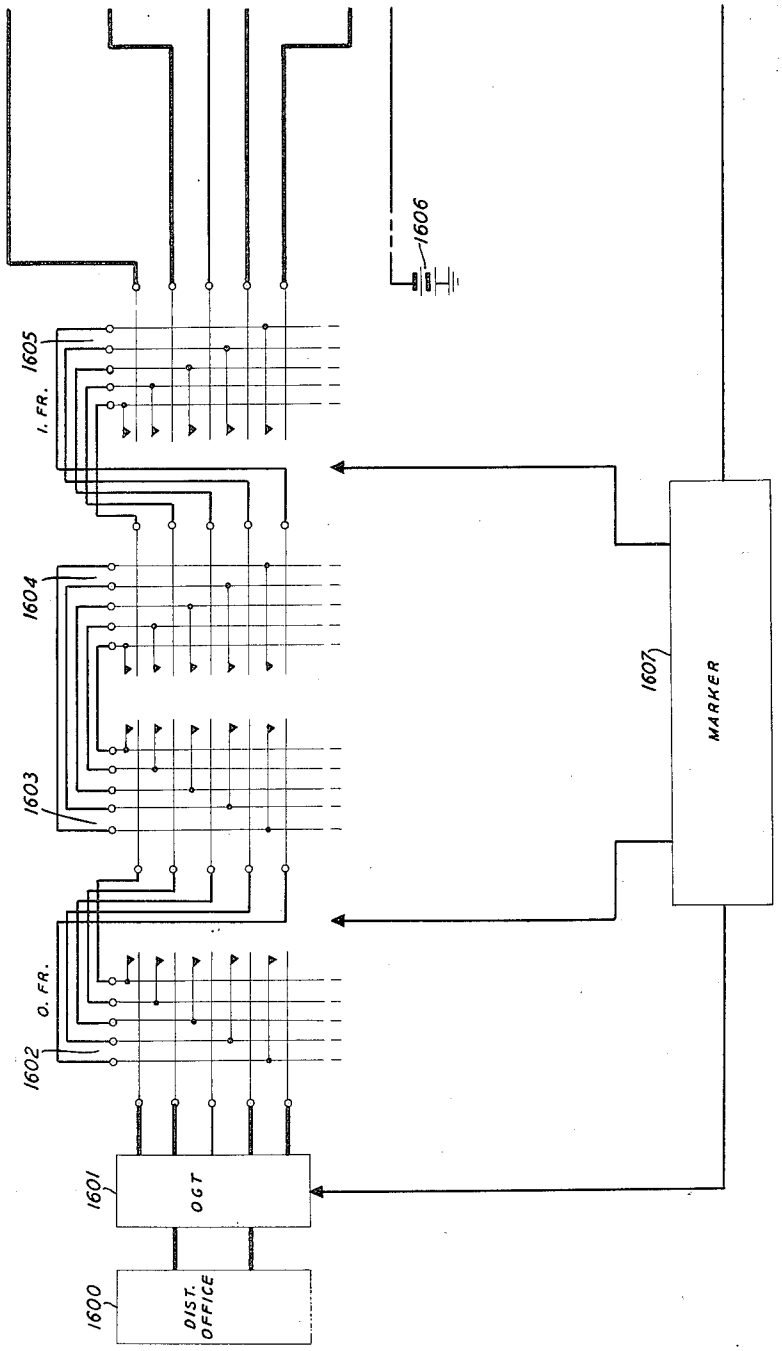


FIG. 16

INVENTORS B. McKIM
O. MYERS

BY M. P. McKenney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 17

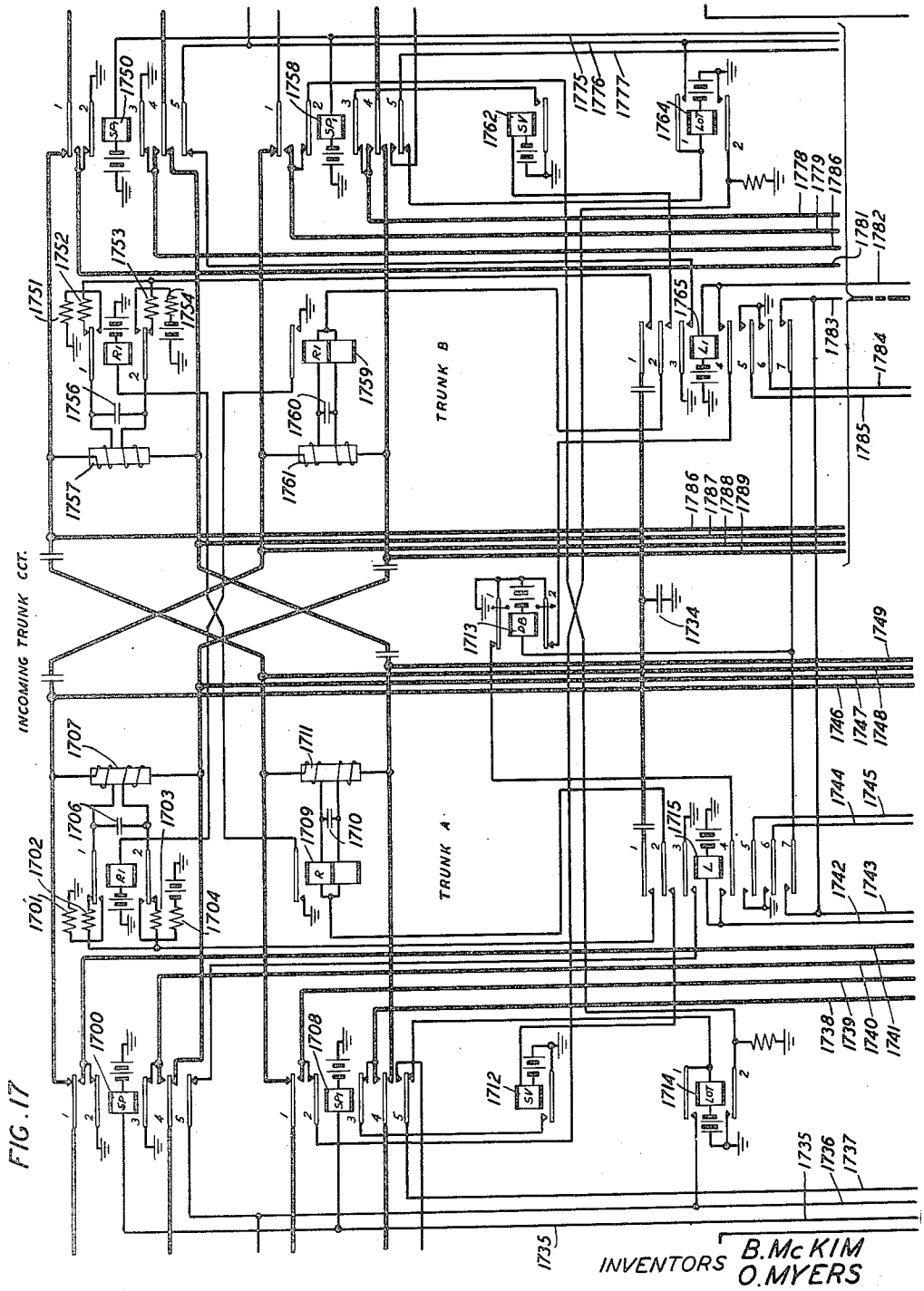


FIG. 17

INVENTORS B. McKIM
O. MYERS

BY W. P. McKenney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 18

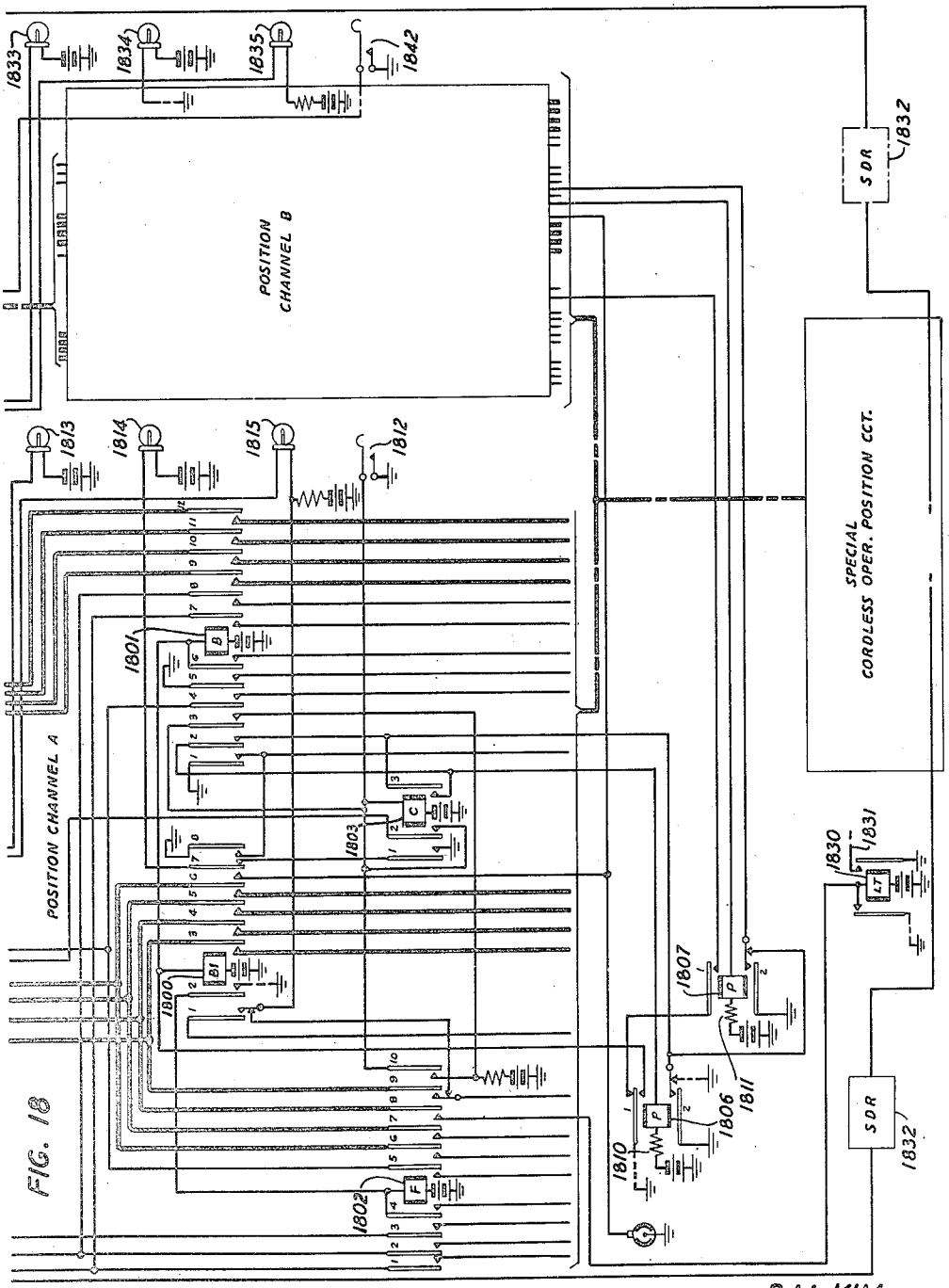


FIG. 18

INVENTORS B. McKIM O. MYERS

BY W. P. McKinney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 19

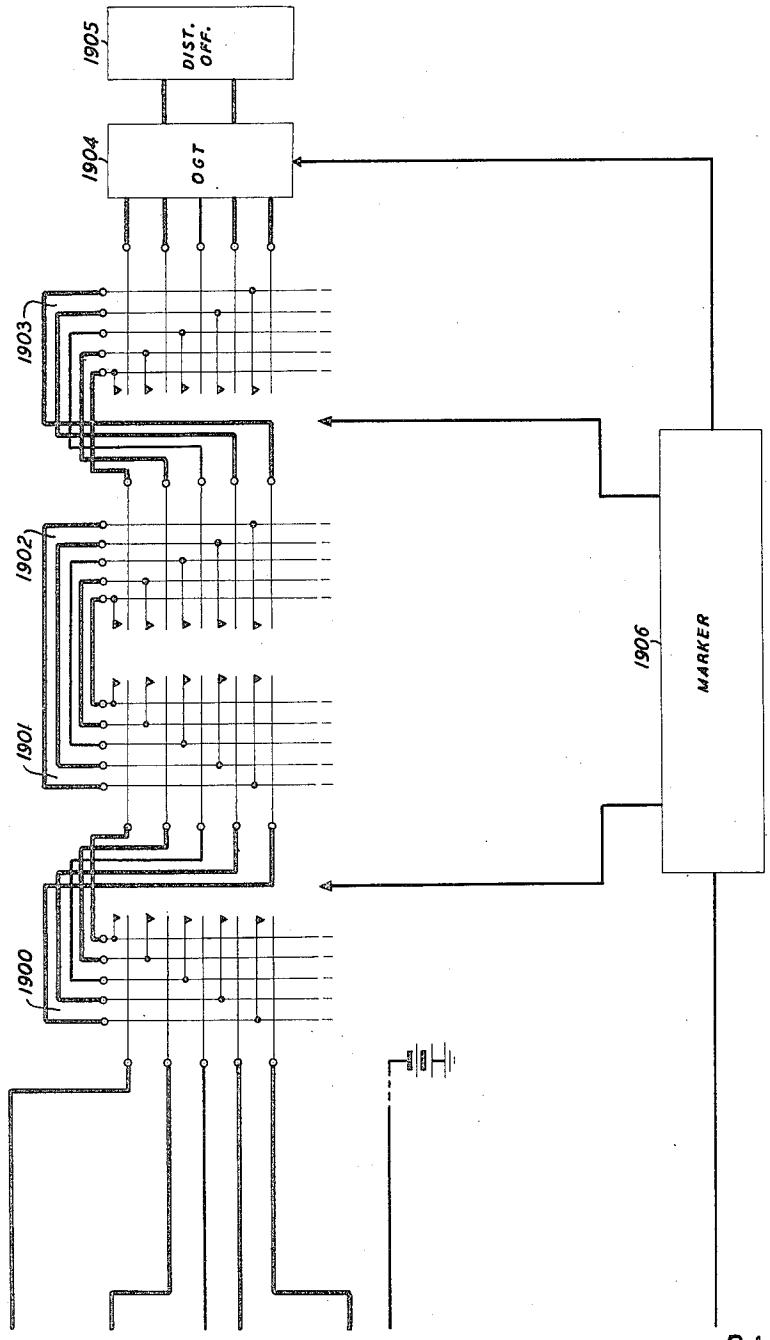


FIG. 19

INVENTORS B. McKIM
O. MYERS

BY M. R. McKenney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 20

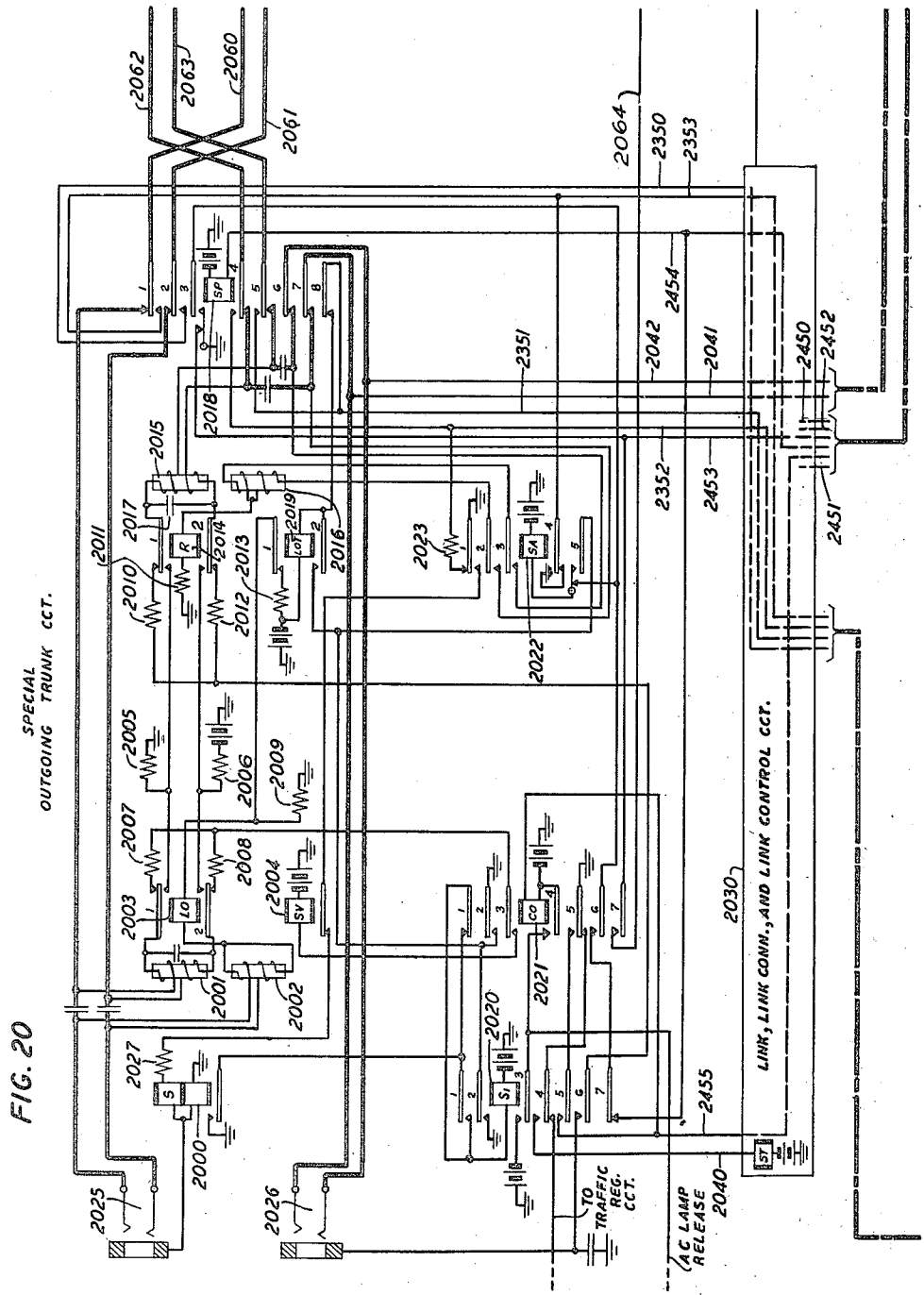


FIG. 20

INVENTORS B. McKIM O. MYERS

BY M. R. McKinney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 21

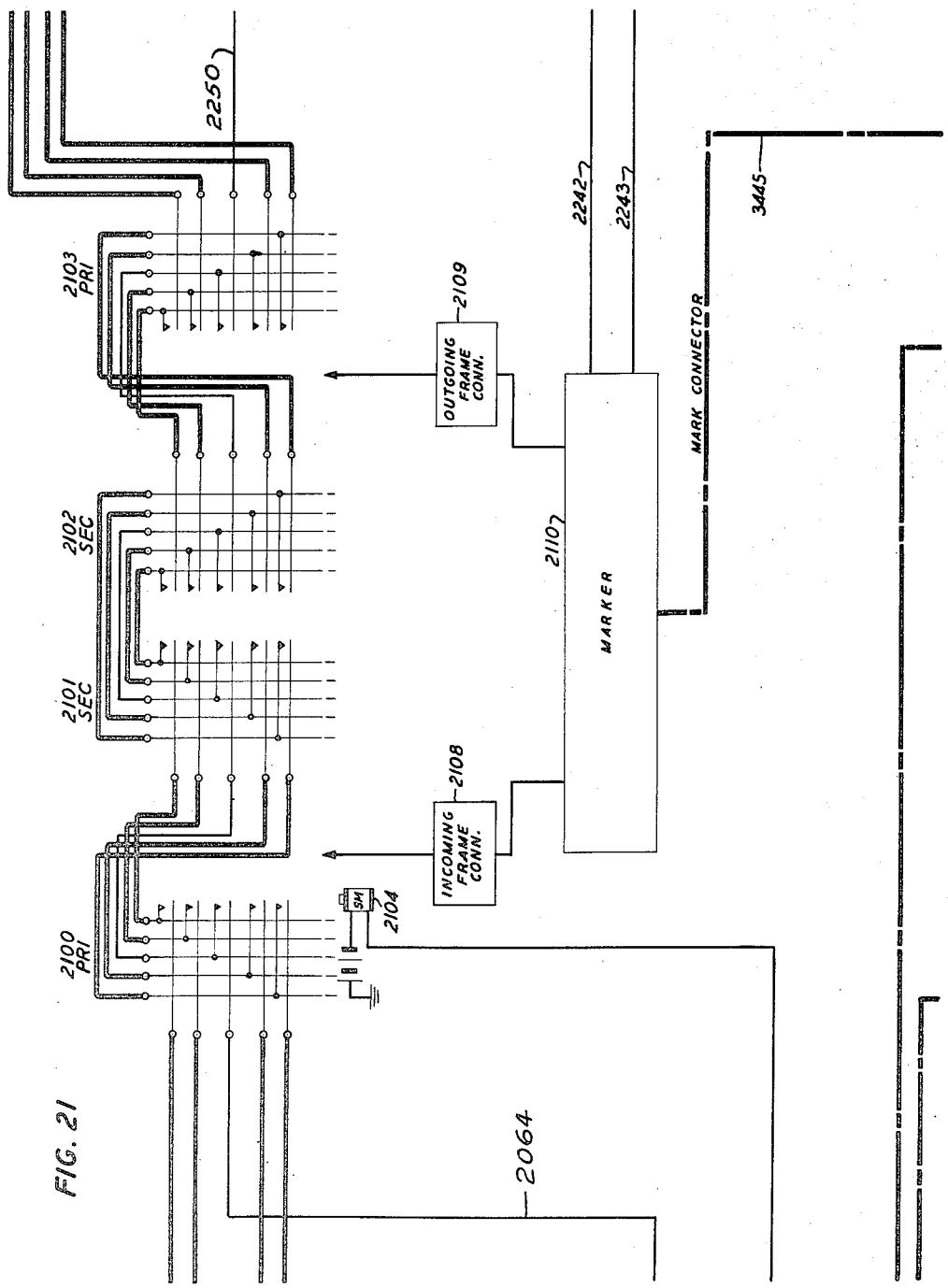


FIG. 21

INVENTORS B. McKIM
O. MYERS

BY W. R. McKinney

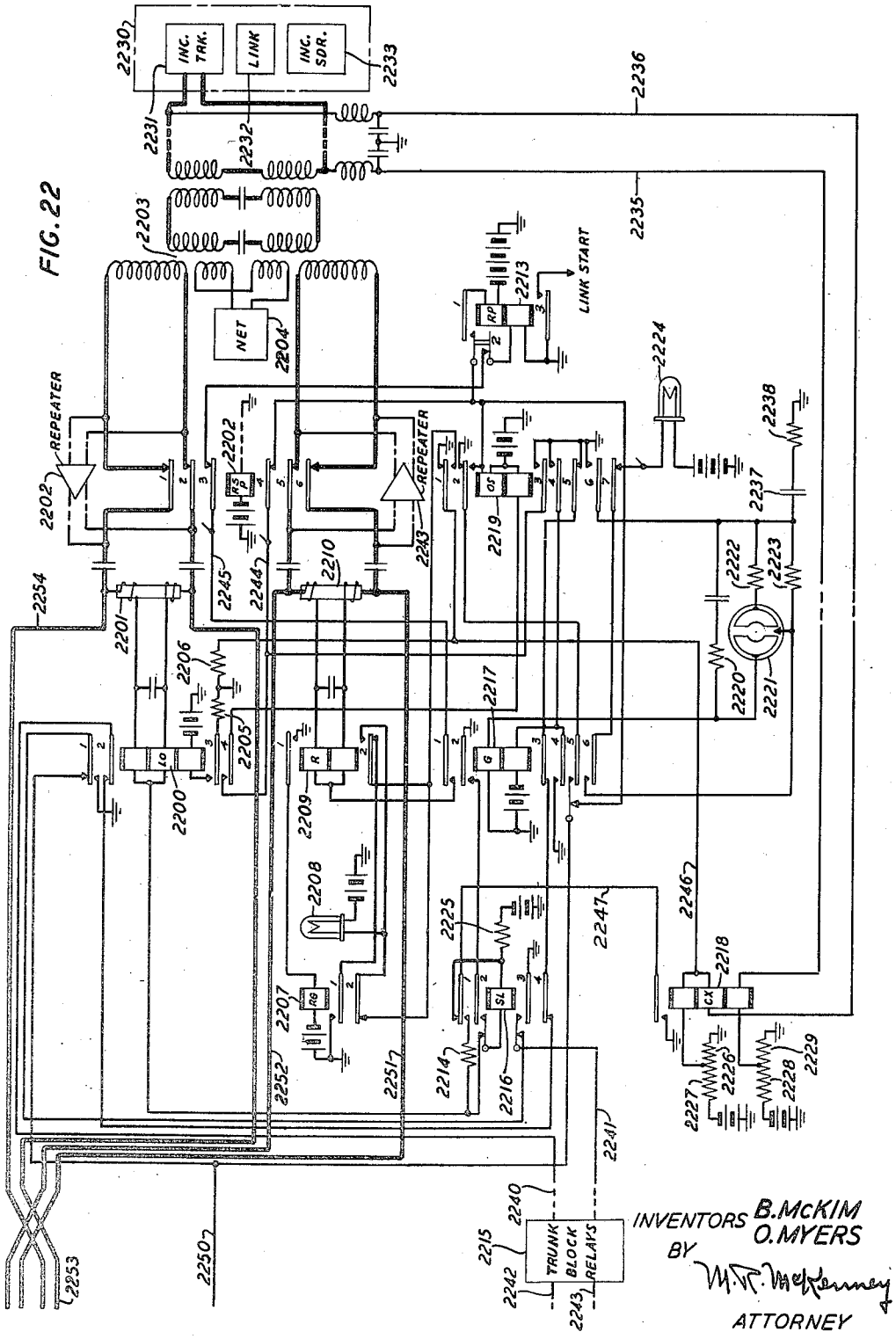
ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 22

FIG. 22



INVENTORS B. McKIM
O. MYERS
BY
ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 23

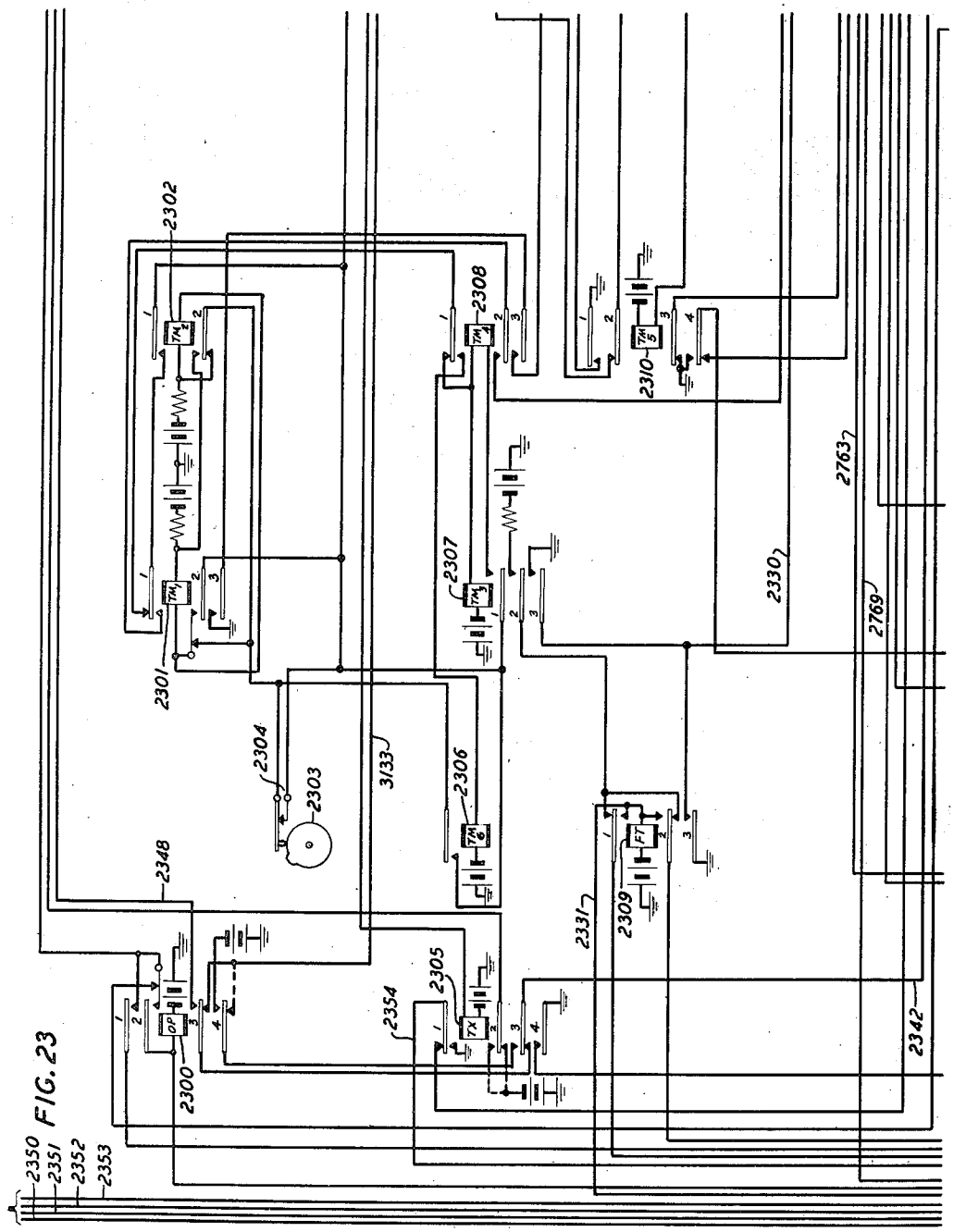


FIG. 23

INVENTORS B. McKIM
O. MYERS

BY M. F. McKenney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 24

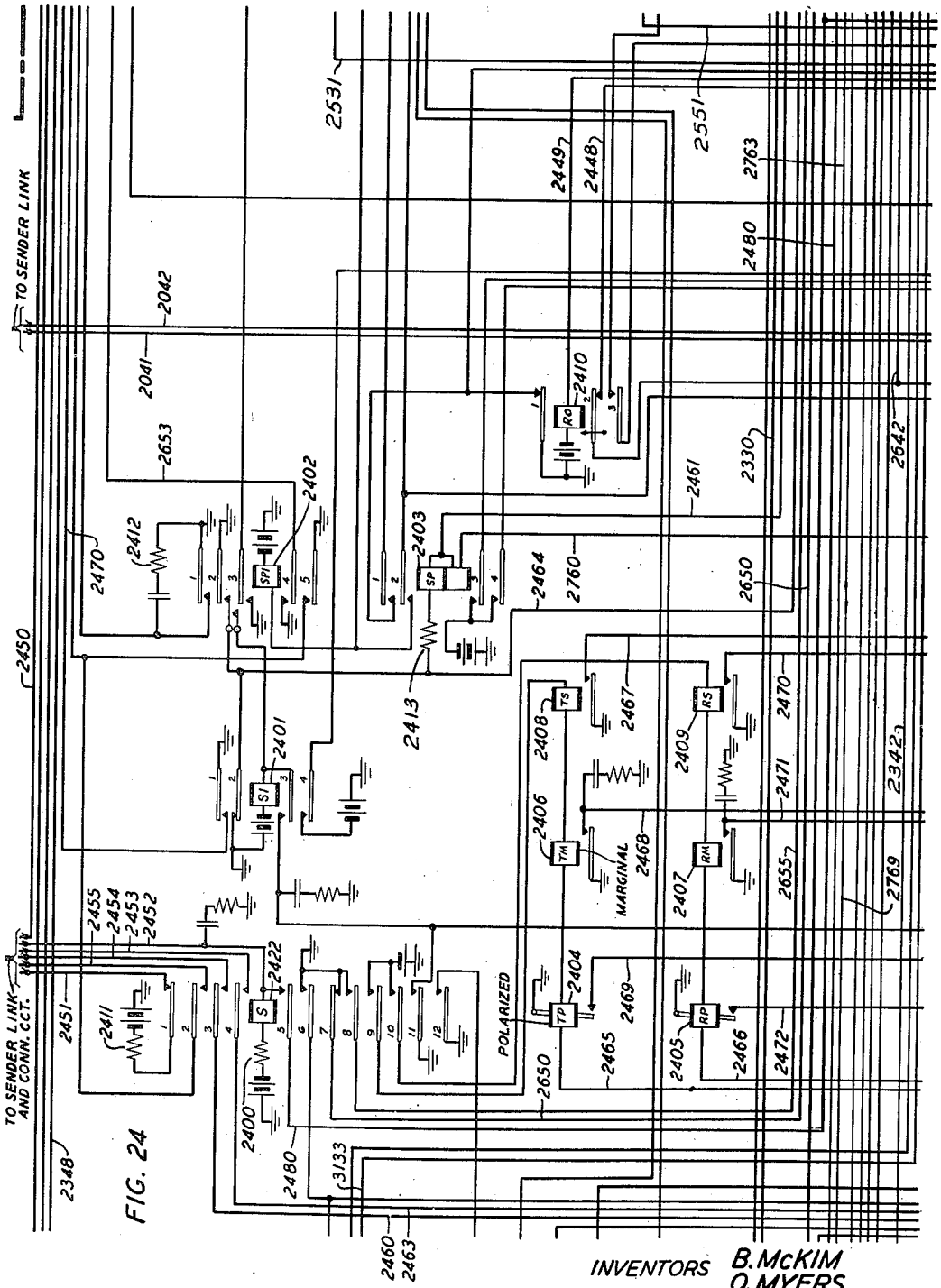


FIG. 24

INVENTORS B. McKIM
O. MYERS

BY W. F. McKinney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 25

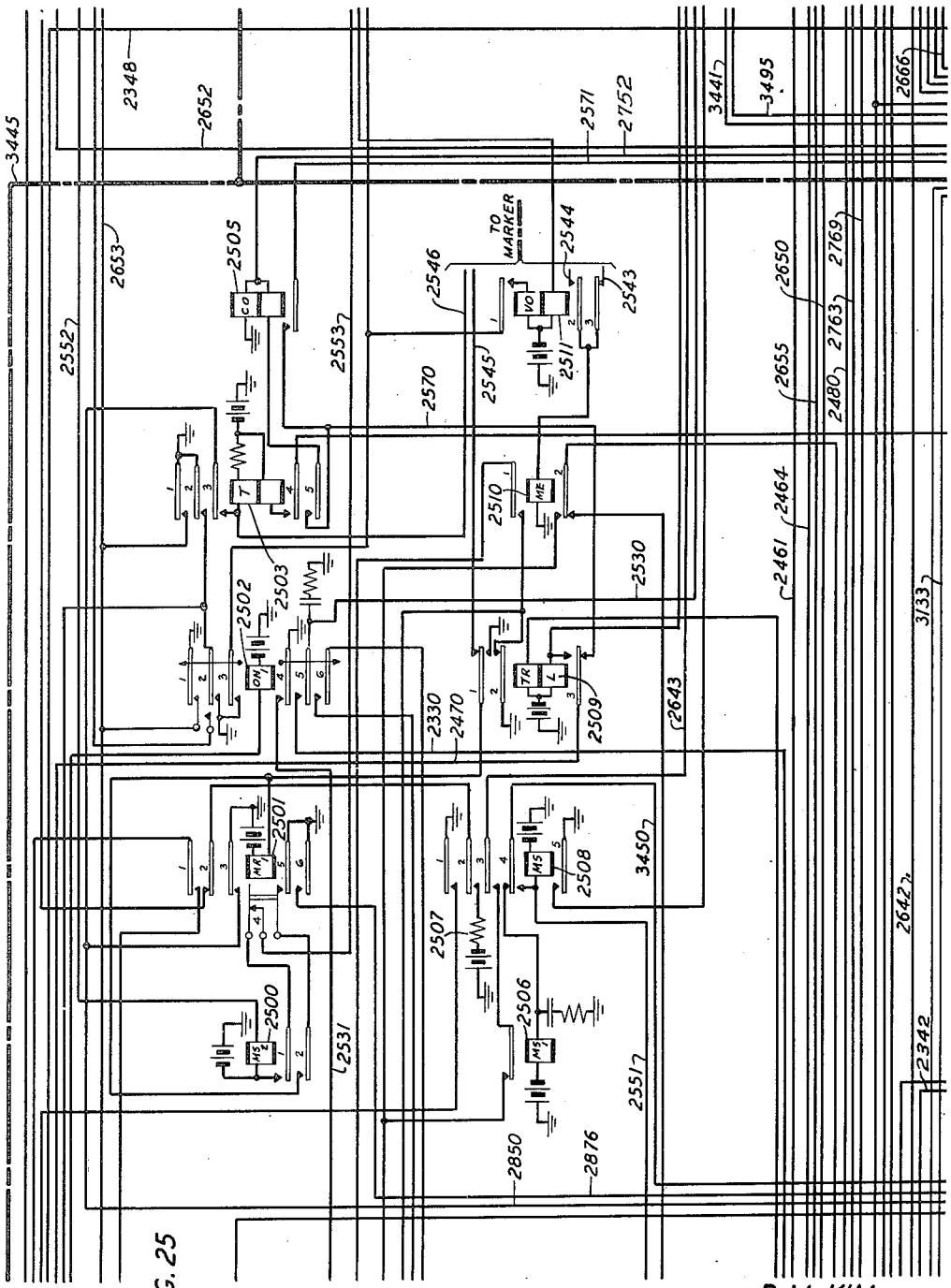


FIG. 25

INVENTORS B. McKIM
O. MYERS
BY M. F. McKenney
ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 26

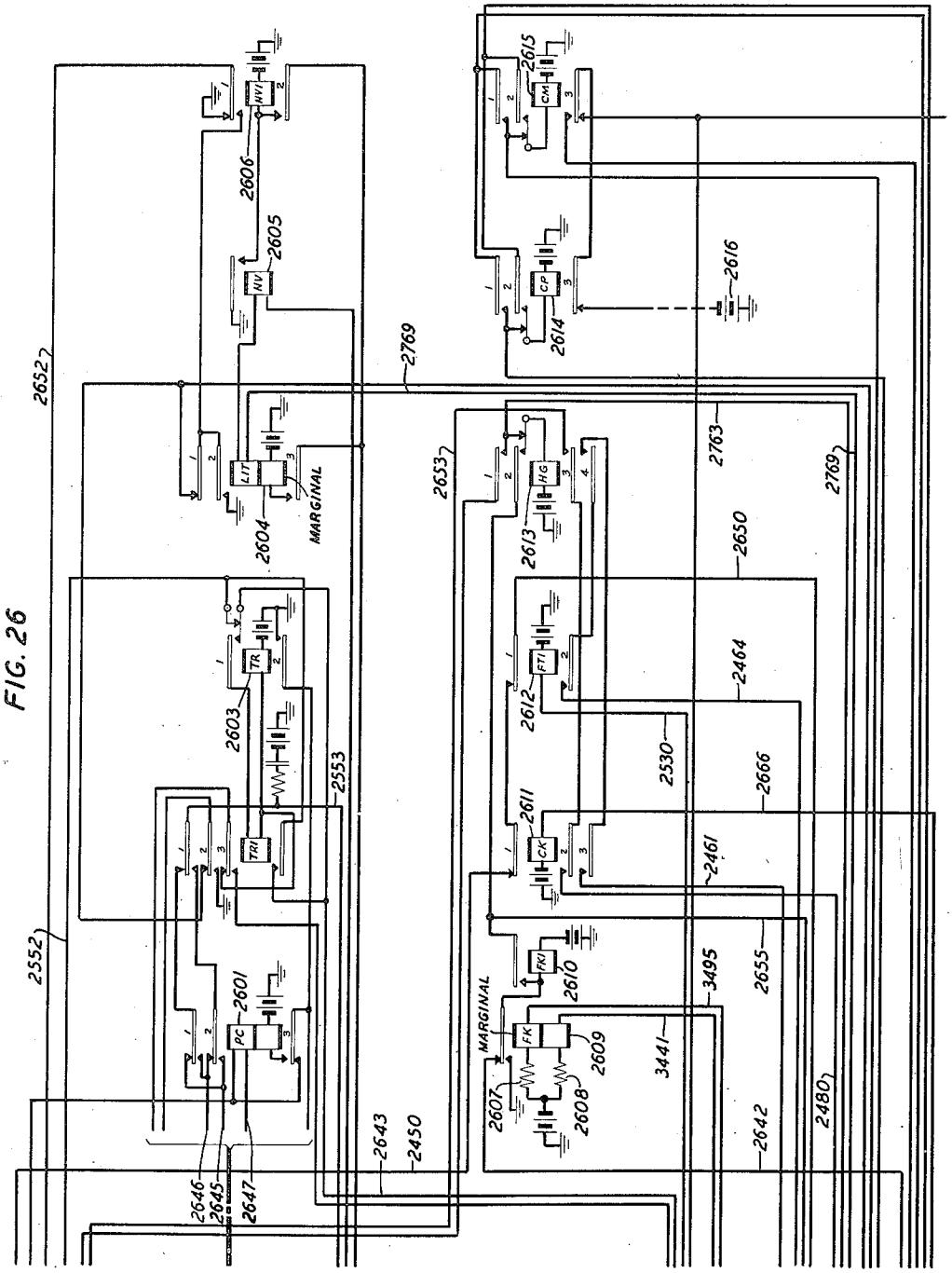


FIG. 26

INVENTORS B. McKIM
O. MYERS

BY M. R. McKenney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 27

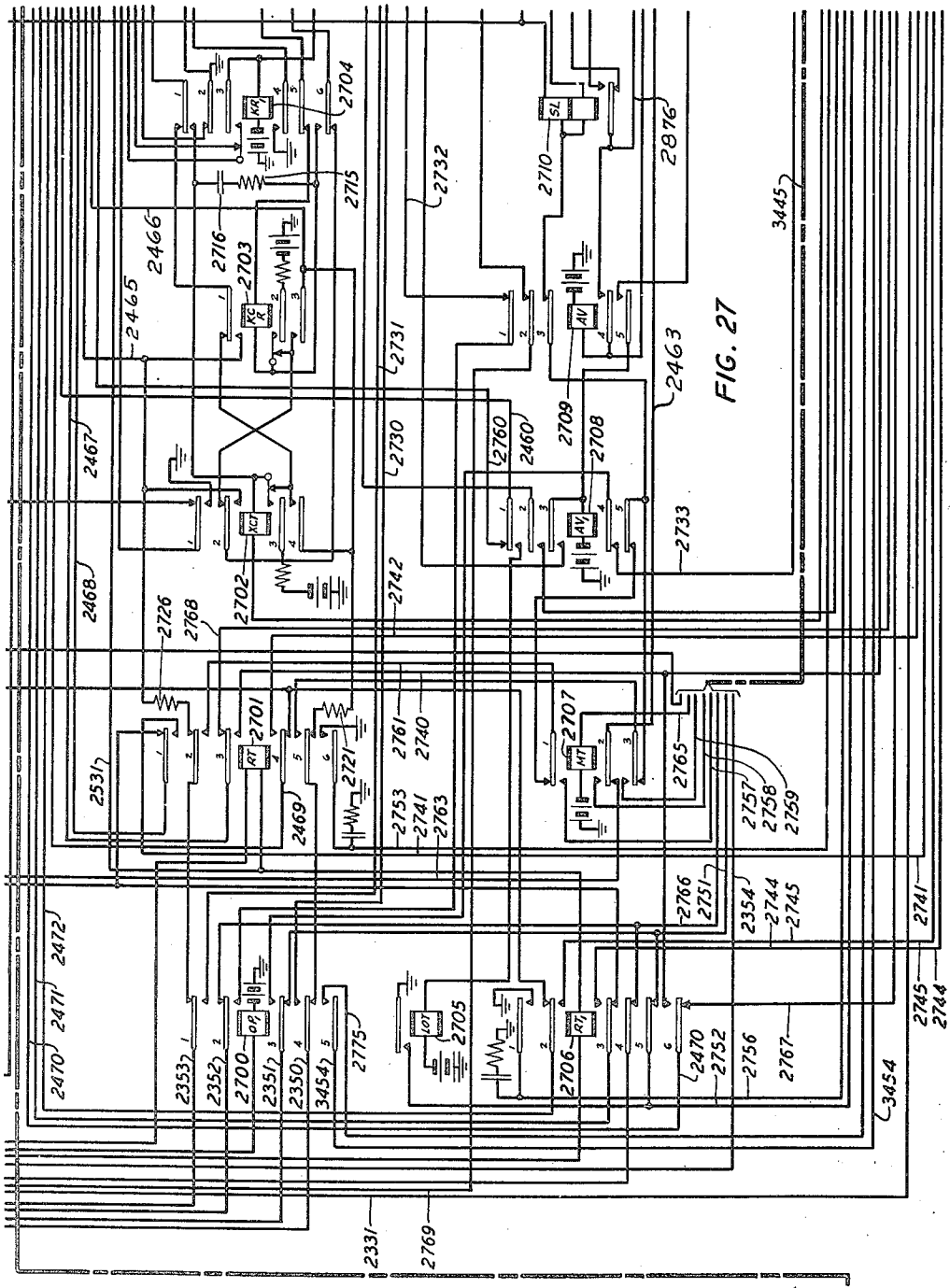


FIG. 27

INVENTORS B. McKIM
O. MYERS
BY M. P. McInerney
ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 28

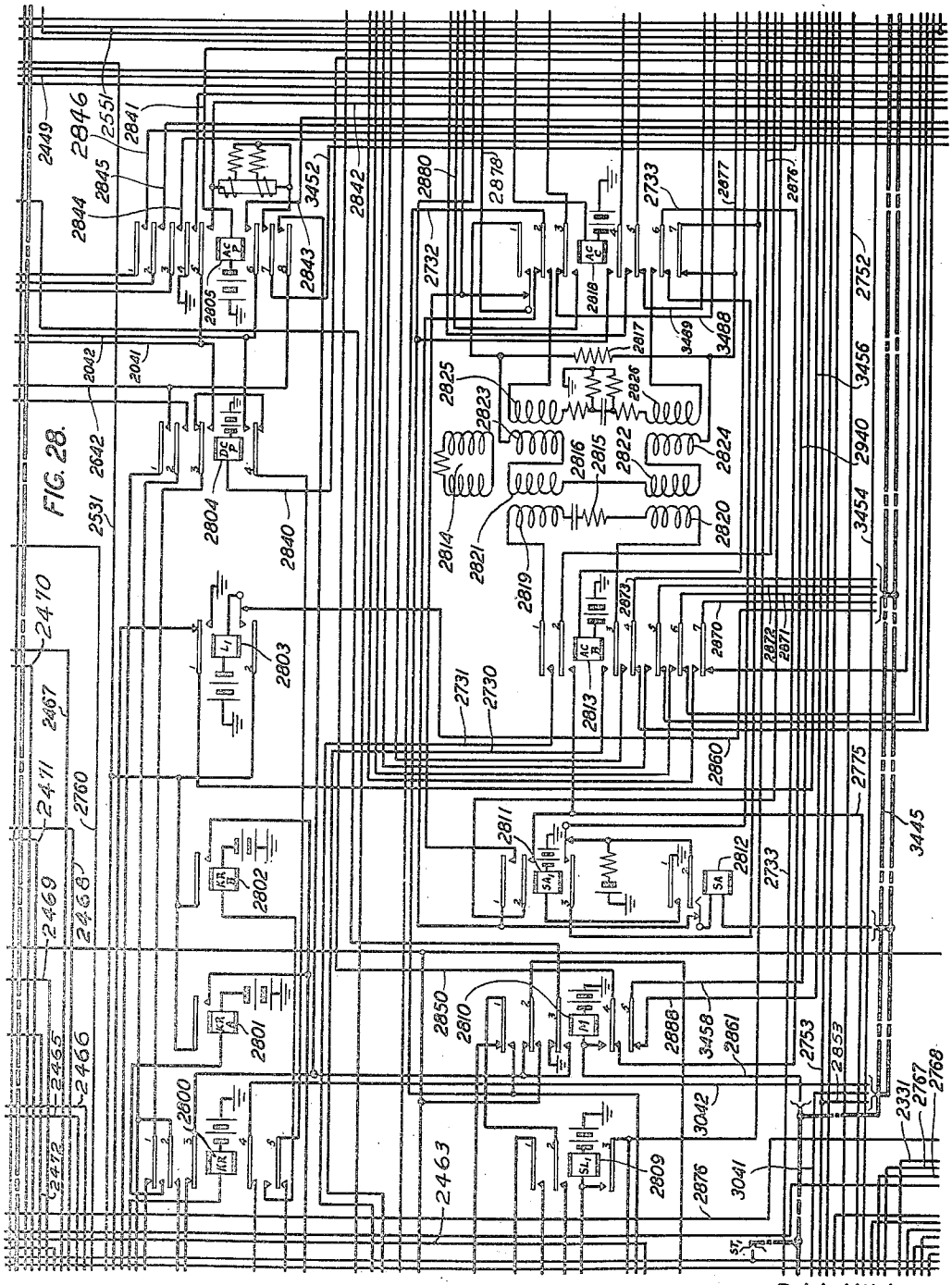


FIG. 28.

INVENTORS B. McKIM
O. MYERS
BY W. T. McKinney
ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 29

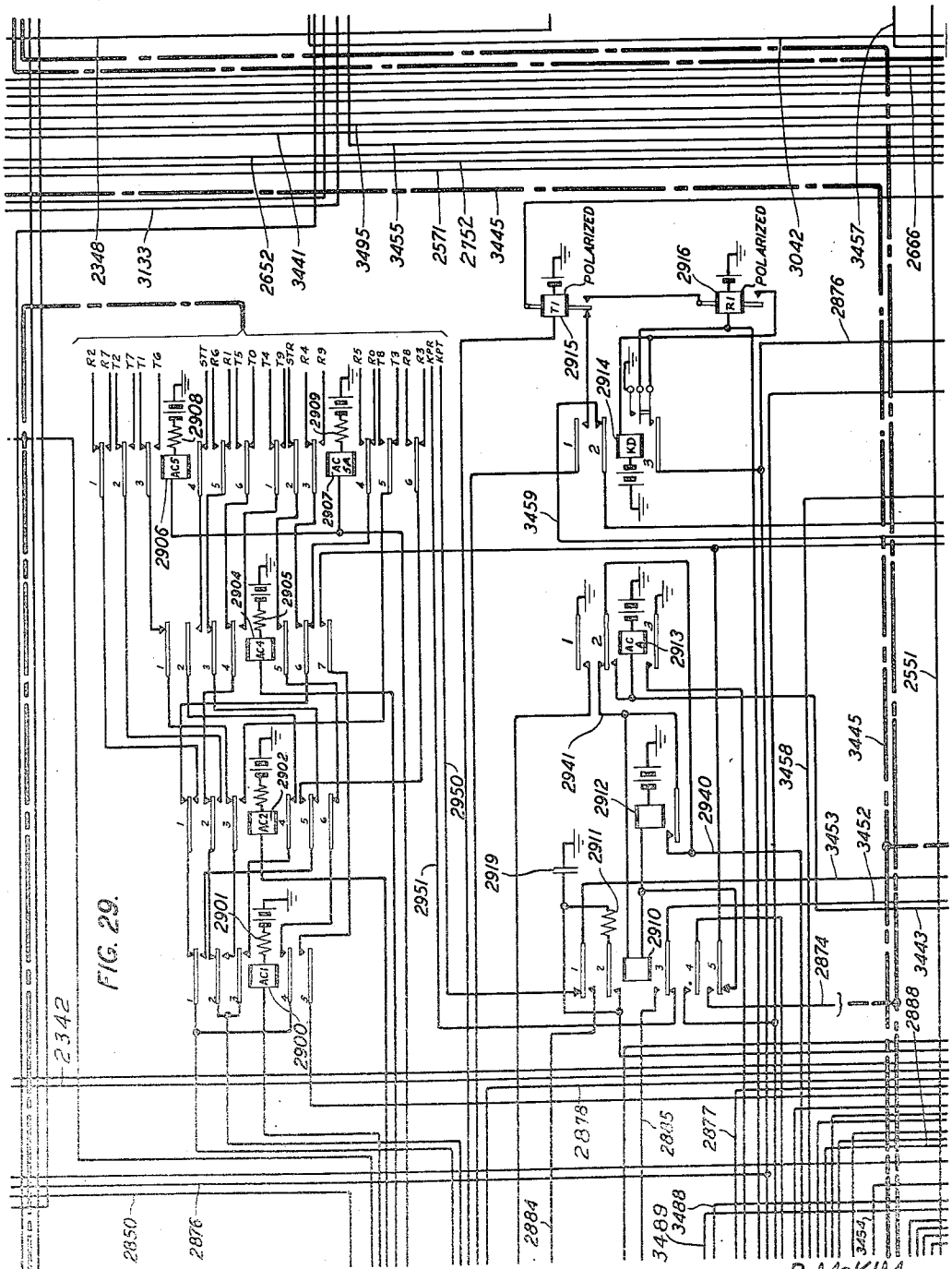


FIG. 29.

INVENTORS B. McKIM
O. MYERS

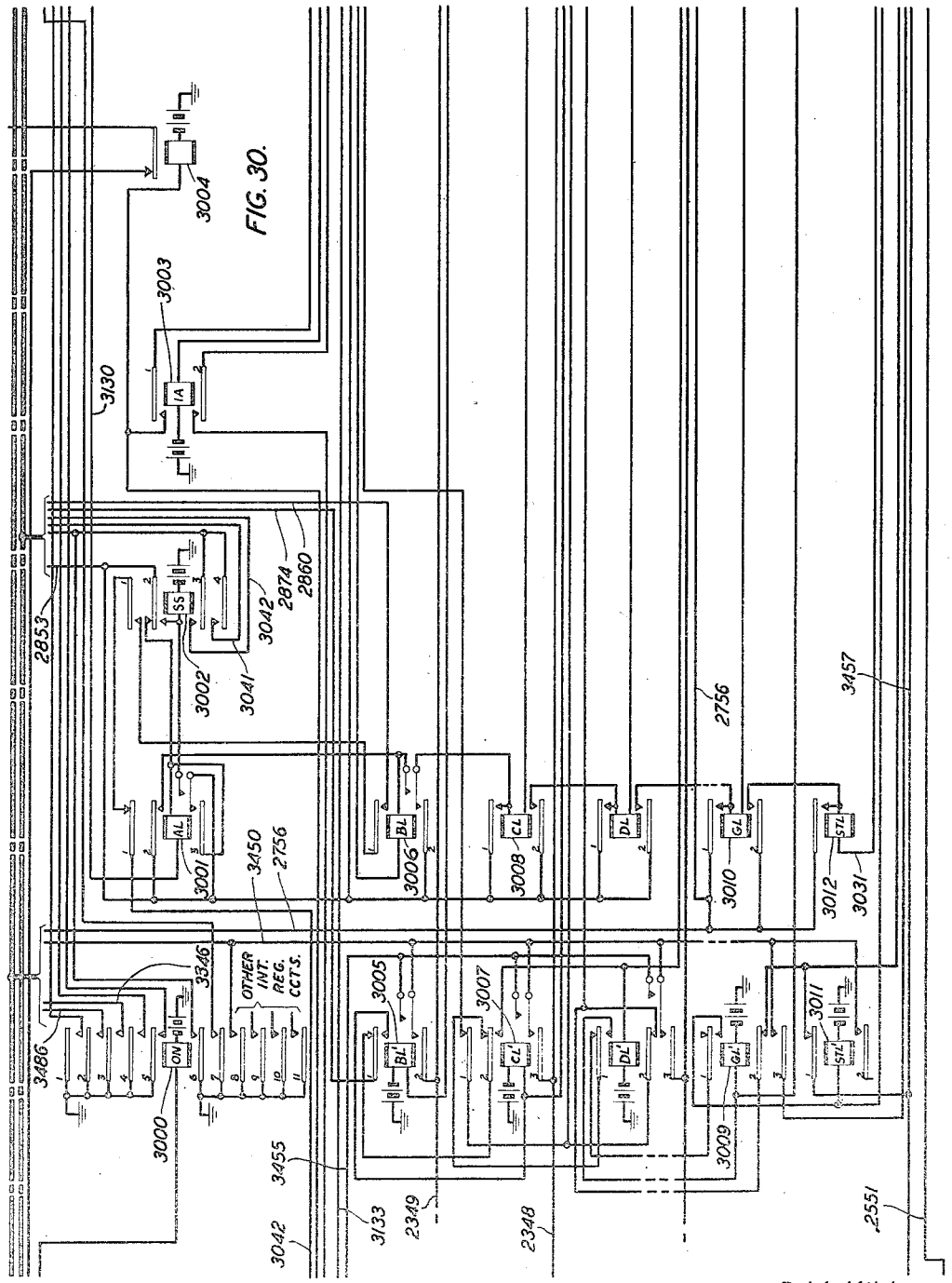
BY W. T. McKinney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 30



INVENTORS B. McKIM
O. MYERS

BY W. F. McTammany

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 31

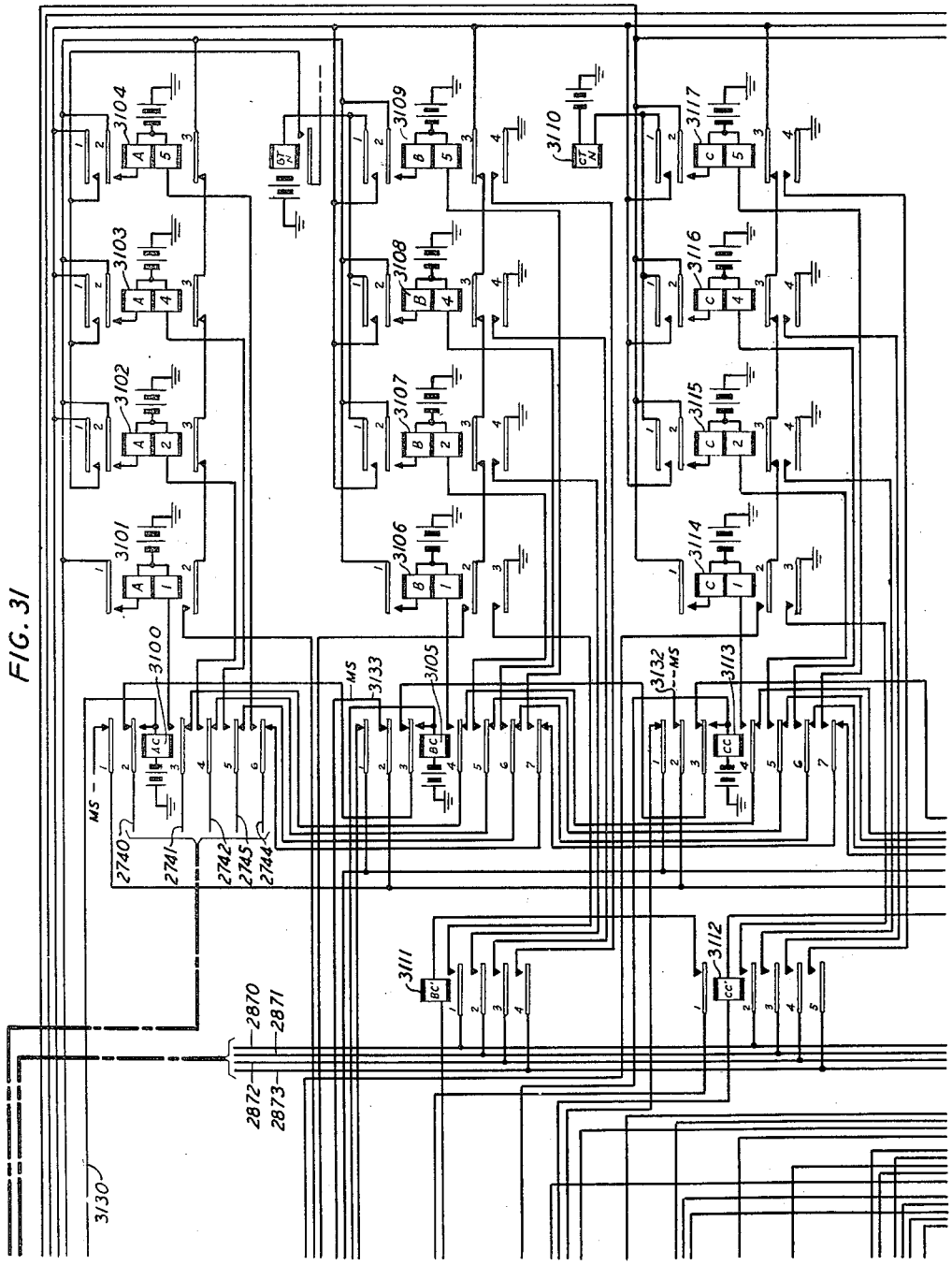


FIG. 31

INVENTORS B. McKIM
O. MYERS
BY M. D. McTierney
ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 32

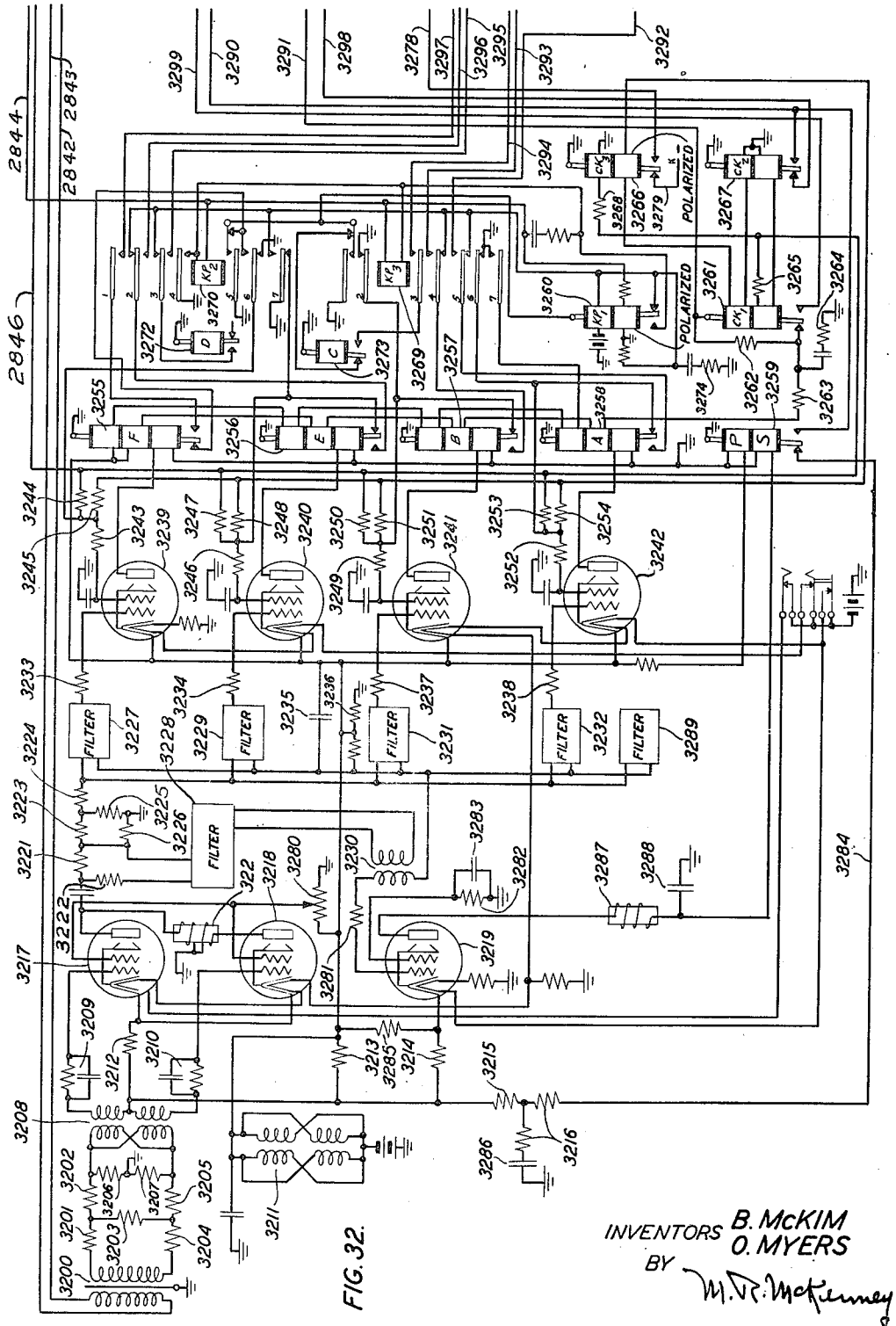


FIG. 32.

INVENTORS B. McKIM
O. MYERS
BY M. D. McKinney
ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 33

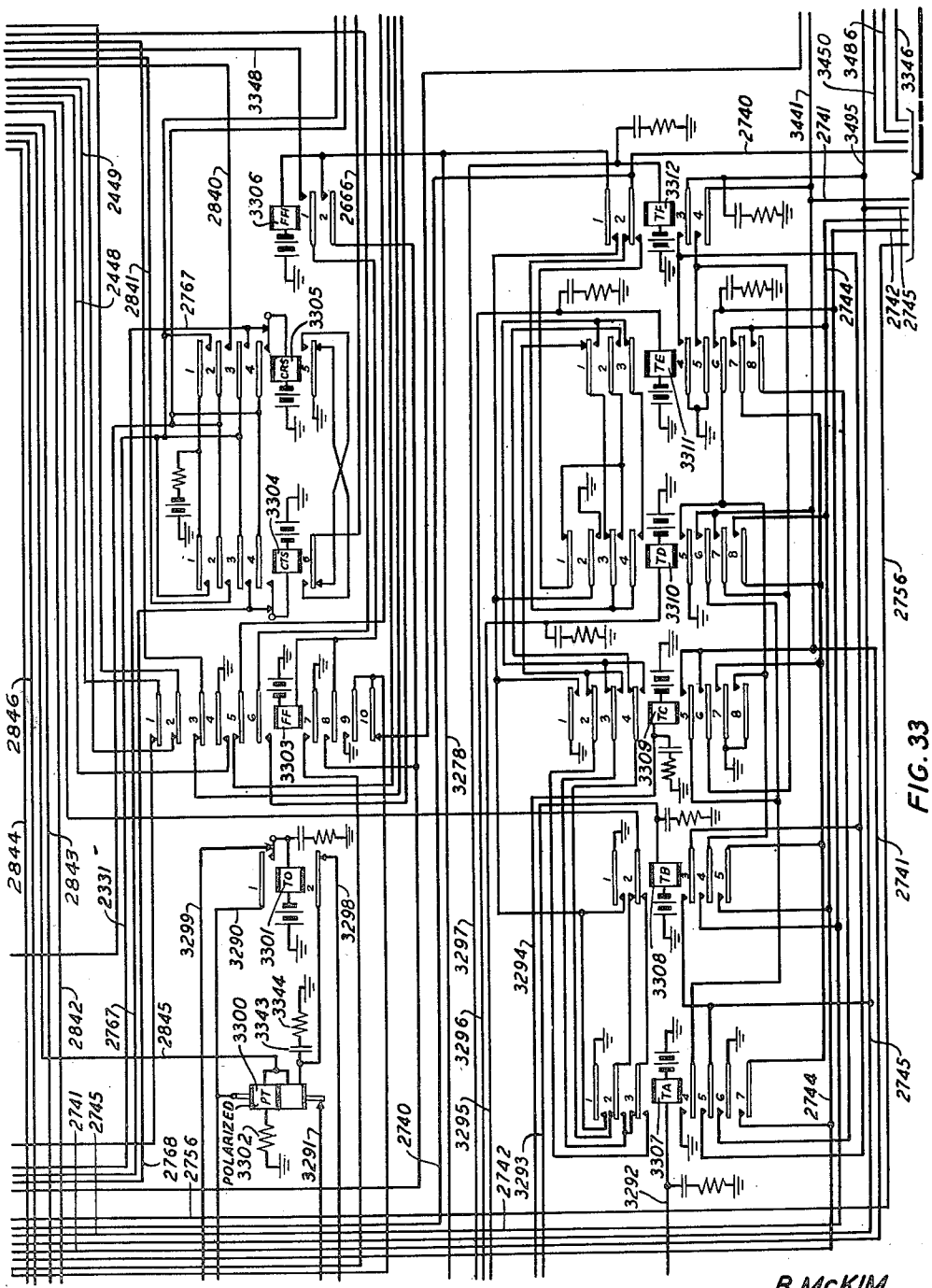


FIG. 33

INVENTORS B. McKIM
O. MYERS

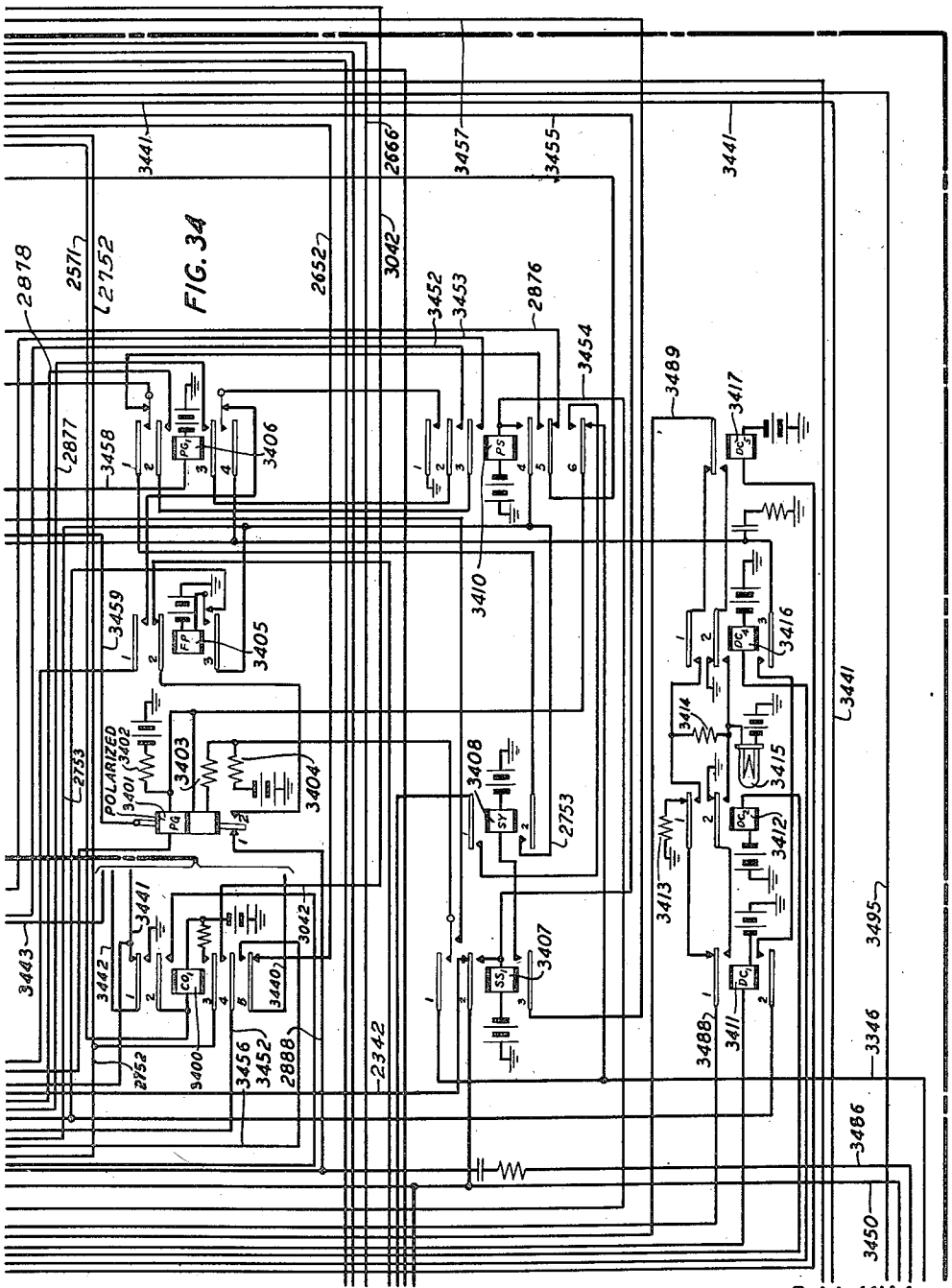
BY M. R. McTamney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 34



INVENTORS B. McKIM
O. MYERS

BY M. R. McKenney

ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 35

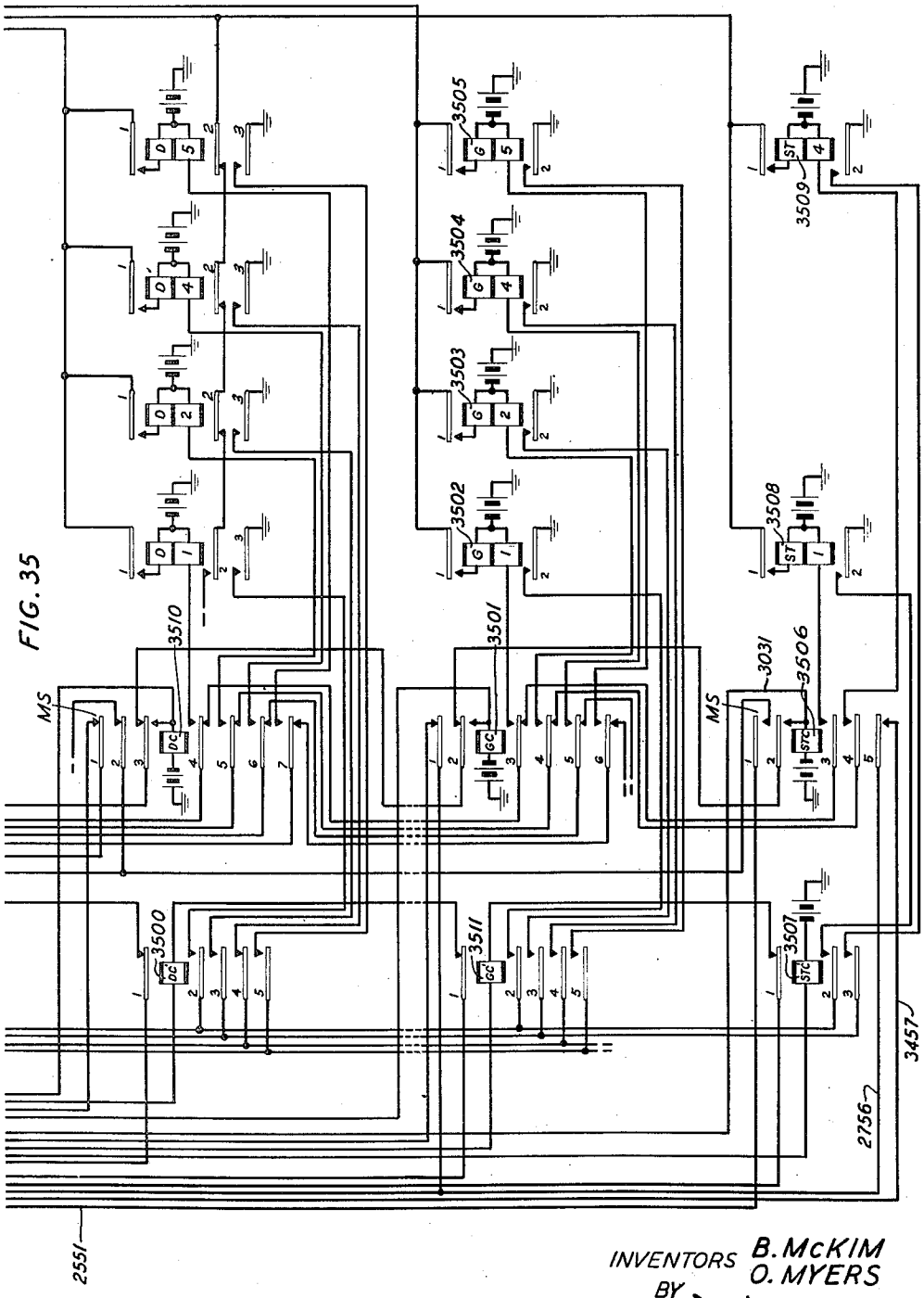


FIG. 35

INVENTORS B. McKIM
O. MYERS

BY M. P. McKenney

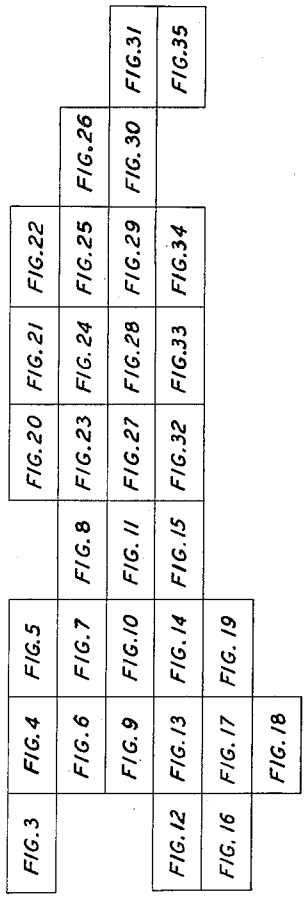
ATTORNEY

Aug. 14, 1945. B. McKIM ET AL 2,382,893

TELEPHONE SYSTEM

Filed Aug. 18, 1944 36 Sheets-Sheet 36

FIG. 36



INVENTORS B. McKIM
O. MYERS
BY M. P. McKenney
ATTORNEY

Patented Aug. 14, 1945 2,382,893

UNITED STATES PATENT OFFICE

2,382,893

TELEPHONE SYSTEM

Burton McKim, East Orange, N. J., and Oscar Myers, Mount Vernon, N. Y., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application August 18, 1944, Serial No. 550,070

22 Claims. (Cl. 179—27)

This invention relates to toll telephone systems and more particularly to the completion of toll connections during busy calling periods.

In an automatic switching toll office there are toll lines incoming from other toll offices directly to automatically operable mechanism which is operated by pulses for selecting an outgoing toll line to complete a toll connection to another city or a toll connection in the city in which the automatic switching toll office is located. Outgoing trunks, connected to the outgoing toll lines, are provided in groups designated with the code of the office to which the toll line extends and code pulses transmitted over a calling line actuate the automatically operable mechanism of the office to select an idle trunk in a particular one of these groups. Other toll lines incoming to the automatic switching toll office are connected to a toll operator who transmits pulses into the mechanism for selecting an idle outgoing trunk for connection with the incoming line.

The number of toll lines from one toll office to other toll office varies with the normal volume and nature of the traffic between the offices and consequently during busy periods there are occasions when the demand for lines to certain toll offices is greater than the number of lines extending thereto and the completion of connection to these offices is delayed. During such periods it is important to keep the calling toll operators in distant and nearby toll offices, who are trying to complete calls, apprised of the condition of these toll line groups and facilitate the completion of these delayed calls to relieve these calling toll operators from making repeated fruitless attempts to secure an idle line for a desired toll connection.

It is, therefore, the object of this invention to provide centralized automatically operable mechanisms to facilitate the rapid completion of toll connections during abnormally busy periods of toll calls.

A feature of the invention consists in centralizing the control of busy line groups in a manually operable switchboard and in automatically operable mechanisms for rerouting a calling toll line to this manually operable switchboard responsive to pulses having been transmitted for a line in a busy group of lines.

Another and related feature consists in making abnormally busy toll line groups unavailable to calling toll lines and only available to facilities in said manually operable switchbroad.

Another and related feature consists in signaling mechanisms in said switchboard individual to each line group for observing the character of the lines in said group and whether an idle line is available.

Another and related feature consists in mechanisms in said switchbroad for rapidly completing delayed toll connections.

Another and related feature consists in the use of special trunk circuits for completing toll connections through the automatic switching mechanism to two different toll offices for making a toll connection from a calling to a called subscriber.

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. 1 and 2 are a diagrammatic illustration of incoming toll lines entering the automatic switching cross-bar office and the routing of these lines under varying conditions of traffic in the office;

Figs. 3 and 4 illustrate the marker mechanism for routing incoming calling lines, the mechanism for testing outgoing trunks for finding an idle trunk and overflow trunk controlling mechanism;

Fig. 5 illustrates an overflow trunk, overflow circuit control relays, a delay quotation circuit, a patching cord between the delay quotation circuit and an overflow trunk and mechanism for determining whether there is an idle trunk in a desired trunk group;

Fig. 6 illustrates a 4-wire incoming trunk from a key pulsing toll office;

Fig. 7 illustrates the trunks to which the incoming trunk, Fig. 6, would be automatically routed under different conditions; an outgoing trunk to a toll line, Fig. 7B, to an overflow trunk, Fig. 7C, to a master busy trunk 7D or to a special 4-wire trunk, Fig. 7A incoming to a manually operable switchboard for handling delayed calls known as the call order switchboard. Fig. 7E diagrammatically illustrates an outgoing call from the call order switchboard to a toll board operator who previously attempted to complete a toll call and found all lines busy. This mechanism is disclosed in detail in Figs. 20, 21 and 22;

Figs. 8, 9, 10 and 11 illustrate the twin plug cord circuit, the telephone circuit, a position circuit and pulsing keys of the call order switchboard;

Figs. 12, 13 and 14 illustrate the alternate routing of an incoming call to either a special trunk

Fig. 7A to the call order board or to a special cordless operator through the special trunk Fig. 13 when an operator does not occupy the call order board;

Fig. 14B diagrammatically illustrates an incoming call which is routed by a cordless operator to the call order board for information on a busy group of trunks;

Fig. 15 illustrates an alternating current supply set for supplying pulsing currents of different frequencies;

Figs. 16, 17, 18 and 19 illustrate special four-wire trunks connected to channels of a cordless operator's postion and other circuits for completing a delayed call to the calling toll operator and to the desired toll line;

Figs. 20, 21 and 22 illustrate a special trunk outgoing from the call order board connected by cross bar switches to an outgoing trunk under the control of the call order board operator;

Figs. 23 to 35 illustrate a sender arranged to be set by either direct current or alternating current pulses and arranged to transmit either direct current or alternating current pulses for setting other registers; Fig. 32 illustrates the alternating current pulse receiving circuit for the sender; and

Fig. 36 illustrates the manner of assembling the drawings to illustrate the invention.

General description

Different characters of toll lines enter a cross bar toll switching system of the type disclosed in Patent 2,236,246 to G. V. King, J. B. McKim and O. Myers, March 25, 1941. These toll lines terminate in the cross bar toll office in incoming toll trunks from other toll offices, which trunks connect the incoming toll lines through links to either senders or a toll switchboard for completing outward toll connections. Key pulsing equipment or dials are used in some toll offices for setting the sender registers of the cross bar toll office and other offices use manually operated toll lines known as "ring-down and straightforward trunking toll lines" which are connected by links to the cordless toll switchboard in the cross bar office. The aforementioned key pulsing or dial toll line incoming trunks when actuated by a distant toll line operator automatically select a sender through link mechanism and the registers of the sender are automatically set by pulsing equipment energized by the operator in the calling toll office. The sender is automatically connected to a marker and the code of the wanted toll line is transferred to the registers of this marker. The registers of the marker function to operate a particular route relay designating the trunk group from which an idle outgoing toll or completing trunk is selected for completing the toll connection to the wanted office. After the idle trunk is selected, cross bar switches are operated by the marker and thus the the outgoing toll trunk is connected to the incoming toll trunk from the originating toll office to complete this toll connection.

The manual type of toll line such as the aforementioned ring-down toll line or straightforward trunking toll line does not have pulsing equipment associated therewith in the originating toll office. The energization of the manual toll line of this character actuates an incoming toll trunk in the cross bar office but instead of selecting a sender, this incoming toll trunk is connected through link mechanism with a toll operator in the cross bar toll office. This toll operator will herein be designated as the cordless toll operator since no cords are used in this toll board. The cordless toll operator in answering a call announces the name of her city and converses with the originating toll operator to ascertain the routing desired for completing the toll connection. This cordless toll operator has a key set and sender associated with her position and responsively energizes her key set for setting the registers of a sender according to the toll code of the office trunk to the city given her by the originating toll operator. This toll code is transferred to the registers of a marker. The originating or calling operator also gives the cordless operator the office and called subscriber's number for certain types of connections which is also pulsed into the sender. The code registered in the marker energizes a route relay designating the group of trunks from which an idle trunk should be selected for completing the toll connection. As soon as the marker has selected an idle trunk, cross bar switches are energized for connecting this outgoing toll line trunk with the incoming toll line trunk and the marker and sender may be dismissed from further service. In most instances the cordless operator is also dismissed since arrangements are available for either the originating toll operator or the operator connected therewith to resignal the cordless toll operator, if further service is required of the cordless operator. In order to easily distinguish between the two types of toll connections, the toll line from a toll switchboard having pulsing equipment will be known herein as a key pulsing toll line and the toll line from a toll office which does not have key pulsing equipment will be known herein as a manual toll line.

For economic reasons, trunk and toll lines between telephone offices are not so liberally provided that a subscriber is always certain to find a toll line or trunk available for completing his call, since it is theoretically possible that a majority of subscribers might wish to make a telephone call simultaneously. Such a possibility is remote, and toll trunks are provided on what is mathematically a practical basis to insure satisfactory service to subscribers without violating the principle of economy. The number of trunks between toll offices may vary with the length of the line and the volume and the nature of the traffic. Therefore, under unusual conditions for a period of time all toll lines between certain offices may become busy and in consequence there is a waiting period for completing certain toll connections.

When the toll lines from one office to another are busy, it is desirable to keep the operator who is trying to complete the toll call apprised of the condition so that she will be relieved of making repeated fruitless attempts to secure the toll line to a distant office. It is also desirable to complete delayed calls as quickly as possible in the order in which the lines to distant points are requested by calling toll operators who are attempting to obtain toll connections for various subscribers. The principal arrangements for accomplishing this purpose in the toll cross bar system are overflow circuits associated with the toll line groups, master busy signals, switchboards for announcing the time of delay for toll line groups in which there is a delay and for completing delayed toll calls, and automatic switching devices for connecting calling lines to signaling devices and to these switchboards.

The toll cross bar system is provided with a

switchboard which will be known herein as the call order switchboard to which calls from key pulsing toll lines are automatically routed when all of the trunks in a group to which the call is routed are busy. The operators of the call order switchboard may apprise the calling operator of the amount of delay to be expected, may under some conditions complete the telephone connection if an idle trunk can be found by this operator, or may write a ticket when requested by the calling operator and complete the toll connection as soon as an idle trunk is available. Manual calls which automatically enter the cordless switchboard are, of course, handled, in so far as possible, by the operator in the cordless switchboard. If a delay is encountered by the originating operator in completing a toll connection, the originating operator may request the cordless operator to advise her the amount of delay and this is quoted by the cordless operator according to a bulletin handed to her by the supervisory staff. This cordless operator may then write a ticket and transfer the ticket to the operator in the call order board who completes the connection as soon as an idle trunk may be found. While calls from manual toll boards to the automatic office on lines over which pulses are not transmitted are not automatically routed to the call order board, facilities are provided in the call order board for completing a connection from one of these toll lines to the desired outgoing line, so that the operator in the non-pulsing toll board is provided with the same facilities on delayed calls as the operator in a key pulsing toll switchboard. The cordless toll operator, when occasion arises, may set up a call through her keys and sender to connect the incoming toll line from a manual non-pulsing toll board directly the operator in the call order switchboard.

Special switchboard positions are provided in the cordless switchboard as a substitute for the call order board for completing connections if a long delay is encountered in obtaining an idle trunk if the call order board is not in use during a normally light load period. These connections are completed with cordless mechanism as hereinafter described. These switchboard positions will be known herein as special cordless operators' positions to differentiate from the call order board which normally handles delayed toll calls.

All toll line groups have a group of overflow trunks associated with them. These overflow trunks do not form part of the toll line group and are tested separately by the marker when it is found that all of the toll lines in the group test busy. If the marker finds all of the toll lines busy, it automatically tests the corresponding overflow trunks associated with the trunk group and connects the call with the first idle overflow trunk found. As will later be described, this condition differs under different traffic conditions, since when a serious delay occurs, the complete group of toll lines is made busy and thereafter the delay is automatically quoted when the toll line attempts to reach this group of toll lines. The overflow control circuit associated with each group of overflow trunks maintains a record of the all-trunks-busy condition by a lead multipled to each of the individual toll lines and as long as all circuits are busy, it returns a slow flash to the connected incoming toll line. When a trunk in a group becomes idle, however, it returns a fast flash known as a reorder flash, which is a signal to the distant toll operator to make another attempt to complete the connection. Under this condition, if the calling line is not under the control of an operator in the cross bar toll office the originating distant operator may disconnect the trunk connection and reestablish it again so that she may reregister the code in the cross bar toll system sender and marker to make a connection to this idle trunk.

The number of overflow trunks provided for each group of toll lines varies from 1 to 4, depending upon the size of the associated toll line group. The intention is to permit as many circuits to wait in overflow as have reasonable prospect of obtaining an idle toll line within about five minutes. The relation between the size of the toll line group and the number of overflow trunks depends upon the number of toll lines in the group and the destination of these toll lines.

In addition to the overflow trunks and the control circuits associated with them, there is also a group of master busy trunks that are common to the entire office. When a marker finds all of the overflow trunks of a group busy, it releases the overflow trunk route relay and seizes a route relay for routing the calling toll line to a master busy trunk. The master busy trunk returns an irregular flashing signal to the calling toll operator to inform her that these particular toll lines are in considerable demand at the time and she may encounter considerable delay in completing the toll connection.

Referring to Fig. 1A, connections of the character described are shown between a toll switchboard and the cross bar toll office, the toll switchboard 103—104 being in the same vicinity as the cross bar toll office. This toll board is known as a C. L. R. board located in an area where it may be reached by a number of local telephone offices. In order to economize in connections between subscribers and a cross bar toll office, which completes toll connections to other cities, there may be a number of C. L. R. switchboards in different local office areas in a large city, all of which make toll line connections for the local subscribers within that area through the cross bar toll office.

A toll call from a subscriber 100 enters local office 101 and is connected by trunk 102 to the outward toll board 103. The outward toll operator makes a record of the toll connection and initiates a toll call which actuates the incoming trunk 105. This incoming trunk actuates a link in the manner fully described in Patent 2,236,246 issued to G. V. King, J. B. McKim and Oscar Myers, March 25, 1941, and the link selects an idle sender diagrammatically illustrated as an alternating current pulsing sender 107. This sender as described herein may be energized by alternating current pulses for setting its registers and may transmit alternating current pulses for setting the registers of a distance office such as office 111. The toll code is thus registered in sender 107 which transfers this toll code to marker 108. The marker operates a particular route relay which designates the toll line group to which the incoming toll line should be connected. The individual trunks of this toll line group are tested by the marker and if an idle trunk is available, such as trunk 110, it is selected by the marker and the cross bar switches 109 are operated by the marker to connect the outgoing trunk 110 with the incoming trunk 105 for establishing the toll connection between the calling subscriber 100 and office 111. Office 111 would ordinarily be another toll office in a distant city and the toll connection may extend to a sub-

scriber in this toll office area or may extend through this toll office to another toll office for reaching the called subscriber.

If the marker should find all trunks in the group busy, it will immediately test the overflow trunks associated with this group and if there is an idle overflow trunk such as overflow trunk 113, it will select the overflow trunk and operate switches 112 for connecting the overflow trunk signal to the calling toll operator in the outward toll switchboard 103. A flashing signal from the overflow trunk indicates to the outward toll operator that all of the trunks in the group are busy. Under normal condition, the outward toll operator holds the line over which this flashing signal is given, anticipating that within a short period this overflow trunk will indicate that a trunk in the group has become idle. This is indicated by a different flash from the overflow trunk to the outward toll operator and if the outward toll operator receives this second flashing signal, a second attempt is made to complete the toll connections as above outlined.

Under conditions where the toll line group is in heavy demand, the marker may find that all of the toll lines in the group are busy and all of the overflow trunks are busy and thus a circuit is automatically established in the marker for causing the selection of a master busy trunk such as trunk 115. The marker thus selects the first idle master busy trunk and operates cross bar switches 114 for connecting the master busy trunk to the calling toll line for transmitting a distinctive master busy flash to the outward toll operator in C. L. R. board 103 to indicate that a delay of considerable extent may be expected. Under this circumstance, this operator will write all of the information on a ticket and send this ticket to an operator in what is known as a delayed outward toll board shown as toll board 104, which will later be further described. The delayed outward toll operator then will complete the call as soon as it is possible for her to get an idle toll line in the group outgoing from the cross bar office. As a rule, the outward toll operator on switchboard 103, attempting to establish a toll connection, does not hold the incoming call more than five minutes in an effort to complete the telephone connection. If this operator does not secure an idle toll line by this time, she may leave a call order with the call order switchboard operator in the cross bar toll office and after writing a ticket, send this ticket to the delayed outward operator on the switchboard 104.

In the cross bar toll office, the groups of trunks are constantly observed by a supervisory maintenance force, and when a group of trunks shows considerable delay, this group is made unavailable to toll operators such as the operators in the outward toll board 103 and this group is then made available only to a delayed outward operator in the cross bar office call order switchboard by automatically operable control means. The overflow trunks associated with this group are connected by jacks and plugs to a delay quotation trunk 118 associated with the call order switchboard 120 as shown in Fig. 1A4. Let it now be assumed that the call shown in Fig. 1A was made under this condition, that the group of trunks was patched for delayed quotation and thus the overflow trunk 113 shown below as overflow trunk 116 would have been patched to the delay quotation trunk 118. Therefore, when the marker found that all of the outgoing trunks in this group were busy and selected an overflow trunk, the calling toll line is routed through the overflow trunk 116, patching cord 117 to delayed quotation trunk 118. The switchboard operator in the call order board 120 upon seeing that a calling line has been connected with delayed quotation trunk 118, announces that a delay of a given time may be expected. The announcement indicates to the outward toll operator or outward operators that the connection between the calling subscriber and the toll board should be released and a ticket written for a delayed toll call, which is transferred to the delayed outward operator in switchboard 104 or other similar switchboards in other offices, for completion as soon as an idle trunk can be obtained. A number of calling lines may be simultaneously connected to the delay quoting trunk which may come in from different toll boards.

Under the above condition when a delay is quoted, a request may be made by the outward toll operator 104 for the cross bar toll switching office call order board operator to provide a toll line and complete the connection as soon as an idle line to the distant toll office is available. This request is made in the manner diagrammatically illustrated in Fig. 1B. A circuit request is made by dialing numerals such as 151 after the operator has made connection with the incoming trunk 122 and sender 125. As herein described trunk 122 actuates link 124 which selects an idle sender 125. The code 151 is registered in sender 125 and transferred to the marker 126. In response to this code having been registered in the marker, a special trunk known as the 151 trunk designated 123 is selected by the marker and switches 127 operated, which connects the outward toll operator 104 with the 151 trunk circuit 123. This trunk circuit is terminated in a jack and a lamp signal which is observed by the operator in the call order board 120, who accordingly inserts a cord circuit plug into the trunk jack. In this instance the outward toll operator in switchboard 104 advises the call order board operator that she wishes a toll line to a certain office which at the present time is on a delayed basis. The call order board operator then writes a call order ticket with all of the information thereon including the number of the operator who initiated the circuit request call. There may have been other requests made for idle toll lines in this group and thus the call order board operator places the tickets in the order in which the calls are received so that they may be completed in this order.

The call order board 120 is of the cord type and uses twin plugs on the cords to permit the connection to be made on a four-wire basis. The plug herein called a twin plug may be made in the form of a six-conductor single plug for connection with six jack springs of a single jack. The trunks 123, 134 and 136 are jack terminating four-wire trunks having twin jacks to be used with the aforementioned twin plugs. These trunks extend to cross bar switch frames in the toll cross bar office and although they appear as an outgoing trunk from the call order board, they are associated with and responsive as incoming trunks. Each call order position has a ten-button key set with which the operators can complete calls to any destination through a sender and marker which selects the desired outgoing trunk. The call order board operator may thus complete a connection between a 151 trunk, de-

noted as trunk 123 and a trunk denoted as trunk 136 for completing a call through the outgoing trunk 141 to a distant office 142 or this operator may set up a call in both directions using trunks 134 and 136 as shown in Fig. 1C.

In the face of the call order switchboard there are also jacks associated with each overflow circuit. These are single three-conductor jacks instead of twin six-conductor jacks as used for the other trunks and each position has a number of cords with single plugs which the operator may connect to the overflow circuits. The operator plugs into the overflow circuit associated with the group of trunks in which she is interested and lamps associated with these cords flash signals sent out by the corresponding overflow circuits to indicate whether an idle trunk may be found in this group of circuits. When a call is received over a 151 trunk the operator inserts a twin plug of the cord circuit into the trunk jack and may use the above single plug to note whether there is an idle trunk in the group of trunks requested and if so, may insert the alternate twin plug of the cord circuit into a trunk 136 to complete the call. Otherwise a ticket is written and the call completed later.

A call completed in the manner shown in Fig. 1C is taken from a ticket previously written by the call order board operator. When she sees that there is an idle trunk in one of the groups that she is watching, the cord circuit plug is inserted into the jacks of trunk 136. As previously stated, the call order board operator has access to trunks in a group which have been patched for delay quotation, and which are not automatically available to the operators such as the operators in the toll switchboard 103 or the operators in a distant toll office such as 202. Consequently, the operator in the call order board 120 after plugging into the trunk 136, operates her key set for registering the outgoing trunk code in sender 138. This sender is selected by link 137 as soon as the trunk 136 is energized and transmits a signal to the operator to start pulsing. The operator may register both the code digits and numerical digits in the sender 138 and the code digits are transferred to the marker 139. Assuming that the idle trunk observed by the operator has not been selected by another similar operator, it will be selected by marker 139 and the cross bar switches 140 energized by the marker for connecting the idle outgoing trunk 141 with the trunk 136. A connection is thus made between the call order board 120 and a telephone office 142. This telephone office may be another toll office in a distant city and may be either a manually operated office or an automatically operated office. In either case, a signal is transmitted from the call order board to the office over the outgoing toll trunk 141. The call order board operator may select the outgoing trunk to the designated office in order to be sure that this connection has been completed before notifying the originating operator that an idle trunk has been obtained. As soon as this connection has been established, the call order board operator inserts the alternate cord circuit plug into the jack of trunk 134. The energization of trunk 134 actuates link 133 which associates sender 132 with the mechanism of position 120. The call order board operator in position 120 now actuates her key set for setting the code registers in the sender 132. This code is transferred to the registers of marker 131 which selects an idle outgoing trunk 130 extending to the originating toll board 104 and energizes the cross bar switches 135 to associate the delay outward toll board 104 with the call order board 120. In this case the code written by the call order board operator is a special code which includes the number of the delay outward operator in the delay outward toll board which operator has the original ticket for completing this toll connection. The delay outward toll operator associates the calling subscribed with this connection which is then completed. In certain instances a connection may be completed in the opposite directions by the call order board operator who may first complete the connection to the delay toll operator 104 so that this operator will not lose time by later connecting the subscriber 100 with the connection. Signals may be transmitted by either of the operators in offices 104 or 142 to the call order board operator.

A lamp for each overflow trunk is provided in a traffic supervisory panel to keep the operating supervisory force informed regarding busy conditions on the various trunk groups. By observing the lighting of these lamps and by keeping track of the tickets in the call order board positions, the chief operator can estimate about the length of the delay expected at any time during this busy period. As the different groups become busy and the delay is estimated to warrant having the delay quoted the trunks are patched for delay quotation and the amount of delay posted.

The delay quotation jacks in the supervisory panel are arranged in groups, one group, for example, showing a half-hour delay, one group for a three-quarter hour delay, another group for a one hour delay and so on for the various delays which may be quoted by the call order board operator. For quoting such delays, one end of a cord is plugged into the jack of the overflow trunk circuit for a particular group and the other end is plugged into a delay quotation jack for the particular delay to be quoted. Calls which are routed by the marker to the various overflow trunks therefore obtain the particular time of delay automatically from the delay quotation operator over mechanism illustrated in the aforementioned Fig. 1A4. The amount of delay for the various groups are posted so that the operators at all times may observe any changes in the delay to be quoted for the different groups.

When a group of trunks is on delay quotation as shown in the main drawing, Figs. 3, 4 and 5, the markers are apprised of the fact by mechanism associated with their route relay and do not follow their ordinary procedure. The overflow trunks associated with the group are patched to the delay quotation trunk and in so doing other mechanism is automatically operated which affects the route relay in the marker which is operated for selecting this group of trunks. As shown in Fig. 2, if the call is from a distant key pulsing toll board, it will be connected directly to the operator in the call order board so that this operator may quote the delay, write out a ticket for later completion or immediately complete the connection. This difference is automatically established in the marker in order to save holding time on toll calls which have partly been established from distant toll offices. A toll call from a key pulsing operator in another city which enters the toll cross bar system and finds the wanted trunk group on delay quotation is automatically routed to the call order board by the action of a route relay switched into the cir-

cuit because this call is from a distant office. If it is possible to do so the operator in the call order board will complete the toll connection by using the 151 trunk 214 and by plugging into a trunk such as 220 for obtaining the desired toll line. An arrangement of this character is diagrammatically illustrated in Fig. 2F4. If the desired group of trunks has not been patched for delayed quotation the calling trunk is routed to overflow, Fig. 2F2, or to the master busy trunk, Fig. 2F3, in the same manner as previously explained for a call from the C. L. R. board shown in Fig. 1A. Under this condition where a toll operator in a distant city encounters an unusual delay of over five minutes, this distant operator may request connection with the call order board operator by dialing 151 in the same manner as explained for the operator in the C. L. R. board. The distant operator may then request the call order board operator to complete the call at the earliest possible moment. If the call order board operator cannot complete the connection from the 151 trunk she will write a ticket and complete the call later.

An operator calling from a distant city has another alternative in the toll cross bar system when a delay is encountered and the call order switchboard is not occupied which might be the case during light load periods for most of the other trunk groups. Under this circumstance, the operator in the toll board of a distant city may dial the normal circuit request number 151 but since the call order board is not occupied, automatic arrangements are provided for switching the call in the cross bar toll office to another special trunk h[illegible]n called the 121 trunk which terminates [illegible] cordless switchboard. The distant operat[illegible], therefore, makes her circuit request to the cordless operator who writes a ticket and causes the connection to be completed at the earliest possible moment by a special cordless operator who has circuits arranged as shown in Fig. 1E. Fig. 1E illustrates a special cordless operator's position 160 with channels extending to trunk circuits 161 and 162 to be used as incoming trunk circuits toward the originating toll office 104 or 202 and toward the desired toll office 163. This operator has a key set, and when an idle trunk is obtainable, operates the sender 159 associated with the position 160 which operates a marker 164 for selecting an outgoing trunk 166 to the distant office 163 which is connected to the incoming trunk 162 by cross bar switches 165, thus releasing the marker and sender for use in making the connection to the originating toll operator. The position sender 159 is thus again set by the special cordless operator 160 and a marker 158 selected. In this case the operator designates the code of the toll office and the number of the operator in the originating office 104 or 202. This marker selects an outgoing trunk to the originating office and operates the cross bar switches 157 for connecting the incoming and outgoing trunks with the originating office and the outgoing trunk to the desired office through two sets of cross bar switches.

The call order board 120 serves as a point of clearance for a majority of the calls that are seriously delayed. These operators have access to the trunks in groups which are patched for delay quotation, whereas the cordless operators do not have access to these groups and since the call order board receives a flash as soon as a trunk becomes idle in the busy groups the operators are able to complete the toll calls as rapidly as facilities become idle and complete them in the order in which the calls arrive in the cross bar toll office. During such periods, toll calls to busy groups are thus completed more rapidly than could be possibly accomplished by the outlying toll operators including the toll operators in distant cities and with much less holding time accumulated for toll lines. Fig. 2K shows the arrangements at the cross bar toll office for serving calls incoming from a manual toll office.

Detail description

An incoming call to the cross bar toll office will first be described which may be from a C. L. R. board in the near vicinity of the cross bar toll office or from a distant toll board in another city, either toll board having key pulsing equipment for transmitting alternating current pulses to the cross bar toll office for setting the registers of the sender in this office.

The seizure of the toll line trunk such as the toll line trunk 650—651 causes the transmission of a signal to the cross bar toll office over the composite signaling circuit 660—659 by associating battery with the signaling circuit in the toll office 600. It is believed unnecessary to describe the operation of the composite signaling relay 619 since this character of composite signaling circuit is well known in the art. It will be sufficient to state that the battery in the toll office 600 causes the energization of the composite signaling relay 619 which connects ground with lead 662 known generally as the composite signaling E lead. This ground extends through contact 7 of relay 620, winding of relay 616 to battery operating relay 616. This ground also extends through contact 8 of relay 620, winding of relay 628 to battery which operates relay 628. Relay 616 in operating disconnects ground from the composite signaling M lead 661 and associates battery through lamp 617 with this lead. Office 600 has a composite signaling relay therein the same as relay 619 which is operated when battery is associated with the M lead 661. This, however, does not cause the release of relay 619 but transmits the signal to the office 600 which is maintained until an incoming sender is associated with the incoming trunk, Fig. 6, and is in readiness to receive alternating current pulses from the operator in office 600. Relay 628 in operating connects ground to the timing circuit comprising condenser 627 which is discharged, if any charge remains in this condenser, and tube 623 with its associated network. Relay 621 is also operated over an obvious circuit through contact 3 of relay 628. Relay 621 in operating locks through its contact 3 under the control of the ionic tube 623 which is the means to later cause its release. Ground is disconnected from the traffic register lead 670. Relay 621 also prepares a circuit for connecting 130-volt battery 672 with ionic tube 623 when relay 628 is released. Ground is also connected to the link start lead 663 from ground on contact 1 of relay 621, contact 5 of relay 620, thence to the link for energizing the start relay of the link. This link may be of the character described in Patent 2,293,191, to A. J. Busch and J. J. Scudder, August 18, 1942, and Patent 2,291,024 to A. J. Busch, July 28, 1942. This type of link has a control circuit associated therewith for selecting the type of sender indicated thereto 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 this type

of sender diagrammatically illustrated as sender 636 is selected by the link. Link switches are operated after the selection of this sender for connecting leads 664—668 and leads 680—683 with the sender mechanism. This sender as later described in detail is shown in Figs. 23 to 35, inclusive, of the drawings. A number of relays in the sender are operated by the link control circuit before the sender is connected through switch contacts to the trunk, Fig. 6, and thus ground is connected by the sender to lead 664 for operating relay 620 and also ground is connected to lead 680 extending through relays 609 and 615 to battery. The circuit extending to relays 609 and 615 within the sender establishes an operating circuit for a sender relay which is high in resistance and does not operate relays 609 and 615 until after the sender has received class signals. At this time a low resistance is associated with lead 680 as later described. Relay 620 in operating establishes a locking circuit through contact 1 of relay 621 and removes ground from the link start lead 663. Relay 620 also opens the original operating circuit for relay 616 but this relay remains operated through contact 7 of relay 620 to ground on contact 2 of relay 631. Relay 620 also connects ground to lead 683 extending to the sender and lead 642 extending through the cross bar switches for later holding the cross bar switch hold magnets in the usual manner. A class signal is transmitted to the sender from ground to contact 3 of relay 615 over lead 667 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 operated in the sender for associating pulse leads 681 and 682 with an alternating current pulse 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 680 to operate relays 609 and 615. The operation of relay 615 establishes a circuit through its contact 4 for operating relay 631 which locks to ground on contact 1 of relay 620. The operation of relay 631 causes the release of relay 616 since at this time no circuit remains established for the latter relay. The release of relay 616 removes battery from the composite signaling M lead 661 which signals the operator in toll office 600 to proceed with the transmission of alternating current pulses.

The switchboard position in toll office 600 has a set of keys therein substantially the same as shown in Fig. 11 and an alternating current supply circuit substantially the same as shown in Fig. 15 both of which will later be described in detail. The operation of these keys by the operator in the toll office 600 transmits currents of two frequencies for each digit over the toll line 650—651 through the hybrid coils 601 to the conductors of the incoming trunk, Fig. 6. The circuit is balanced by transmitting the alternating current pulses to both channels, the lower channel being connected through contacts 2 and 5 of relay 615 which are bridged by resistance 632. The alternating current pulses over the upper channel extend through contacts 2 and 5 of relay 609, thence over the tip and ring leads 681 and 682 to the receiving circuit associated with the sender 636. As later will be shown the receiving circuit actuates two pulse relays according to the current of two signal frequencies which operate the sender registers by converting these currents of two frequencies into direct current paths for operating sender registers according to the digit transmitted. Code and numerical digit pulses may be transmitted and registered in sender 636, the code digits being transferred to marker 700. These code digits are transferred from the registers in the sender to the registers in the marker as fully described in Patent 2,236,246 to King, McKim and Myers, March 25, 1941, or as shown in Patent 2,283,395 to W. B. Strickler, May 9, 1942.

In response to the setting of the marker registers a route relay is operated for selecting a trunk from a group of trunks according to the code registers. As previously set forth in the general description, the trunks of this group according to the route relay operated are tested in an effort to find an idle trunk extending to the desired distant toll office. If all of the trunks in this group are busy an overflow trunk is automatically selected by the marker to indicate to the originating operator that all of the trunks in the group are busy. When all of the trunks in the group are busy and the overflow trunks associated with that group are also all busy the marker automatically associates the calling line with a master busy trunk to indicate to the calling operator that a substantial delay may be encountered. This operator may then make a circuit request to the call order switchboard and advise the call order switchboard operator to obtain an idle trunk as soon as possible. Fig. 7 illustrates the cross bar switches for connecting the calling line to either the outgoing toll trunk, Fig. 7B and Fig. 22, an overflow trunk, Fig. 7C and Fig. 5, a master busy trunk, Fig. 70, or a special trunk Fig. 7A to the call order switchboard.

The connection to an outgoing toll trunk according to the office code registered in the marker will first be described.

Test of outgoing trunks

The portions of the marker 700 with which the invention is concerned are shown in Figs. 3 and 4, a group of trunks being diagrammatically shown as trunks 0 to 35 in the lower portion of Fig. 4 having four overflow trunks 36 to 39 associated therewith, with the leads extending from these trunks through the contacts of a trunk block relay 430 to the testing relays 410 to 421, inclusive. The sender 300 represents sender 636 which is connected through a marker connector 301 to the mechanism of the marker. This sender is shown in Figs. 23 to 35, inclusive as later described. The marker registers are diagrammatically shown as a rectangle 325 with a circuit extending through the control relays 320 and 321 to route 310. For this description it may be assumed that route relay 310 was operated responsive to the code registered for the outgoing toll trunk, Fig. 22, extending to toll office 2230. It may also be assumed that trunks 0 to 35, diagrammatically shown in Fig. 4, represent a group of trunks such as shown in Fig. 22. The route relay 310 is associated with the same character of marker mechanisms as is the route relay 4702 shown in Fig. 47 of the aforementioned Patent 2,236,246 to G. V. King, J. B. McKim and O. Myers. The trunk block relay associated with this group of trunks is operated in the manner fully described in the aforementioned Patent 2,236,246, and the circuits shown in Figs. 3 and 4 are established without including all of the immediate steps shown in the patent for operating the mechanisms involved in a description of the invention.

Circuits are extended through the contacts of

route relay 310 for marking the number of trunks to be tested in this group. As indicated there are thirty-six trunks in the group and therefore relay 410 is operated to mark the beginning of this group for the zero trunk and relay 411 associated with trunk 35 is operated to indicate the end of this group. The trunks starting with trunk zero are therefore tested in an effort to obtain an idle trunk. In Fig. 4 the test relays are shown only for trunk zero and trunk 35. There are, however, a set of relays such as 410, 414 and 418 for each trunk in the group. The total number of sets of relays in this group therefore constitute forty sets of relays, thirty-six for the outgoing toll line trunks and four for overflow trunks associated with the toll line trunks of this group. Relay 406 is operated from battery through its winding, contact 2 of route relay 310, to ground on contact 1 of an overflow control relay 402. Relay 410 is operated from battery through its winding, contact 4 of route relay 310, contact 1 of relay 401, contact of relay 406 to ground. Relay 411 is operated from battery through its winding, contact 3 of the route relay 310, contact 2 of relay 423, contact of relay 406 to ground. By referring to the trunk circuits diagrammatically shown in the lower portion of Fig. 4, relays have been represented which operate when a trunk is taken for use thus connecting ground with a lead extending to the test relays when a trunk block relay is operated under control of a route relay. When the zero trunk is busy, ground is thus connected to lead 450, through a contact of the operated trunk block relay which extends through contact 1 of relay 418, winding of relay 414 to battery 437 thus energizing relay 414. All trunks that are busy therefore are indicated in the testing relays by the operation of relays such as 414 to 415 as soon as the trunk group is associated with these testing relays. An idle trunk is seized by the operation of a relay such as 418 and 419. The testing circuit extends through the start and end relays and may be traced from ground 436 through contact 3 of end relay 411, contacts 2 and 3 of start relay 410 to the armature 1 of relay 414. If this trunk is idle, relay 414 is normal and thus the circuit extends through back contact 1 of relay 414, winding of relay 418 to battery 438. If the zero trunk is busy relay 414 is operated and thus the circuit extends from armature 1 of relay 414 through its associated inner contact to the armature of the adjacent trunk one relay which if idle would operate a relay similar to relay 418 but if this trunk is busy the lead extends over this chain continuing throughout the group of trunk relays 414 to 415 until the relay which is not operated is found. If trunk 35 is idle the circuit would extend through armature and back contact 1 of relay 415, winding of relay 419 to battery which would operate relay 419. When an idle trunk is found the operation of a relay 418 or 419 or any intermediate relay, connects battery 439 through contact 2 of the operated relay to the select magnet of the primary cross bar switch connected to the idle trunk. Ground 440 also extends over the front contact 1 of the operated relay 419, lead 451 thence through the winding of a relay in the idle trunk circuit to battery, which operates this relay and then causes the operation of another trunk circuit relay which connects ground to lead 451. The marker 700 then operates the cross bar switches for connecting the outgoing toll trunk, Fig. 22, with the incoming trunk, Fig. 6, and the associated sender since at this time relays 609 and 615 are operated. Mechanism in the outgoing trunk circuit, Fig. 22, and the sender are operated as later will be described causing the sender to transmit either alternating current pulses or direct current pulses depending upon the nature of the toll call for setting the registers of a sender in the office to which the outgoing trunk, Fig. 22, is connected. After this operation by the sender relays 609 and 615 are released and the calling party is connected over the toll line to the called party.

All trunks busy

Returning now to the operation of trunk block relay 430 and assuming that trunks 0 to 35 are all busy, ground will be connected to all trunk leads such as 450 to 451 and thus relays 414 to 415 including all such intermediate relays for trunks 1 to 34 are operated indicating that all trunks in the group are busy. When all trunks of a group are busy, the overflow relay such as overflow relay 555 in Fig. 5 is released. Relay 555 is held operated by leads from each idle trunk connected to ground as shown for trunks 0 to 35. Thus when all of the trunks of the group are busy no circuit is established for overflow relay 555 and it is released. Under this condition a circuit is established from 48-volt battery 577 through resistance 561, contact 1 of overflow relay 555, contact 5 of relay 541, lead 578, contact 1 of the regular route relay 310, polarized relay 308, winding of relay 304 to battery. Relay 304 operates in this circuit but polarized relay 308 does not operate since the current flow is not in the correct direction to operate it. Relay 304 in operating associates ground through contact 2 of relay 305, contact of relay 304, left winding of relay 401 to battery operating relay 401 which locks through its right winding and contact 3 to ground. The operation of relay 401 causes the release of start relay 410 for the group of regular outgoing toll trunks, thus establishing a circuit for the overflow relay 402. The circuit for relay 402 may be traced from battery through its winding, contact 1 of relay 401, contact of relay 406 to ground. Relay 402 locks through its contacts 3 to ground. Relay 412 is now operated to indicate the starting point of the overflow group of trunks. The circuit for relay 412 may be traced from battery through its winding, contact 2 of relay 411, contact 3 of relay 424, contact 8 of relay 402 to ground. The operation of relay 412 establishes a circuit for relay 423, from battery through its winding, contact 4 of relay 402, contact 1 of relay 412, contact 2 of relay 411, contact 3 of relay 424, contact 6 of relay 402 to ground. Relay 423 locks through contact 2 of relay 402 and its contact 1 to ground. The operation of relay 423 releases the group end relay 411 since the circuit for holding this relay operated was carried through a contact on relay 423. Relay 424 is operated from battery through its winding, contact 1 of relay 411, contact 1 of relay 413, contact 3 of relay 423 to ground. Relay 424 in operating establishes a locking circuit for itself through its contact 2, contact 3 of relay 423 to ground. The overflow group end relay 413 is now operated from battery through its winding, contact 1 of relay 424, contact 6 of relay 402 to ground. The test of the overflow trunks cannot be made until relay 411 is released but upon the release of relay 411 and the operation of the overflow group end relay 413 the test of the overflow trunks is made in an effort to find an idle overflow trunk for signaling the originating toll operator that all trunks of

the group desired are busy. Four overflow trunks are shown for this trunk group and the test of these trunks diagrammatically represented as trunks 36 to 39 is made. A circuit is established from ground 436 through contact 2 of relay 413, contact 2 of relay 412, contact 3 of relay 412, to the armature 1 of the first overflow relay 416. The overflow trunks are tested in the same manner as the outgoing trunks of the regular group and therefore if the first overflow trunk is idle the circuit is extended through the winding of relay 420 to battery 438 operating relay 420 and establishing a circuit over lead 442 for the select magnet of the first overflow trunk designated herein trunk 36. When the first overflow trunk is busy relay 416 is operated from ground on lead 452 as previously explained and the circuit is extended through the first contact 1 of relay 416 to other test relays in the overflow group. If the last overflow trunk is idle relay 421 is operated but if all four of the overflow trunks are busy the circuit extends through the inner contact 1 of relay 417, contact 4 of relay 413, winding of relay 425 to battery which indicates to the marker that all of the regular trunks in the group and all of the overflow trunks supporting this group are busy. The operations in the marker responsive to this condition will be later described since under this condition the calling toll line is routed to a master busy trunk. Let it first be assumed, however, that the last overflow trunk is found idle and thus relay 421 is operated to connect battery at its contact 2 over lead 443 to the select magnet of the cross bar switch connected to the overflow trunk circuit. This may be assumed as the cross bar switches shown in Fig. 7C which are the same as the primary cross bar switch 500.

Upon the seizure of the overflow trunk shown in Fig. 7C and Fig. 5 the marker immediately associates ground through the winding of relay 505 to battery operating this relay and also selects a channel through the cross bar switches to the incoming trunk, Fig. 6, operating the cross bar switches to associate the overflow trunk first with the sender connected with the incoming trunk, Fig. 6, and later for connecting the overflow trunk directly with the calling toll operator. The operation of relay 505 energizes the offnormal relay 530 and establishes a circuit through the winding of relay 504 to battery. The latter circuit extending through contact 1 of relay 505 and contact 5 of relay 504 is connected to the mid-point of retardation coil 503 and extended over line leads 501 and 502, contacts of the cross bar switches through contacts 1 and 6 of incoming trunk relay 615 over leads 667 and 668 to the sender where it extends through a sender control relay to battery. This sender control relay operates through a high resistance winding and thus does not operate relay 504 until other devices in the sender have operated. After these other sender devices have operated a low resistance is associated with the circuit for relay 504 and at this time relay 504 operates to establish circuits in the overflow trunk. Relay 504 locks through its contact 5 and contact 1 of relay 505 and establishes an obvious circuit for the traffic panel lamp 508. The sender now functions to release relays 609 and 615 which connects the overflow circuit with the calling toll operator. The marker and sender thereafter release since their functions have been completed. Returning to the operation of relay 530 when the overflow trunk was seized it is apparent that contacts 1 and 2 associate ground through interrupter contacts 534 and 536 which intermittently operate and release relays 537 and 538. The interrupter 533 is of such speed as to indicate to the calling toll operator that all of the trunks are busy at this time. Ground through the contact of relay 537 extends through contact 3 of relay 555, contact 7 of relay 541, winding of relay 540, contact 1 of relay 541, contact 3 of relay 530, resistance 531 to battery thus operating relay 540 upon each operation of interrupter 533 and relay 537. The interrupted operation of relay 540 associates ground through its contact 1, resistance 532, contact 6 of relay 504, retardation coil 503, thence over line conductors 501 and 502 which now extend through the incoming trunk circuit to the calling operator. Under normal conditions the calling toll operator will hold the toll line awaiting a reorder signal which would indicate that an outgoing toll trunk has become idle while she was holding the toll line. This reorder signal is automatically sent to the calling toll operator when relay 555 reoperates. It is clear that the latter relay reoperates from ground through the contact of any trunk relay 0 to 35 that becomes idle and releases its relays. The operation of relay 555 opens the circuit from the contact of relay 537 and closes a circuit from ground on relay 538. This relay is operated at a different periodicity than relay 537 and indicates to the calling operator that a trunk has become idle. This circuit is traced through the contact of relay 538, contact 2 of relay 555, contact 7 of relay 541, winding of relay 540, contact 1 of relay 541, contact 3 of relay 530, resistance 531 to battery. Relay 540 is thus operated and released intermittently to associate ground through resistance 532, contact 6 of relay 504, to the mid-point of retardation coil 503, which changes the period of flash to the calling toll operator. The calling toll operator will responsively release the trunk to the cross bar toll office in order to release the incoming trunk mechanism and the connection to the overflow trunk and again seize this trunk or another trunk to the cross bar toll office in an attempt to obtain an idle outgoing trunk to the destination desired.

Master busy trunk

For this part of the description it may be assumed that all of the trunks Fig. 22 are busy and that all the overflow trunks associated with this group are busy. As will be remembered, when all of the trunks Fig. 22 are busy, relays 414 to 415 representing the thirty-six trunks, are operated, since ground is connected to the associated leads 450, 451 and a transfer is therefore automatically made to the overflow trunks associated with this group. After this transfer is made, it is found that all of the overflow trunks are busy, which is indicated by relays 416 to 417 being operated. At this time relays 410 and 411 are released and the starting relay 412 and the end relay 413 are operated. A circuit is therefore automatically established to transfer the incoming call to a master busy trunk of which there are a group common to the equipment of the office. A circuit is established for relay 425 from battery through its winding, contact 4 of relay 412, contact 2 of relay 416, thence through the relays representing the overflow trunks to contact 2 of relay 417, contact 3 of relay 413 to ground. Relay 425 operates route switching mechanism and establishes a circuit for relay 323 through contact 2 of an overflow relay 402. The route switching

mechanism adjusts the mechanism of the marker so that a circuit is established from ground through contact 1 of relay 323, resistance 324 and other mechanism of the marker, winding of master busy route relay 309, winding of relay 314 to battery. Relay 314 does not operate in this circuit but the route relay 309 operates to control the test of the master busy trunks. After relay 323 is operated and locked through its contact 2, the trunk testing mechanism shown in Fig. 4 is completely released and again used for testing the master busy trunks in order to select an idle one of these trunks. A trunk block relay associated with the master busy trunks is accordingly operated to connect the trunks with the mechanism of Fig. 4 and the test of the trunks is made in the same manner as previously described for testing other trunks of a group. Upon the selection of an idle master busy trunk, shown diagrammatically in Fig. 7D, the cross bar switches are operated for connecting this idle busy trunk with the incoming trunk, Fig. 6, and a flashing signal from the master busy trunk mechanism is transmitted to the calling toll operator who recognizes this as an indication that the trunks of the regular group and the overflow trunks are busy and that, therefore, this group of trunks is in considerable demand.

It will be noted that both of the overflow signals and the master busy signal are transmitted by associating ground at different speeds of interruption with the incoming trunk circuit Fig. 6. This ground is transmitted over conductor 643 and 644 through the retardation coil 614, to the composite signaling circuit through contact 4 of relay 620, winding of relay 616 to battery. The association of ground over this circuit, therefore, intermittently operates and releases relay 616 which alternately connects ground and battery with the M lead 661 of the composit signaling circuit. A similar relay, the same as relay 619, located in the toll office 600 is responsively released and energized intermittently according to the speed of the interrupter associated with these different circuits. The relay in the toll office 600 has an E lead similar to lead 662 which is connected with a signaling circuit to signal the operator in the toll office, giving her the conditions found in the group of trunks desired in the cross bar toll office.

Circuit request call

The toll operator in toll office 600, which may be a C. L. R. board or a toll office in a distant city may now choose to establish a circuit request call to the call order board operator in the toll cross bar office, requesting her to obtain an idle trunk in the desired group as soon as possible and connect her with this idle trunk. In this instance the operator in the toll office 600 gives the call order board operator the number of the operator initiating the toll call so that the call order board operator may include this information on a ticket covering the circuit request for an idle trunk in a particular group of trunks. The call order board operator in calling the toll office 600 includes this operator's number with the code pulsed when she has obtained an idle trunk.

A special code 151 is used by the toll operators to make a circuit request to the call order switchboard operator in the cross bar toll system. This code is set up by the toll operator on keys as previously described which in this area transmits alternating current of different frequencies for setting the registers in sender 636. This may be the same sender or a different sender than the one used on the previous call when this operator attempted to obtain a connection to the desired trunk. The code 151, which is set on the registers of the sender, is transferred to the registers of marker 700. It may be assumed that this 151 code has been registered upon the register relays 325 shown in the lower portion of Fig. 3 and that this setting of the registers operated the 151 route relay designated as 312. The route relay 312 is operated from two different sources, the one source in the circuit request which registers responsive to a code 151 having been dialed or keyed as just described and the other source resides in an automatic switching arrangement responsive to the registration of a regular trunk group code when this group is patched for delay quotation. This will be described later along with the delayed quotation mechanism which is operated when a trunk group is patched for a delayed quotation, that is, with the patching cord and plugs 510 inserted in jack 509 and 511. Under the condition being described at the present time, where route relay 151 is operated from the code registers in the marker, the tests of the group of trunks such as shown in Fig. 7A is made by the testing relays shown in Fig. 4 in the same manner as previously described. The route relay 312 has contacts thereon for controlling the starting point and ending point of the group test and the busy trunks in the group are designated in the same manner as shown for the group of trunks previously described as the trunks shown in Fig. 22. When the marker finds an idle 151 trunk, the select magnet associated with the cross bar switch connected to this trunk is energized and relay 728 is operated by a ground from the marker designated on Fig. 4 as ground 440 hereinbefore described. This ground extends from the marker over lead 740 through the trunk block relay 715, contact 1 of relay 712, winding of relay 728 to battery. An idle trunk is thus taken for use and the marker energizes cross bar switches for connecting this 151 trunk shown in Fig. 7A with the incoming trunk shown in Fig. 6. This incoming trunk may or may not be the same trunk as used for the previously described call which was routed to overflow and master busy but is the same type of trunk as used for the former call. The operation of relay 728 supplies locking grounds for various circuits later distinguished. The marker then operates relays in the trunk circuit to indicate the character of the trunk circuit which has been connected thereto. For example, if office 600 is a distant office connected to the cross bar toll office over a long trunk, this will be indicated on a class relay to the sender and marker from the trunk shown in Fig. 6 and the marker responsively connects a high voltage circuit through the incoming trunk circuit, thence over lead 641, upper winding of retardation coil 714, contact 2 of relay 712, lower winding relay 725, to ground.

The operation of relay 725 is being described at this time since there are occasions when this trunk is used by the call order board for a through-toll connection 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 made this circuit request call. The operation of relay 725, as will later be seen, establishes a circuit in a call order board position mechanism for indicating the type of incoming toll line. If this

incoming toll line is long and is connected to an outgoing line which is also long, a repeater is inserted in the outgoing toll line. This indication is, therefore, required for transmission purposes over long lines. If the call is from a short toll line, such as from a local C. L. R. toll board, relay 725 is not operated. Relay 725 being operated, establishes a locking circuit for itself through its contact 1 and upper winding to ground on contact 4 to relay 728.

The 151 trunk circuit Fig. 7A is used by different toll offices having different types of trunk circuits outgoing from these toll switchboards. These toll trunk circuits may be of the key pulsing type, ring-down toll trunks or straightforward toll trunks. When a call is from a ring-down toll trunk, an indication is given to the sender and marker by the incoming trunk arranged somewhat in a different manner to the trunk shown in Fig. 6 which operates a relay in the marker causing the marker to connect battery to the incoming trunk circuit over lead 640 which extends through the lower winding of retardation coil 714, contact 3 of relay 712, contact 3 of ring-down control relay 727 to ground. Consequently, if the 151 trunk 7A is connected to a ring-down toll trunk, relay 727 is operated and locked from battery through its lower winding and its contact 4 to ground of contact 4 of relay 728. This relay is operated in order to control the type of signaling to the originating toll operator.

At this time the marker having served its purpose may release but the sender is held connected to the trunk of Fig. 6 until such time as other mechanism in the trunk Fig. 7A is operated and relays 609 and 615 are released in the manner previously described. The marker, previous to its release, energizes relays in the sender for connecting a relay through a high resistance over leads 643 and 644 retardation call 705, contacts 1 and 2 of relay 711, resistances 709 and 710, contact 5 and winding of relay 712 to battery. The sender relay associated therewith is operated as a signal that the outgoing toll trunk is connected through the cross bar switches and thereafter associates a lower resistance with relay 712, causing the operation of relay 712. Relay 712 in operating, locks through its contact 5 to ground on contact 2 of relay 728 and also establishes a circuit from battery through its contact 6, contact 3 of relay 729, lamp 733 to ground. At this time the sender mechanism is adjusted in a manner to release relays 609 and 615 for connecting the calling operator in the toll board to the terminals of jacks 723 and 724. This lamp 733 and jacks 723 and 724 are located in a position of the call order switch board and indicate an incoming call to the operator in that position. Relay 712 further disconnects relay 728 from its contact 1 and associates ground with lead 740 to the marker. As previously explained, this ground extends to a contact of the trunk block relay 715 so that when this trunk block relay is again operated, this trunk appears busy to the marker test relays as previously explained in connection with the trunk test circuit Fig. 4 as represented in Fig. 4 by leads 450 and 451. Relay 728 is held operative through the cross bar switch contacts over lead 642 to ground in the sender which is maintained on this lead until after the sender has released relay 615. At this time lead 642 extends through contact 7 of relay 615 to ground on contact 2 of relay 620. Therefore, relay 728 is maintained operated throughout the period when the trunk circuit 7A is in use. This circuit arrangement also applies to various other types of trunk circuits.

Call order operator answers request call

The call is answered in the call order switchboard by operating the talking key 803 and inserting the twin plug 800 or the twin plug 820 into jacks 723 and 724. Trunk circuit relay 716 is thus operated from ground through its upper winding, sleeve of the jack and plug, contact 4 of relay 802, lamp 809 and resistances 811 and 810 to battery. The operation of relay 716 establishes an obvious circuit for relay 729 which operates. Relay 716 also connects ground through resistance 713, contact 4 of relay 712, resistance 709 and 710, contacts 1 and 2 of relay 711, upper and lower windings of retardation coil 705, thence over the tip and ring lead through the cross bar switches, leads 643 and 644, contacts 1 and 6 of relay 615, upper and lower windings of retardation coil 614 through resistances 610 and 611, contact 4 of relay 620, winding of relay 616 to battery. The operation of relay 616 establishes a circuit over the M lead 661 of the composite signaling circuit to operate a relay similar to relay 619 in the toll office 600 for indicating to the originating toll operator that the call has been answered by the operator in the call order switchboard. The operation of the talking key 803 operates relay 802 and 815 and causes the association of her telephone circuit Fig. 9 with the transmission circuit. Relays 802 and 815 are energized through the upper contact of the talking key 803 over lead 838, contact 1 of relay 900 to ground on contact 2 of relay 943 which at this time is operated. Relay 943 is operated whenever an operator is attending the call order switchboard position since the telephone headset 941 is connected through jacks 902 and 903 to the telephone transmission coils. Relay 901 is also energized from battery through its winding lead 839, lower contact of talking key 803 to ground on lead 838 which ground is replaced as soon as relay 901 operates. Upon the operation of relay 901 ground extends through its contact 1 over lead 832, contact 7 of relay 802 through the windings of relays 802 and 815 and also through contact 7 of relay 815, lower contact of the talking key 803, thence over lead 839, winding of relay 901 to battery, holding this relay operated as long as the talking key is actuated. This change in the ground supply is made since relay 900 is operated through contact 8 of relay 901 which operates relay 906 for position grouping signal purposes. The operation of relay 901 connects winding 924 of the telephone circuit hybrid coil with one side of the four-wire transmission circuit and connects winding 927 of the telephone circuit hybrid coil with the other channel of the four-wire transmission circuit. Relay 1006 is operated responsive to the operation of relay 802, from battery through its winding, winding of relay 1011, thence over lead 831, contact 4 of relay 802, sleeve of plug 800 and jack 723, upper winding of relay 716 to ground. The circuit to the telephone circuit from the upper channel of the four-wire circuit may be traced through contacts 1 and 2 of relay 802, leads 836 and 837, contacts 1 and 2 of relay 1006, contacts 1 and 2 of key 1004, contacts 1 and 2 of key 1001, leads 1041 and 1042, contact 5 of relay 901 to the hybrid coil winding 927. The leads from the lower chan-

nel of the four-wire circuit may be traced to the telephone circuit through the contacts of key 801, contacts 5 and 6 of relay 802, leads 834 and 835, contacts 4 and 5 of relay 1100, contacts 3 and 4 of relay 1006, contacts 3 and 4 of key 1001, leads 1043 and 1044 and contact 4 of relay 901 to winding 924 of the telephone circuit hybrid coil. Hybrid coil windings 922 and 930 are in the talking circuit of the telephone set, since it may be seen that these coils are in series with the coils 918, 919 and 920. Hybrid coils 923 and 929 are placed in the network circuit in series with network coils 935, 936 and 937 and receiver 932 to balance the four-wire transmission circuit. The current flow through these hybrid coils for balancing the transmission circuit and for preventing transmission echoes either with repeating coils in the transmission circuit or without repeating coils, is fully described in Patent 2,294,237 issued to J. B. McKim August 25, 1942, and therefore a complete explanation of this telephone circuit need not be made in this description.

The calling toll operator in toll switchboard 600 may now advise the operator in the call order switchboard that she has attempted to obtain a trunk for a toll connection, that the trunks of this group were busy, and that she wishes to leave a request for a toll connection over a trunk in this particular trunk group when an idle trunk is available. Since the operator in the call order switchboard knows that this particular group of trunks is not on delayed quotation and, therefore, that a trunk in this group might have become idle, an investigation of the condition of the trunk group is made by the call order board operator by placing plug 567 into jack 564. The springs of jack 564 are connected to a contact of the overflow relays such as relay 555 which indicate whether all trunks in the group are busy by being released, and that there is an idle trunk in the group by being operated. Two such leads are shown, lead 575 and lead 576. Lead 575 is connected to a contact of an overflow relay associated with the terminal group of trunks and lead 576 extends to an overflow relay associated with a via group of trunks. This distinction is made for the operator in the call order switchboard because a telephone connection over a via trunk may extend a long distance through other toll switchboards and a connection with a terminal trunk ordinarily terminates in the area in which the cross bar office is located. Regardless of which character of toll trunk is being investigated, with the overflow relay such as 555 operated, a ground is connected through its contact and the filament of lamp 566 contact of key 580, contact 572 of interrupter 571 to battery. The flashing of lamp 566 thus indicates to the operator in the call order switchboard that there is an idle trunk in the group of trunks desired by the calling toll operator. A ground on lead 576 would flash lamp 565 to indicate to the operator in the call order switchboard that a via trunk is idle in the group desired. It is apparent that the lamp which flashes helps the operator to decide whether the call should take precedence over other calls for this trunk group. If at this time the operator in the call order switchboard believes that the toll call should be extended over this idle trunk, the plug 820 may be used for completing the connection as hereinafter described. Under the foregoing conditions the trunks of the trunk group may remain busy which would be indicated by the absence of a flash on either lamp 565 or 566. In consequence of this the call order board operator would write a ticket and complete the telephone connection as soon as possible. After this the operator would remove plug 800 from jacks 723 and 724, causing a release of relays 716 and 720. The calling toll operator also removes the plug from the jack in the toll switchboard, releases relay 619 which, in turn, causes to release relay 628. The release of relay 628 releases relays 621 and 620 and thus releases the cross bar switches by opening the circuit to the cross bar switch magnets. This opens the holding circuit for relay 728 in the 151 trunk, causing the release of relay 712, which completes the release of the trunk circuits.

Delay quotation on incoming calls from toll switchboards

Jacks such as 509, associated with the various overflow trunks of the office and jacks such as 511, connected to the delay quotation circuit, are located in a supervisory panel which includes jacks, lamps and control keys, the operation and maintenance of which is under the control of a supervisory personnel in the cross bar toll telephone office. This group of people observe the busy condition of overflow circuits associated with the different toll trunk groups of the office as indicated by lamps 508 for each overflow trunk and observe the number of requests for trunk connections in trunk groups where delay has been encountered. A record of delayed calls is obtained by the supervisory group from the tickets that have been written by call order board operators responsive to circuit request calls from various outlying toll operators. By noting the action of the overflow lamps and by keeping a record of the tickets, a supervisory operator can estimate the approximate length of delay expected in completing calls to other toll offices. When the delay is of a given minimum time period, the trunk group is patched for delay quotation by connecting one plug of the patching cord 510 to jack 509 of the overflow trunks associated with the trunk group and the other plug to jacks 511 of the delayed quotation circuit. The delay for this group of trunks is then announced periodically by an operator in the call order board over toll lines which have been connected to the overflow trunks as hereinafter described.

There are a number of delay quoting circuits of the type shown in the right-hand portion of Fig. 5 for quoting different time periods of delay, such, for example, as 30, 40, 50, or 60 minutes delay for completing connections over trunks of different groups. Each delay quoting circuit has a plurality of jacks 511 in multiple so that a number of overflow circuits associated with the same or different trunk groups may be connected thereto depending upon the time of delay to be quoted for completing calls to trunks in these particular groups. The jacks 511 are arranged in groups on the supervisory panel for the convenience of the supervisory force and the delay quoting circuit jacks 529 in the call order board are assigned for particular time periods of delay for the convenience of the call order board operators. Notices are also placed in convenient locations in the operating room, stating the groups of trunks involved and the delay to be quoted for each trunk group. These posted delays can be seen by the operators

in both the call order switch board and the cordless switchboard.

The delay quotation circuit is placed in service by inserting one plug of the patching cord 510 in the jack 511, causing the operation of relay 522 which establishes a circuit for the heating element of tube 514. The alternate plug of patching cord 510 is inserted in an overflow jack 509. Subsequent patches may be made from jacks in multiple in the delay quotations jack 511 to the jacks 509 of other overflow trunk circuits. The insertion of the patching cord plug in jack 509 causes the operation of relay 541 common to the overflow circuits of one trunk group and connects relay 540 in the sleeve circuit extending through resistance 545 and the winding of relay 548. This circuit is completed by the operation of relay 504 whenever an incoming toll line is connected to the overflow trunk. The result of the operation of relay 541 will be described after the following description of the delayed quotation circuit.

A calling line connected to an overflow trunk, which is patched for delay quotation, causes the operation of relay 548 and the operation of relay 548 establishes an obvious circuit for relay 542. Under this condition, relay 540 does not operate since this relay is marginal and resistance 545 is high enough to prevent its operation. Relay 542, in operating, establishes the plate battery circuit from battery through resistance 543 and contact 1 of relay 542, winding of repeating coil 513 to the plate of tube 514. The operation of relay 542 also establishes a circuit through its contact 3 and the contact of relay 563 for lighting lamp 547. The operator in the call order switchboard operates the talking key 803 and inserts plug 800 into the delay quotation circuit jacks 527 and 529. A circuit is thus established for sleeve relay 562 from ground through its lower winding, sleeve of the jack and plug, contact 4 of relay 802, lamp 809 and resistance 811 in multiple, resistance 810 to battery. The operation of relay 563 extinguishes lamp 547. The operation of this talking key 803 operates relays 802 and 815 as previously described to ground over lead 838 which extends through the contacts of relays 900 and 943. The telephone circuit relay 901 is now operated over lead 839 through contact 2 of the talking key 803, contact 7 of relay 815, contact 1 of the talking key, thence over lead 838 to ground. The operation of relay 901 associates the telephone set talking circuit with the delay quotation circuit and connects ground to relay 900 for operating this relay and connects ground to lead 832 which replaces the ground over the original circuit from contact 2 of relay 943. An announcement of the amount of times of delay for completing telephone connections to trunks in this group is now made by the operator. It will be noted that the talking circuit from the operator's position extends over the tip and ring conductors of plug 871 and jack 527 to resistance 528. This arrangement is used to balance the telephone circuit which is arranged for four-wire transmission. After the delay announcement has been made, the call order board operator operates key 801 to operate relay 544. This circuit may be traced from battery through resistance 825 which is connected over all of the contacts of key 801, thence over the tip and ring conductors of plug 870 and jack 529, retardation coil 526, winding of relay 544 to ground. The operation of relay 544 causes the operation of relay 548 and connects battery through resistance 456 over the sleeve conductor of the patching cord 510, winding of relay 540, contact 7 of relay 541, contact 4 of relay 504 to ground, which operates relay 540. If other overflow control circuits for other trunk groups are patched to this delay quotation circuit, all relays, the same as relay 540, are operated at this time. Relay 540 and other similar relays, connect ground to retardation coil 503 and other similar retardation coils, in all overflow circuits thus connected. This transmits signals to all calling operators connected to the delay quotation circuit. The call order board operator thereafter may repeat the delay announcement and again operate key 801. This continues from the call order switchboard intermittently, giving the time of delay for completing a call to these trunks and operating key 801 to signal the calling toll operators to release the connection from the calling toll boards to the cross bar toll office. The release of all toll lines connected to the overflow circuits causes the release of relays 548 and 542 which lights the cord circuit supervisory lamp 809 over a circuit from battery through resistance 810, lamp 809, sleeve conductor of plug 871 and jack 527, low resistance upper winding of relay 562, resistance 549 to ground on contact 2 of relay 542. The call order board operator is thus aware that all of the calling lines which were connected to the delay quotation circuit have disconnected therefrom and she may then remove the plug 800 from the jacks 527 and 529. The removal of plug 800 releases relays 562 and 563. This operator may then plug into another delay quotation circuit for announcing the time of delay for the group or groups of trunks patched thereto.

Under overloaded conditions in an office there may be periods requiring considerable attention of the call order board operators in announcing delays of different periods. Under this condition a number of calling toll lines may be connected to particular delay quotation circuit before the operator has had time to connect the cord circuit therewith to give an announcement. This is, however, done as rapidly as possible in order to prevent delay in the calling toll switch boards. An amplifier is, therefore, provided in the delay quotation circuit to function adequately when a number of calling operators are connected thereto. This amplifier functions with the overflow trunk circuits as a zero gain device. It supplies a low impedance source to which from 1 to 80 simultaneous connections may be attached without appreciable variation in the output level. The output speech voltage across the low resistance load retardation coil 526 will be approximately double the input voltage. The low impedance of the output, combined with the corrective effects of reversed feedback, keeps the output voltage substantially constant in spite of variations in the connected load. The feedback path is through condenser 515, resistances 523 and 518 and condenser 521 to the cathode. A 7.5-volt direct current grid bias is provided by resistor 519 for the heater circuit. Resistor 543 is provided to give a maximum of 110 volts on the plate and screen of the tube.

The patching of a group of trunks to the delayed quotation circuit automatically alters the routing of incoming calls for trunks in this group and places the trunks of this group under the control of the operators in the call order switchboard. This saves the time of the outlying toll operators in obtaining a telephone connection to a trunk in this group since one call to a call order board operator is sufficient to obtain this connection when an idle trunk is available and also provides

a means for completing calls over the trunks of this group in the order in which the calls were made by various subscribers from different areas. An exception to this may arise when a toll call is incoming from a long distance which may be urgent and which may have expensive toll equipment already set up. Calls of this character are automatically routed to the call order board operator instead of to an overflow trunk. If an idle trunk is available and the completion of this call appears warranted to the call order board operator, it may take precedence over other waiting calls.

Automatic rerouting of calls for trunks on delay quotation

The operation of relay **541** as herein described responsive to the insertion of the plug of patching cord **510** into an overflow jack **509** connects ground to lead **578** which, as shown in the following, will operate the market mechanism in a manner to indicate that all trunks are busy whenever a call is made for a trunk in this group by an outlying toll operator, even though there may be idle trunks in the group at the time. These idle trunks, as previously set forth, are now only available to the call order board operator. It will be recalled in the previous description of a toll call to a trunk in a group not patched for delay quotation, that when all trunks of the group are busy, relay **555** is released and thus a circuit is established from 48-volt battery through contact **5** of relay **541** released, winding of relays **308** and **304** to 24-volt battery. This operated relay **304** but did not operate the polarized relay **308** and in response to the operation of relay **304**, the calling line was routed to an overflow trunk. With a group of trunks on delayed quotation and relay **541** operated, the circuit over lead **578** is from ground through the winding of relays **308** and **304** to 24-volt battery which operates both relays since the current flow is in the correct direction to operate polarized relay **308** as well as relay **304** whenever the route relay **310** operates responsive to a registration of the code for this group.

Under all conditions the code is registered by the marker in the usual manner reponsive to a call from a C. L. R. toll board operator over a short toll line, from a distant toll operator over a long toll line or from a cordless toll operator in the cross bar toll office.

Call over short toll line

A call from a C. L. R. toll operator operates the regular trunk group route relay such as route relay **310** in the usual manner and when the route relay closes its contact **1** a circuit is established for relays **308** and **304** and a circuit is established for relay **406** through its contact **2**. As previously traced, relay **304** operates relay **401** and the resulting action in the test relays immediately operates the overflow control relay **402** which routes the calling line to an overflow trunk if one is found to be idle. The calling C. L. R. toll operator then hears the announcement of a certain time delay as given by the call order board operator over the delay quotation circuit as explained. The C. L. R. toll board outward operator disconnects from the cross bar toll office and this operator or another special operator makes a circuit request call to the cross bar toll office call order board operator. The toll connection is then completed as hereinafter described by the call order board operator.

Call from distant toll office over long toll line

Responsive to a call from a distant toll office over a toll line which may terminate in the cross bar toll office on the incoming trunk circuit, Fig. 6, a trunk indication is signaled from the trunk to the sender **636** and transferred to the marker **700**. The result of this signal as shown diagrammatically in the marker, Fig. 3, establishes a circuit over lead **351** which operates what is known as the via only relay **317**. The code for the trunk group is registered and operates the regular trunk group route relay such as route relay **310**, which causes the operation of relays **304** and **308**. Relay **308** now operates relay **316**, which in this instance, operates relay **319** from ground through the contact of the via only relay **317**, contact of relay **316**, winding of relay **319** to battery. Relay **319** opens the operating circuit for the regular route relay **310** and establishes a circuit for the **151** trunk group route relay **312**. The regular group route relay **310** immediately releases and, therefore, the marker does not test either the trunks of the group or the overflow trunks associated with this group.

The **151** group route relay is operated over a circuit from ground on contact **3** of relay **319**, contact **2** of relay **318**, contact of relay **313**, contact of key **550**, winding of route relay **312** to battery. The special **151** trunk is shown in Fig. 7A as previously described and the operation of the **151** route relay **312** causes the operation of a particular trunk block relay for associating a group of special trunks of the type as shown in Fig. 7A with the testing equipment shown in Fig. 4. These trunks are tested by the marker in the same manner as the trunks previously described and when an idle trunk is found the select magnet connected with the **151** trunk cross bar switch is operated and as previously described, relay **728** is operated for the seizure of this idle trunk. The trunk circuits established are the same as described for a circuit request call over the incoming trunk, Fig. 6, in which the calling operator dialed the special call **151** in order to connect with this **151** trunk. In the present instance, however, it is believed clear that the distant toll operator dialed the code of a trunk which was on delayed quotation and in order to facilitate such connections, the calling operator is automatically connected to a **151** trunk, Fig. 7A, to immediately reach the call order board operator instead of permitting the disconnection of this line and a second connection for obtaining access to the call order board operator, as described in connection with a call from a local toll board over a short toll line. The **151** trunk, Fig. 7A, is connected with the sender through the calling incoming trunk relays such as **609** and **615** by the operation of the cross bar switches and in response, relay **712** is operated as soon as the sender is aware of its connection with the special **151** trunk circuit. Relays **609** and **615** are then released in the manner previously described and lamp **733** lighted before the call order board operator to indicate an incoming call over this trunk. Plug **800** is then inserted in jacks **723** and **724** and the incoming call is answered by the call order board operator as described.

At this point the action of the call order board operator will depend to a considerable extent upon the nature of the incoming call and at times upon her knowledge of the length of the toll line which has already been established from some distant point. Under one condition with the busy trunk group heavily loaded with incom-

ing calls, the operator will write a ticket as usual and inform the distant toll operator that a connection will be established as soon as possible for her. Under another condition the toll connection may be completed as soon as an idle trunk is noted by the call order board operator, the connection to the distant operator being held awaiting this idle trunk. This call is then completed over a path from the distant operator through the incoming trunk circuit Fig. 6, 151 trunk circuit Fig. 7A, the call order board cord circuit, to an idle outgoing trunk of the desired group by inserting plug 820 into a trunk as shown in Fig. 20. To complete this connection, the call order board operator sets up the code of the outgoing toll trunk on the keys shown in Fig. 11, after first making sure that the sender has been associated therewith. This connection is thus established as hereinafter described over two sets of cross bar switches, one set as shown in Fig. 7 and the other set as shown in Fig. 21, instead of the usual connection which is established over only one set of cross bar switches. Before completing the outward toll call over the trunks, Figs. 20 and 22, other description will be given of the automatic routing features in the marker.

Delayed quotations by cordless switchboard operators

There are occasions when the call order board is not occupied by operators. On such occasions the cordless switchboard operators may be called upon to quote delays for all characters of incoming toll lines and complete delayed calls.

Under normal conditions the cordless operator only quotes delays to operators making incoming toll calls over straightforward and ringdown toll lines both of which may be held by cordless toll operators for completing toll connections or a ticket is written and sent to the call order board. As fully disclosed in Patent 2,236,246 to G. V. King et al., March 25, 1941, all calls from toll offices using straightforward or ringdown trunks into the cross bar toll office are connected through a link to the cordless toll operator's positions. Each cordless position is disclosed having a sender associated therewith and a key-set for operating this sender. Upon the association of straightforward or ringdown toll line with a cordless position the cordless operator ascertains the routing of the call and accordingly operates her key-set to set the registers of the position sender for the code of an outgoing toll trunk or an outgoing completing trunk whichever is required. Class signals are transmitted from the incoming trunk directly to the sender through the link switches indicating to the sender the character of an incoming trunk which is connected thereto. After the sender is completely set the trunk information and the code registration is transferred from the sender to a selected marker. The marker selects an outgoing trunk to a distant toll office of the character required or an outgoing completing trunk to a local office depending upon the code registered in the marker and associates this trunk through cross bar switches with the incoming trunk. In most cases the universal type of sender is required for each cordless position since a call incoming over a straightforward trunk or ringdown trunk may be connected to an office having senders with registers to be set by alternating current pulses. The senders of other offices to which these trunks may be connected will be set by direct current pulses. There is considerable difference in the operation of the sender and marker for connection with alternating current or direct current offices as will be hereinafter described.

Under normal operating conditions of the cordless switchboard, delays in completing calls when trunk groups are busy are announced to the calling toll operators by the cordless operators since these operators have access to bulletins covering the delay on trunk groups. When there is considerable delay and the call order board is at the time occupied by a complement of operators the cordless operator may write a ticket which is sent to a call order board operator and the call order board operator accordingly completes the connection when a trunk is available for this call. If, however, the call order switchboard is not at the time occupied by operators these delayed calls are completed by special operators in the cordless switchboard arranged for this character of service. Also when the call order switchboard is not occupied by operators and a distant operator makes a circuit request call, after having found the trunks busy, this call is automatically routed to a cordless operator instead of being automatically routed to the call order board.

In the conditions to be described let it be assumed that a toll operator either in a C. L. R. toll board or a distant toll office has registered the code of a particular trunk group and that all of the trunks in this group are busy, that therefore the incoming toll line was routed either to an overflow trunk or a master busy trunk in the manner herein described and that the toll operator then made a circuit request call, herein known as a 151 call, and that at this time the call order board is not occupied by a complement of operators. In this event key 550 in the call order board switchboard is operated. A call of this character is shown in Figs. 12, 13 and 14 and also is shown in Fig. 1D and Fig. 2G.

Fig. 12 illustrates the originating toll office 1200 and the incoming trunk circuit 1201 which responds when the originating toll operator initiates the call. In response to actuation of the incoming trunk a link 1228 is actuated which associates sender 1211 with the incoming trunk and the 151 code is set in the registers of the sender 1211. This code along with other information from the trunk circuit is transferred to marker 1212 which now operates in the manner shown on Figs. 3 and 4. The 151 code is registered in register relays 325 and in this instance it attempts to operate the 151 route relay. In this instance with key 550 operated the circuit from the register relays now extends to the 121 route relay 311 for selecting a trunk such as shown in Fig. 13. A group of such trunks are therefore tested by the marker in the manner previously described and an idle 121 trunk is selected to route this call to a cordless operator instead of routing the call to the call order switchboard operator. Since the cordless switchboard does not use cords and plugs the arrangement of the 121 trunk, Fig. 13, is of necessity different in that it must actuate a link to select a channel to a cordless operator's position. The 121 trunk is operated by the marker substantially in the manner previously described for outgoing trunks. When the marker selects this idle trunk it associates ground with lead 1225 for operating relay 1319. Lead 1225 was previously tested by the marker and is shown extended through the

trunk block relay over lead 1226 to the marker. The cross bar switches 1207, 1208, 1209 and 1210 are then operated which associates the 121 trunk, Fig. 13, with the sender 1211. If the call originated over a long trunk, relay 1314 is operated by the marker over a path through the sender, incoming trunk, and cross bar switches which may be traced from ground on contact 1 of relay 1319, lower winding and contact 2 of relay 1314, contact 1 of relay 1318, upper and lower windings of relay 1301, upper and lower windings of coil 1303, contacts 1 and 5 of relay 1309 thence over leads 1221 and 1222 over the cross bar switches, incoming trunk, sender and marker where a battery is applied to this circuit from a relay which responded to the indication from trunk 1201 indicating that a long trunk is connected thereto. After the marker has completed its functions and indicated this to the sender 1211 a low resistance ground is connected by the sender to lead 1223 and lead 1224 causing the operation of relay 1318. Relay 1318 locks through contact 2 of relay 1319, resistance 1317, contact 4 of relay 1318 to ground on contact 1 of relay 1319. Relay 1318 in operating opens its operating path which transmits a signal to the sender that the outgoing trunk no longer relies upon the sender for its operation. The operation of relay 1318 also establishes a connection for actuating the link 1320. This circuit may be traced from ground through contact 3 of relay 1318, contact of relay 1301, contact 1 of relay 1313 thence over lead 1350 through the winding of the link start relay (not shown) to battery. The link has mechanism therein for testing the various channels entering the cordless operator's positions and chooses an idle channel. Link switches are then operated which connect this channel to leads 1350 to 1364 shown between the trunk circuit and the link. The majority of these leads are connected through the switch contacts to the cordless operator's position for operating and signaling purposes as fully disclosed in the aforementioned Patent 2,236,246 to G. V. King et al. A signal lamp is lighted in the cordless operator's position and an automatically operable mechanism associates the cordless operator's telephone set with the incoming calling line. The trunk relay 1313 is also energized over lead 1351 which relay locks to ground on a lead 1353 connected thereto by the automatically operable mechanism in the cordless operator's position.

The calling operator in toll office 1200 now converses over the four-wire channel comprising leads 1354, 1355, 1356 and 1357 which are associated with the cordless operator's telephone circuit and indicates to this operator that she wishes to make a request call for completion of a telephone circuit over trunks which she has found busy. In response the cordless operator will, when necessary, advise her that there is considerable delay on this group of trunks. Under other circumstances when a time delay bulletin has not been issued for this group of trunks the cordless operator may attempt to complete the connection at once. The cordless operator in position 1408 will operate her key-set to set the registers in the position sender 1409. In response to the setting of this register a marker 1410 tests the outgoing trunks of the desired outgoing trunk group in the manner herein described. If an idle trunk is found the marker then operates the cross bar switches 1402, 1403, 1404 and 1405 which connects the idle outgoing trunk 1406 with the 121 trunk, Fig. 13. This outgoing trunk may be of various types but may be assumed to be of the type shown in Fig. 22. The marker after finishing its functions may release but the sender 1409 may have other functions to perform. The numerical registers of sender 1409 may have been set by the cordless operator and relay 1310 operated by the automatically operable mechanism of the position circuit. Thus, a connection is established from the sender 1409 through the link switches, thence over leads 1358, 1359, 1360 and 1361 through the cross bar switches and the outgoing trunk 1406 to the distant office 1407. The sender 1409 thus operates to set the registers of the sender in the office 1407 after which relay 1310 is released and the sender 1409 may be dismissed. The circuit request call therefore in this instance resulted in a connection having been made to the desired toll office since at the time the circuit request was made an idle trunk was found by the cordless operator which group appeared busy when the original call was made. The release of relay 1310 associates the mechanism of office 1407 with office 1200 and in this instance the telephone connection is completed over two sets of cross bar switches instead of one set of cross bar switches which is the usual procedure when an idle trunk is available when the incoming call is initiated.

The above-described call, with toll office 1200 connected to the incoming trunk 1201 would be routed to the 151 trunk 1206 if the call order board is occupied by a complement of operators and key 550 is normal as shown. This call thus terminates in jacks 1400 and 1401 in a call order board operator's position and would be answered by the insertion of a cord circuit plug, Fig. 8, into the above jacks in a manner described herein instead of being routed to the 121 trunk and the cordless position operator.

Incoming call over ringdown trunk

Mechanism is included in the marker, Fig. 3, for routing an incoming call from a ringdown trunk to a master busy if the desired trunk route is patched for delayed quotation and the cordless operator has attempted to complete a telephone connection to this busy trunk route. Assuming in this instance that the delay for this group has not been posted, the cordless operator upon receiving a call from a distant operator over a ringdown trunk line would operate her keys for setting the code registers of the position sender. The position mechanism would in this case have received an indication from the trunk that would operate relay 317 and also relay 313 in the marker when the marker is connected thereto and the code registration is transferred from the sender to the marker. It may be assumed again, for example, that a route relay such as relay 310 is operated responsive to the registration in the marker and since the group of trunks desired according to the code registered is patched for delayed quotation a circuit is extended through contact 1 of route relay 310 for operating relays 308 and 304. Relay 308 in operating establishes a circuit for relay 316. Since at this time relays 313 and 317 are operated a circuit is established for relay 319 through contact 2 of relay 316 and the contact of relay 317 to ground and therefore a circuit is established for a master busy route relay 309. The circuit for the master busy route relay may be traced from ground through contact 3 of relay 319, contact 2 of relay 318, contact of relay 313, winding of master busy route relay 309, winding of relay 314 to battery. Relay 314 is marginal and does not operate. As previously

described the operation of relay 319 opens the operating circuit for the route relay 310 of the regular group which releases this relay. In consequence of the foregoing operations the calling ringdown toll trunk is routed immediately to master busy to advise the calling operator that considerable delay has been encountered in completing calls to this group of trunks.

Connection from cordless board to call order board

The calling operator may then disconnect and make a circuit request call over a 151 trunk to the cordless operator requesting that this operator connect her with the call order board or write a ticket for a delayed call and pass this ticket to the call order board operator. The manner of the latter call is shown in Fig. 14B and the operator in toll office 1450 actuates the incoming trunk 1451 which causes a link to connect a cordless operator's position through the trunk to the toll operator in the toll office 1450. The request is then made by the calling toll operator in office 1450 that she has an urgent telephone call and that she be connected at once to the delay operator in the call order board. The cordless operator 1460 may then operate her keyset for setting registers in position sender 1461 for a 151 call. This call is transferred to the marker 1462 and a 151 trunk 1456, as shown in Fig. 7A, is selected by the marker. This jack terminating trunk is then connected through the cross bar switches 1452, 1453, 1454 and 1455 thence over the incoming trunk to the calling toll operator under the control of the marker and the position sender. Upon the response of the call order board operator by inserting the cord, Fig. 8, into jacks 1457 and 1458 the originating operator in toll office 1450 initiates her request to the call order board operator that if possible the connection be completed at that time and if this is not possible to set up a connection for her to the wanted toll office at the earliest possible moment. If it is necessary for a call order board operator to complete this connection later she thereupon writes the information on a call order ticket so that she may complete the call to the wanted office and to the originating operator at the earliest possible moment.

Completing toll connection from call order switchboard

In the preceding description it was brought out that the trunks of a trunk group patched for delay quotation are not available to the outlying toll operators by registration of the regular trunk code and the operation of the corresponding route relay, since the operation of this regular route relay immediately actuates other relays including relays 304 and 308 which prevent the test of the trunks in this group and the routing of an incoming toll call over a trunk of this group. It was also brought out that the trunks of the group or groups patched for delay quotation are now made available to the call order board operators for completing delayed calls in the order received. Special trunks as shown in Fig. 20 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. The call order board operator after observing an idle trunk in a patched group actuates a trunk, Fig. 20, by inserting twin plugs of the cord circuit, Fig. 8, into jacks 2025 and 2026 which initiates the series of functions later described in detail. This series of functions comprises the actuation of a link and the selection of a sender by the link and the connection of the trunk, Fig. 20, to the selected sender followed by the establishment of circuits between the trunk and sender mechanism and also followed by the transmission of code pulses for selecting a trunk in the patched trunk group. These code pulses are transmitted by operating keys in the call order board position for setting the registers of the sender. One of the circuits established between the trunk, Fig. 20, and the sender causes the operation of a call order relay in the sender which connects ground to a call order lead. A connector is then selected between the sender and an idle marker and this grounded call order lead is connected to the winding of a call order relay in the marker substantially at the same time as the code registration is transferred from the sender register relays to the registers of the marker and as diagrammatically shown in Fig. 3. The marker call order relay designated as relay 307 may operate a fractional part of a second ahead of the route relay which is operated responsive to the code registered in the marker. Relay 307 opens the circuit extending from ground on relay 541 over lead 578 through contact 1 of the route relay, which circuit if established would have caused the operation of relays 304 and 308. The normal functions of the route relay for this group of trunks are thus restored since they are not altered at this time by the operation of relay 304 or relay 308. An idle trunk in this group is now selected in the manner previously described by the operation of a trunk block relay which connects the trunks of a group with the testing relays, Fig. 4. This idle trunk which may be an outgoing toll trunk as shown in Fig. 22 is connected by cross bar switches under the control of the marker with the trunk, Fig. 20, and the call order board cord circuit, Fig. 8. The other end of the cord circuit may have already been connected to a calling toll line such as would be the case responsive to a call from a distant operator over a 151 trunk, Fig. 7A to the call order switchboard as previously described. The call order board operator may, however, be required to complete a connection as above described and also complete a connection to the originating operator when an idle trunk is available as will presently be described along with the detailed description of the sender, Figs. 23 to 35.

Senders

For an example of initiating the operation of the sender shown in Figs. 23 to 35, inclusive, a connection will be established between the call order board operator's position cord circuit shown in Fig. 8 and the trunk circuit shown in Fig. 20. The description of the sender will, however, include features responsive to other characters of trunk circuits and differences in control for which the sender is arranged. Office 2230 to which the trunk, Fig. 20 will be connected by the selection of a trunk, Fig. 22, may be assumed for one example as having senders therein which respond to alternating current pulses and for another example as having senders which respond to direct current pulses. The sender, Figs. 23 to 35, is capable of having its registers set from either direct current pulses or alternating current pulses and is also capable of transmitting direct current pulses or alternating current pulses for setting registers in a connected office sender.

When the registers of a sender in another office

are set by alternating current pulses, these pulses are transmitted directly from the sender, Figs. 23 to 35, to the sender in the connected office. When the sender in the connected office requires direct current pulse for setting its registers the use of an outgoing sender is required in combination with a sender such as shown in Figs. 23 to 35. When an outgoing sender is required it is attached to the outgoing trunk circuit under the control of the marker. This outgoing sender is selected by the trunk circuit in the manner fully disclosed in the Patent 2,293,191, issued to A. J. Busch and F. J. Scudder August 18, 1942, the registrations by direct current are first completed in the sender, Figs. 23 to 35, and transferred to the outgoing sender after this sender has been attached to the trunk circuit. This enables the sender, Figs. 23 to 35, to release and enables the outgoing sender to transmit the pulses after the connected office has been actuated. The method of operating the registrations in the sender, Figs. 23 to 35, by either direct current pulses or alternating current pulses and the method of transmitting either alternating current pulses or direct current pulses from the sender, Figs. 23 to 35, is according to the following description.

The call order board toll operator's key-set circuit, Fig. 11, and multifrequency supply set, Fig. 15, may be considered to be substantially the same as in an outward toll operator's position in a C. L. R. toll office connected by toll lines with this toll office, or a key pulsing outward toll operator's position in a distant toll telephone office at least in so far as its relation with and operation of the sender is concerned. This will aid in the understanding of connections as shown in other figures of the drawings in which a diagrammatic showing of the sender has been made. The cooperative action between the trunk, Fig. 20, and the sender is broadly the same as between the incoming trunk, Fig. 6, and this sender shown diagrammatically as sender **636** in so far as the registration of alternating pulses is concerned.

The insertion by the call order board toll operator of the cord circuit plug **800** or **820** into the trunk circuit jacks **2025** and **2026** causes a circuit to be established from battery in the cord circuit through the lower winding of relay **2000** to ground. Relay **2000** in operating establishes an operating circuit for relay **2020** which is locked through its contact **1** to ground on the contact of relay **2000**. Relay **2020** in operating establishes a link start circuit by connecting ground from contact **5** of relay **2021** to the link start lead **2040**. The other connections established by relay **2020** will be described in the order in which they are used. Other characters of trunk circuits in the toll telephone office, some of which have been shown, have a relay similar to relay **2020** for actuating the link start circuit when the services of a link are required.

The link energized by the trunk circuit, Fig. 20, for selecting an idle sender such as shown in Figs. 23 to 35, 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 Figs. 22 and 32, 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**. The description of the link circuit in this patent is described more in detail for selecting an idle cordless switchboard operator's position for completing telephone connections from distant toll operators using straightforward or ringdown trunks. The selection operations in the link for selecting the sender **2214** is also described in this patent as being of the same character as described for the selection of an idle cordless operator's position. Patent 2,293,191 to A. J. Busch and F. J. Scudder August 18, 1942, however, describes in detail the selection of an incoming sender in the same manner that the incoming senders disclosed herein are selected. The incoming sender described in the latter patent, however, is arranged for transmitting direct current pulses only and therefore the outgoing trunk selects an outgoing sender when numerical pulses are to be transmitted to a distant office sender. A feature of this link and a link control circuit is also covered in Patent 2,291,024 to A. J. Busch July 28, 1942. This patent illustrates a method used for selecting idle senders by transferring the testing leads from one sender group to another during busy periods when an idle sender cannot easily be located.

In general, the links disclosed herein operate in the following manner. The leads from a plurality of trunk circuits such as the trunk circuit shown in Fig. 20 are connected to primary switches in the link as shown in the above patents. A plurality of senders are connected to the contacts of secondary switches associated with the primary link switches. The trunks connected to the primary side of the switch are in groups and consequently when one trunk circuit has established a connection with a link serving its group, the remaining trunk circuits cannot at this time establish a connection with this link. Arrangements are, however, made so that all trunk circuits may immediately establish proper link connections. The aforementioned start circuit established by the trunk circuit extends to what is known as a link connector so that the trunk is not only connected to the primary side of a switch but is also connected to a link connector for obtaining the services of a link control circuit. This link control circuit immediately tests all available senders to find an idle sender for use by the trunk circuit. When the idle sender is found the link control circuit energizes the select magnets and hold magnets associated with the primary link switch and a particular secondary link switch to which this idle sender is connected. The operation of this secondary link switch and the primary link switch thus connects the idle sender to the trunk circuit.

During the test of senders by the link control circuit an idle sender may be recognized by the presence of ground on lead **2450** which as noted extends through the contacts of relays **2611** and **2612**, thence over lead **2650** to ground on contact **8** of relay **2422**. The link control circuit also tests for battery on lead **2451**. This battery is shown connected to contact **1** of relay **2422**. It is seen that lead **2450** extends through the contacts of three relays and lead **2451** extends through the contact of one relay which relays are the last to release when the sender has finished a service connection and become idle. The battery and ground extending to the link control circuit energize mechanisms therein which cause the operation of the select magnets and hold magnets of the link switches to connect the trunk circuit with the sender. The operation of the link switches connects ground from the link control

circuit through the primary and secondary link switch contacts to lead 2452, winding of relay 2422, resistance 2400 to battery, operating relay 2422. The operation of relay 2422 removes battery from lead 2451 and removes ground from lead 2450 so that this sender no longer appears as an idle sender to any one of the link control circuits attempting to find an idle sender.

The connection of the leads from the trunk to the sender establishes a circuit for relay 2403. The circuit for relay 2403 extends from ground on contact 2 of relay 2401 which is normal, resistance 2413, upper and lower windings of relay 2403, lead 2760, contact 1 of relay 2708, lead 2460, contact 3 of relay 2422, thence over lead 2454 through the winding of trunk circuit relay 2018 to battery. The high resistance of the two windings of relay 2403 prevents the operation of relay 2018. Relay 2403 operates and in so doing establishes a circuit for relay 2402 from ground on contact 2 of relay 2509 which is connected through the winding of relay 2402 to battery. The operation of relay 2402 substitutes through its contact 2 the operating ground for relay 2403 and establishes an operating circuit for relay 2401. Circuits are also established at this time for the off-normal relay 3000 and the off-normal relay 2502. The circuit for relay 2502 extends from battery through its winding to ground on contact 1 of relay 2402. The circuit for relay 3000 extends from battery through its winding to ground on contact 3 of relay 2402.

The timing circuit, Fig. 23, is energized as soon as the sender starts its functions in order that these functions be completed within a timing limit plus tolerances which are calculated for any eventuality during the correct operation of the sender. This timing circuit is actuated by the connection of ground through contact 6 of relay 2422, interrupter contact 2304 and to the windings of relays 2301 and 2302 which operate and release as the interrupter 2303 rotates. This timing circuit will be later described in detail. Relay 2613 is operated by relay 2422, the circuit for which may be traced from battery through the winding of relay 2613, lead contact 2 of relay 2707, conductor 2463, contact 4 of relay 2422, lead 2453 to ground on contact 3 of relay 2018. Relay 2622 also connects 24-volt battery to the windings of relays 2408 and 2409 which are selectively operated depending upon the class of information transmitted from the trunk circuit. This information is transmitted from the trunk circuit over leads 2350 and 2353 which extend through resistances 2720 and 2721 to leads 2465 and 2466, windings of the relays 2404, 2406, 2408 to battery, and relays 2405, 2407 and 2409 to battery on contacts 9 and 10 of relay 2422. It will be noted that ground from contact 4 of relay 2022 is connected to lead 2353 and that lead 2350 is open. Before finishing with the functions of relay 2422 it should be shown that this relay provides an operating circuit for relay 2021 in the trunk which extends from battery through the winding of relay 2021 over lead 2455, contact 2 of relay 2422, to ground on contact 5 of relay 2402. It should also be shown that relay 2422 obtains a locking circuit through the contacts of relays 2613 and 2611 immediately following the closure of the link switch contacts and the operation of relay 2422. This locking circuit extends from battery through the winding and contact 5 of relay 2400, over lead 2480, contact 2 of relay 2614, contact 3 of relay 2613, thence over lead 2653 to ground on contact 4 of relay 2402. The operation of relay 2611 results from a trunk signal between the trunk and the sender for indicating the class of the calling trunk. As above set forth, leads 2350 and 2353, connected between the trunk circuit and sender were traced through the windings of 2408 and 2409. The trunk circuit, Fig. 20, places a ground on lead 2353 and lead 2350 is open. These leads are, however, used by other types of trunks for different signals as outlined hereinafter. The ground on lead 2353 operates relay 2408 and relay 2408 operates alternating current class relay 3304 which locks to ground on contact 11 of relay 2422. Relay 3304 in operating establishes a circuit for relay 2611 from ground on contact 5 of relay 3305, contact 5 of relay 3304, thence over lead 2666 through the winding of relay 2611 to battery to operate relay 2611 and provide the above-traced path for locking relay 2611. A ground on lead 2350 would operate relay 2409 which would operate class relay 3305 for direct current pulsing.

Trunk circuit signals

As above indicated relays 2404 to 2409 inclusive, are arranged to be variably operated depending upon the character of the trunk associated with the sender and the character of pulses transmitted over the conductors of the trunk for setting the registers of the sender. According to the table below it will be seen that relays 2408 and 2409 are operated whenever a circuit is established over the trunk lead extending through their windings. Relays 2406 and 2407 are marginal and operate to zero ohm ground but not when a 300-ohm resistance is in series with the circuit. Relays 2404 and 2405 are polarized relays and only operate when 48-volt battery is connected by the trunk to the lead extending through their respective windings to 24-volt battery on contacts 9 and 10 of relay 2400. Information to a marker, later selected, is also derived from the operation of the above relays since, as previously explained, a marker requires a signal from the sender for governing the selection of an outgoing sender and the connection of this outgoing sender to the outgoing trunk when it is required for completing a direct current pulsing telephone connection.

Pulse control signals

Lead 2353	Lead 2350	Relays operated	Connection	Type of pulsing
0-ohm ground	Open	2406–2408 3304–2615	Intertoll or toll completing	A. C.
300-ohm ground	do	2408–3304	Intertoll	A. C.
300-ohm 48 v. battery	do	2404–2408 3304–2614	Toll completing	A. C.
Open	0-ohm ground	2407–2409 3305–2615	Intertoll or toll completing	D. C.
Do	300-ohm ground	2409–3305	Intertoll	D. C.
Do	300-ohm 48 v. battery	2409–2405 3305–2614	Toll completing	D. C.

Other trunk signals are transmitted over lead **2352** as follows for indicating the type of incoming trunk used for the call so as to guide the sender and the selected marker in their operation such, for example, as the selection of repeaters for the connection if the outgoing trunk selected by the marker also indicates that a repeater is required. The selection of a particular character of outgoing trunk is governed by the code which is registered in the sender and marker as fully covered in the aforementioned Patent 2,236,246 to G. V. King, J. B. McKim and O. Myers.

The trunk circuit, Fig. 20, is arranged to connect ground from contact **1** of relay **2022** thence through a 2400-ohm resistance **2023** and over lead **2352** through the link switches to the sender. In the sender this lead extends through contact **2** of relay **2700**, contact **4** of relay **2706**, over lead **2769**, winding of relay **2604**, winding of relay **2605**, lower winding of relay **2511** to battery. Relays **2604** and **2511** are marginally operable and do not operate in series with the 2400-ohm resistance in the trunk circuit and, therefore, relay **2605** is the only relay to operate in the circuit traced. The operation of relay **2605** establishes an obvious circuit for relay **2606** which is locked to ground on contact **3** of relay **2502**. As will be shown later the operation of relay **2606** sends a signal to a selected marker indicating a characteristic of the calling trunk.

Other incoming trunks indicate a different characteristic to the sender and marker by differentiating between the indications over lead **2352** in the trunk as follows:

Lead 2352	Relay operated	Lead to marker	Grounded
Open	None	NVO—2543	GRD. WDG. 2510 3–2511
		LIT—3440	GRD.—1–2606 over lead 2652
Zero res. grd	2511—2604—2605—2606	LIT—3440	GRD.—2–2604 over lead 2652
		VO—2544	GRD. WDG. 2510 2—2511 over lead 2544
700-ohm res. grd	2511—2605—2606	VO—2544	GRD. WDG. 2510 2—2511 over lead 2544
2400-ohm res. grd	2605—2606	NVO—2543	GRD. WDG. 2510 3—2511 over lead 2543

As described in Patent 2,236,246 to G. V. King, J. B. McKim and O. Myers and Patent 2,293,191 to A. J. Busch and F. J. Scudder, the signals over leads **2543**, **2544** and **3440** indicate the character of the incoming trunk to guide the operations of the marker for signaling purposes and the selection or non-selection of voice amplifying repeaters for a telephone connection.

A particular indication is given by the delay toll operator's trunk, Fig. 20, over lead **2351** which extends from battery through the winding of marginal relay **2019**, contact **8** of relay **2018** thence over lead **2351** through the link switch contacts to the sender where it extends through contact **3** of relay **2700**, lead **2751**, contact **5** of relay **2706**, lead **2752**, upper winding of relay **2505** to ground. Relay **2505** operates in this circuit but the marginal trunk relay **2019** does not operate at this time. Relay **2505** establishes a circuit for relay **3400** from battery through the winding of the latter relay, lead **2571**, contact of relay **2505**, lead **2570**, contact **3** of relay **2509**, lead **2470** to ground on contact **1** of relay **2401**. The operation of relay **3400** connects signaling paths with mechanisms in the marker over leads **3440** and **3442** which are represented by the dot and dash lines **3445** along with other leads extending to the marker. This circuit and the relays involved are particularly for use on calls completed by the call order board operator to an idle trunk in groups of outgoing trunks which are patched for delay quotation and made unavailable for calls from outlying toll operators. These trunks are made available to the call order board operators by the operation of sender relay **3400** which connects ground to lead **3442** to operate a marker call order relay designated CO, which functions in the manner shown diagrammatically in Fig. 3 as relay **307**. Upon the connection of the sender to the marker as later described the marker relay **307** operates substantially at the same time as the marker registers and a fractional part of a second preceding the operation of the route relay. This makes the regular routing and test of the trunks in this group effective since the circuit for relays **304** and **308** is opened by relay **307** and thus the trunk, Fig. 20, can only be routed to an idle outgoing trunk in the group designated by the code registered. Preceding the actuation of the trunk, Fig. 20, the sender and the marker, the call order board operator has observed the condition of the trunks in the group of outgoing trunks of the routing desired and is aware that there is one or more idle trunks in the group. The utility of other signal paths established by relay **3400** will be later explained for particular features of operation in connection with the delay call operator's switchboard.

The above trunk class indicating devices are opened responsive to the operation of trunk relay **2018**, a circuit for which is established when relays **3304** or **3305**, **2309** and **2612** are operated. It will be remembered that relay **2408** was operated by a trunk class signal and that relay **2408** established a circuit for relay **3404**. A circuit is thus established for relay **2309** from ground on the contact of relay **2408** which operates relay **3304** and after the operation of the latter relay extends through contact **3** of relay **3304** over lead **2331**, winding of relay **2309** to battery. Relay **2309** in operating connects ground to lead **2330** extending through contact **5** of relay **2502**, lead **2530**, winding of relay **2612** to battery. Relay **2612** in operating short-circuits the high resistance winding of relay **2403** causing the operation of relay **2018** over the circuit originally traced through the winding of relay **2018** and both windings of relay **2403** for operating relay **2403**. When relay **2409** is operated from a trunk which sets the sender for direct current pulsing, a circuit is established for relay **3305** over leads **2470** and **2767** and the operation of relay **3305** connects lead **2767** to lead **2331** for operating relay **2309** in the same manner as above described.

Relays **2611** and **2613** were previously operated and thus the operation of relay **2612** connects lead **2461** to lead **2464** which short-circuits the upper winding of relay **2403** and resistance **2413**. The operation of trunk circuit relay **2018** establishes an obvious circuit for relay **2022** which locks to ground on contact **2** of relay **2020**. Relay **2022** connects ground through the upper winding of trunk selector relay **2000** for signaling the toll call delay operator that the sender has been connected to the trunk circuit.

The operation of the trunk relays as described above causes the release of any of relays **2404** to **2409** which were operated and causes the op-

eration of relays 2701 and 2706. Both of these relays are operated from ground on lead 2531, which extends through the windings of both relays and the winding of relay 2309 made effective by the release of relay 2408 or any of relays 2404 to 2409 which causes this removal of ground from lead 2331 previously traced for operating relay 2309. The ground on lead 2331 places a shunt on relays 2701 and 2706 to prevent their operation until the trunk class signals have been registered by the sender. Relay 2701 in operating establishes a circuit for the register steering relays 3001 and 3100. The circuit for these relays may be traced from ground on contact 6 of relay 2701 over lead 2753, lead 2853, contact 2 of relay 3002, windings of steering relays 3001 and 3100 in series to battery, operating both relays preparatory to receiving code and numerical digit pulses. The operation of relay 3001 establishes a locking circuit for itself and a circuit for relay 3002 from the same ground through contact 3 of relay 3001, winding of relay 3002 to battery. The operation of 3001 extends ground from lead 2853 through its contact 2, windings of steering relays 3006 and 3105 to battery causing their operation. The operation of relay 3006 extends ground from lead 2853 through the windings of steering relays 3008 and 3113 which continues until all of the steering relays are operated successively responsive to the connection of ground to lead 2853. These steering relays are released successively responsive to successive digits transmitted.

Alternating current and direct current pulsing

It was previously explained that the trunk circuit signaling paths which are energized, indicate to the sender whether preparation should be made for receiving alternating current or direct current pulses for setting the registers of this sender. When relay 3304 is operated the sender is responsively arranged for receiving alternating current pulses and when relay 3305 is operated the sender is arranged for receiving direct current pulses. These relays operate either the alternating pulsing control relay 2805 or the direct current pulsing control relay 2804 with which the pulsing leads 2041 and 2042 from the toll position and trunk are connected. Relay 2805 is operated over lead 2841, contact 2 of relay 3304 to ground on contact 11 of relay 2400 or relay 2804 is operated over lead 2840, contact 2 of relay 3305 to ground on contact 11 of relay 2400. It should be noted that either relay 3304 or 3305 when operated is locked to this ground on contact 11 of relay 2400. Relay 3002 which is locked to ground on lead 2853 establishes circuits for mechanisms associated with either the alternating current pulsing circuit of the sender or the direct current pulsing circuit of the sender depending upon whether relay 2805 or relay 2804 has been operated. Leads 3041 and 3042 connect ground from contacts 3 and 4 of relay 3002 traced through sheets 29 and 28 where lead 3041 extends through the winding of direct current pusling relay 2702 and contacts of other direct current relays to the tip pulsing lead 2041 if the direct current pulsing relay 2804 has been operated. Lead 3042 extends through the winding of direct current pulsing relay 2703, contacts of other relays to the ring pulsing lead 2042 if relay 2804 has been operated. The method of pulsing by direct current will be described in a separate paragraph. With the alternating current relay 2805 operated the pulsing leads 2041 and 2042 are connected to the receiving circuit input coil 3200 and a circuit is established for relay 2803 when relay 3002 is operated.

Sender registers set by direct current pulses

Let it be assumed for this part of the description that relay 2804 has been operated and therefore that direct current pulses are used for setting the sender registers. Relay 2703 is operated from ground supplied from the contact 6 of relay 3000, contact 3 of relay 3002 over lead 3042 which extends through the winding of relay 2703 to the ring conductor 2042 to battery in the direct current pulsing key-set not shown. This key-set may be substantially the same as shown in the aforementioned Patent 2,236,246 to King et al. and other key-sets shown in the art for operating the registers of a sender of cross bar telephone systems. Relay 2703 is locked to battery through its contact 2. Ground is also connected through contact 4 of relay 3002 over lead 3041 to the winding of relay 2702 which under certain conditions has an operating circuit to battery on tip lead 2041. This relay is operated when a call originates in certain switchboards in order to indicate to a marker that the call is from this switchboard over a long trunk. Both relays 2703 and 2702 otherwise serve the same function of connecting the windings of relays 2404 to 2409, inclusive, to the leads 2041 and 2042 from the pulsing keys. The pulsing keys transmit positive and negative potential through low and high resistances over either the tip lead 2041 or the ring lead 2042 or in different combinations over both of these leads for operating relays 2404 to 2409 individually or in combinations to set the sender registers as designated in the following table.

Key	T-lead 2041	R-lead 2042	2408	2409	Relays 2406	2407	2404	2405
0	L+		X					
1	H+		X		X			
2 ABC	L−		X				X	
3 DEF	H−		X		X		X	
4 GHI	L+	L−	X	X				X
5-J JKL	L+	H+	X	X		X		
6-M MNO	H+	H+	X	X	X	X		
7-R PRS	L−	H+	X	X		X	X	
8 TUV	H−	H+	X	X	X	X	X	
9-W WXY	L+	H−	X	X		X		X
ST	H+	L−	X	X	X			X

H+ indicates direct ground.
L+ indicates high resistance ground.
H− indicates low resistance battery.
L− indicates high resistance battery.
X indicates the relay operated.

Assume that the number to be registered is CH3—1378. The letter C is the same as the numeral 2 and the depression of the 2 key will connect 48-volt negative potential to conductor 2041 to operate relay 2408 and polarized relay 2404. Relay 2408 operated connects ground to lead 2467, contact 3 of relay 2701, lead 2740, contact 2 of relay 3100, lead 3130 to a winding terminal of relay 3001 which places a shunt on the winding of the latter relay to cause its release. This ground acts as a locking ground for relay 3100 which holds the latter relay operated. The operation of polarized relay 2404 connects ground to lead 2469 which extends through contact 4 of relay 2701 to lead 2742, contact 4 of relay 3100, lower winding of the No. A2 register relay 3102 operating this register relay which locks to ground

on contact 5 of off-normal relay 3000. The release of the No. 2 key releases relays 2408 and 2404. The release of relay 2408 removes the locking ground for relay 3100 which releases. The release of relay 3100 transfers the pulsing relay leads from the A register relays 3101 to 3104 to the B register relays 3106 to 3109 since the progression relay 3105 has already operated in unison with the steering relays shown in the left portion of Fig. 30.

The operator depresses key 4 to register the code digit H immediately after the 2 key has been released. This connects positive potential through a high resistance to the tip lead 2041 and negative potential through a high resistance to the ring lead 2042 which operates relays 2408, 2409 and 2405 as shown in the table. Ground connected to lead 2740 by relays 2408 and 2409 shunts down relay 3006 and holds relay 3105. Ground from the contact of relay 2405 is connected to lead 2745 which extends through contact 5 of relay 3100, contact 6 of relay 3105, lower winding of the B4 relay 3108 to battery operating the latter relay which locks to ground on contact 5 of relay 3000. The steering relays are progressively released as the digits are registered and thus the register relays for code and numerical digits are successively operated in the above manner.

When the operator has finished the key pulsing operation she depresses a start key which connects positive potential through a low resistance to the tip lead 2401 and negative potential through a high resistance to ring lead 2042 to operate relays 2408, 2409, 2406 and 2405. The operation of relays 2406 and 2405 connects ground to leads 2741 shown connected to lead 3441 and to lead 2745 shown connected to lead 3495 which operates relay 2609. Relay 2609 operates only when both the upper and lower windings are energized as in the circuit traced from ground on the contacts of relays 2406 and 2405 and either of these relays operated alone will not cause the operation of relay 2609. At this time the steering relay 3506 remain operated and the other steering relays have been progressively released as the digits were registered. The operation of relays 2406 and 2405 therefore cause the operation of start registers 3508 and 3509 since ground is connected to leads 2741 and 2745 which extend through the contacts of the released steering relay to contacts 3 and 4 of relay 3506 and the lower windings of relays 3508 and 3509 to battery. Returning to the operation of relay 2609 it is apparent that this relay only remains operated while relays 2406 and 2405 are operated and then releases. The operation of relay 2609, however, establishes a circuit for relay 2610 which locks over lead 2655 which extends to ground on contact 8 of relay 2400. The purpose of operating relays 2609 and 2610 in the manner described is to provide an operating path for relay 2800 after the pulses for all digits have been received by the sender and pulse relays 2406 and 2405 have released for the last time. The circuit for relay 2800 extends from the locking ground for relay 2610, back contact of relay 2609 released, lead 2642, contact 1 of relay 2804, contact 3 of relay 2704, winding of relay 2800 to battery. The operation of relay 2800 connects relay 2801 to the tip conductor 2041 and relay 2802 to the ring conductor 2042. At this time these conductors terminate in polarized relays associated with the key pulsing key-set which are now operated as a signal that the sender has satisfactorily registered the digits. The operation of these polarized relays connects ground to the tip and ring leads 2041 and 2042 which causes the operation of both relays 2801 and 2802 which close a circuit for operating relay 2704 which locks to ground on lead 2642, releases relay 2800 and connects resistance 2715 and condenser 2716 across the tip and ring conductors. A signal is thus given the operator that the sender has responded to the signals sent from the operator's position circuit.

The seizure of a marker and the operation of the sender responsive to the seizure of a marker will be described after a description is given of the methods used for setting the sender by the transmission of alternating current pulses from a key-set as shown in the operator's position circuit, Fig. 11. However, the manner of connecting the sender to a marker and the operation of the code registers of the marker may be assumed as substantially the same as fully described in Patent 2,283,395 to W. B. Strickler, May 19, 1942. The operation of an outgoing sender may be assumed as substantially the same as fully described in Patent 2,293,191 to A. J. Busch et al., Aug. 18, 1942.

Sender registers set by alternating current pulses

The sender (Figs. 23 to 35) may be set by alternating current pulses when associated with a toll operator's position equipped for sending pulses of different frequencies which may be of the character shown in Figs. 8, 9, 10, 11 and 15. The cord circuit and position mechanism associated with the alternating current supply system shown in Fig. 15 is part of the equipment for a call order switchboard position. Alternating current pulsing equipment of substantially the same character may, however, be located in an outward toll operator's position in a different office arranged for connection with the senders of this office over an incoming trunk circuit, such as shown diagrammatically herein. In the following description the association and operation of the cord and position equipment will be given and also the manner of operating the signal current supply circuit (Fig. 15) will be described. The signals as transmitted from the signal current supply circuit (Fig. 15) by the operation of keys in the key-set to the receiving circuit (Fig. 32) and the operation of this receiver circuit will be necessary for a complete understanding of the association of this mechanism with the sender (Figs. 23 to 35). The responsive operation of the sender to the alternating current signals transmitted by the key-set will be given following the description of the transmitting and receiving mechanisms.

Operator's position circuit

When the call order board operator's position is occupied ground is connected to lead 838 from the contact of relay 900 and therefore the operation of key 803 establishes an operating circuit for relays 802 and 815. Key 803 is operated for establishing a connection with a sender after plug 820 has been inserted in trunk jacks such as jacks 2025 and 2026. Relay 901 in the operator's telephone circuit (Fig. 9) is energized from battery through its winding, lead 839, contact 2 of key 803, contact 7 of key 815, contact 1 of relay 803 to ground on lead 838. The operation of relay 901 connects ground through its contact 1 to lead 832 which establishes a locking circuit for both relays 802 and 815. At this time the circuit is extended from ground through the lower high resistance winding of trunk relay 2000 over the sleeve conductor, contact 4 of relay 815, lead

850, upper winding of relay 1012, winding of relay 1009 to battery. Relays 2000 and 1009 operate in the circuit traced but due to the higher resistance of the lower winding of relay 2000 relay 1012 does not operate at this time. Relays 1012 and 1011 are biased to give marginal operation. The operator now energizes key 1111 which establishes circuits for relays 1103 and 1113. The circuit for relay 1113 may be traced from battery through its winding, contact of key 1111, contact 5 of relay 1009, contact 1 of relay 1016 to ground on contact 1 of relay 1100. The circuit for relay 1103 extends from battery through its winding, thence through the contact of key 1111 to ground on contact 1 of relay 1100 over the circuit traced for operating relay 1113. The operation of relay 1103 lights lamp 1104 over an obvious circuit through contact 6 of the relay. Relay 1103 in operating locks through its contact 3, contact 3 of relay 1115, contact 7 of relay 1103, contact 5 of relay 1009, contact 1 of relay 1016, to ground on contact 1 of relay 1100. Relay 1113 in operating also is locked through its contact 2, contact 3 of relay 1112 and thence to ground through contact 7 of relay 1103 as previously traced. The operation of relay 1113 opens the circuit for lamp 1114 through its contact 1. It should be noted at this time that the contact of relay 1012 is at this time connected through contact 8 of relay 1103, contact 3 of relay 1113, winding of relay 1112 to battery. Relay 1012 is not, however, operated until an idle sender has been selected and the mechanism of the sender is in readiness for receiving signals for setting the registers. The operation of relay 1103 connects leads 847 and 848 from the trunk circuit through contacts 4 and 5 of relay 1103 to windings C and D of repeating coil 1106. Lead 1132 is also extended through contact 2 of relay 1103 to a point between the C and D windings of repeating coil 1106.

At this point in the operation of the switchboard position mechanism a signal from the sender is required to assure the position mechanism that an idle sender is in readiness to receive alternating current pulses. It will be remembered from the previous description in connection with the operation of the sender when associated with the direct current pulsing mechanism that the trunk circuit actuates a link start circuit in order to select an idle sender. This start circuit is energized when relay 2000 operates after the operator has connected plug 820 with jacks 2025 and 2026. The operation of relay 2000 establishes a circuit for relay 2020 which connects ground from contact 5 of relay 2021 through contact 4 of relay 2020 to the start circuit 2040. As previously described, this start circuit energizes the link and actuates a link control circuit as fully described in Patent 2,236,246 to V. B. King et al., March 25, 1941. As related in the previous description of the sender a number of relays are energized when the link selects this sender. This includes relays 2400, 2401, 2403, 2402, which cause the connection of the trunk circuit (Fig. 20) with the sender through the link switches and cause the dismissal of a link control circuit which operated to select the sender. The off-normal relays of the sender such as relays 2502 and 3000 are operated as soon as the sender is connected with the trunk circuit and thereafter other relays are operated as previously described depending upon the class of trunk associated with the sender. In this instance, it may be assumed that class relay 3304 is energized since the sender is associated with a trunk and operator's position circuit which are arranged for alternating current pulsing signals and that the operation of relay 3304 established a circuit for the alternating current pulse relay 2805 from battery through its winding, lead 2841, contact 2 of relay 3304, to ground on contact 11 of relay 2400. Relay 2805 connects the tip and ring conductors 2041 and 2042 extending from the operator's position circuit through the trunk, to the receiving circuit (Fig. 32). It will be remembered in the previous description that relays 2701 and 2706 are energized as soon as the class of trunk registrations have been transmitted to the sender. The operation of relay 3304 also establishes a circuit for relay 2611 from ground through contact 5 of relay 3305, contact 5 of relay 3304, thence over lead 2666, winding of relay 2611, to battery. Previous to this time relays 2612 and 2613 were operated when the sender was seized, also as previously described. The operation of relay 2611 connects lead 2461 extending from the winding of relay 2403, contact 3 of relay 2611, contact 4 of relay 2613, contact 2 of relay 2612, lead 2464 to ground on contact 2 of relay 2402. This therefore short-circuits the upper winding of relay 2403 and resistance 2413 and in consequence connects ground directly through the lower winding of relay 2403 over lead 2760, contact of relay 2708, lead 2460, contact 3 of relay 2400, lead 2454, winding of relay 2018 to battery which causes the operation of relay 2018. Relay 2018 in operating establishes a circuit from ground through its contact 3, winding of relay 2022, to battery, operating the latter relay and the latter relay locks to ground on contact 2 of relay 2020. The operation of relay 2022 establishes a circuit from ground through its contact 1, contact of relay 2004, resistance 2027, upper winding of relay 2000, thence over the trunk sleeve conductor, contact 4 of relay 815, lead 850, upper winding of relay 1012, winding of relay 1009 to battery. Since the resistance of the circuit through the upper winding of relay 1012 has been reduced by the foregoing operation, this relay operates and associates ground through its contact, contact 8 of relay 1103, contact 3 of relay 1113, winding of relay 1112, to battery, operating the latter relay. Relay 1012 also connects ground through resistance 1030 to lead 851 for lighting the cord circuit lamp 812 as a signal that the sender is now prepared to receive the alternating current pulses for setting the registers. Relay 1112 connects two leads 1134 and 1135 from the alternating current signal circuit (Fig. 15) through its contacts 1 and 2 to windings A and B of coil 1106. The key pulsing start signals are immediately transmitted through windings C and D of repeater coil 1106 and thence over tip and ring conductors 847 and 848 through the cord circuit and trunk circuit, thence over leads 2041 and 2042, contacts 5 and 6 of sender relay 2805, leads 2842 and 2843, to the receiving circuit input transformer 3200 to prepare the receiving circuit for the alternating current digit pulses successively keyed thereafter. In this manner alternating current of two frequencies, 1100 cycles and 1700 cycles, are transmitted to the input transformer 3200 for setting the receiving circuit, as will be later described. The manner of transmitting combinations of alternating currents of two frequencies over these leads will also be described. The operation of relay 1112 opens

the locking circuit for relay 1113 which extended through contact 3 of relay 1112. Relay 1113 is, however, slow to release in view of the fact that resistance 1110 is in shunt with its winding. The time of release of relay 1113 insures the operation of the sender receiving circuit mechanism before causing the release of relay 1112. The locking circuit of relay 1113 is opened through contact 3 of relay 1113 which opens the signaling leads 1134 and 1135 described as extending through the receiver circuit of the sender. Signal lamp 1114 is thus lighted since a circuit for this lamp is established through contact 1 of relay 1113, contact 4 of relay 1112, contact 7 of relay 1103, thence through contact 5 of relay 1009, contact 1 of relay 1016, to ground on contact 1 of relay 1100.

The lighting of lamp 1114 is a signal to the operator that the sender mechanism has operated and associated the receiving circuit with the operator's position mechanism and therefore that the system thus associated together is in readiness for the transmission of alternating current signals from the operator's key-set 1108 for setting the registers of the sender. The operation of each key in the operator's key-set 1108 transmits current of two frequencies from the frequency mixing coils 1586 to 1597 depending upon the key energized. The numerical value of each key is shown on the key which has its equivalent in code letters according to a table which will be presented. Before proceeding further, the following description is given of the signal current supply circuit for alternating current key pulsing shown in Fig. 15.

Signal current supply circuit

Referring to Fig. 15 the theory of oscillator operation for the alternating current supply circuit is as follows: Referring as an example to the oscillator which is the source of 700 cycle frequency alternating current, the general theory of operation of the bridge type oscillator used in this circuit will be described as follows: The oscillator consists of a vacuum tube 1563 which is arranged in the circuit to function as a high gain pentode tube. The usual filament and plate battery supplies are provided, together with a frequency and amplitude controlling bridge. Two arms of the bridge are formed by the left windings of the output transformer 1568 which transformer, incidentally, affords a low impedance output, terminated in jacks for testing. The third arm is the resistance 1569 which is mounted in the same unit with varistor 1566. The fourth arm is an anti-resonant circuit consisting of retardation coil 1567 and condenser 1565 in parallel which are different for each oscillator. A part of the inductance of coil 1567 is shunted by the thyrite varistor 1566. A blocking condenser 1564 and a grid leak 1561 are provided to isolate the grid of the tube from the direct current component of the plate voltage. The impedance presented by the arm of the bridge consisting of retard coil 1567, condenser 1565 and varistor 1566 depends upon both the frequency and the amplitude of the voltage across the arms. At the frequency of anti-resonance this impedance is a pure resistance slightly larger than the resistance in the opposite arm consisting of the resistance unit mounted with the varistor. For frequencies above or below the anti-resonant frequency, it is respectively a capacity or an inductive reactance of a magnitude becoming smaller as the frequency departs farther from anti-resonance. The thyrite varistor 1566 makes this impedance responsive also to amplitude variations. For low voltages, the varistor has a very high effective resistance but its value decreases rapidly as the amplitude of the voltage is increased. Taps are provided on inductance 1567 to allow adjustment of the resultant "damping" of the anti-resonant circuit. These effects of frequency upon the phase angle of the impedance near anti-resonance, and of amplitude upon the magnitude of the anti-resonant impedance are used as described below to stabilize the frequency and amplitude of the oscillations.

Because of the high gain of the pentode tube the grid swing needs to be only a volt or two (depending upon the external load) to give the normal signal amplitude of 103 peak volts between the plate and ground. Thus the bridge operates quite close to balance and is very sensitive in its controlling functions. For example, suppose an external load is drawn from the circuit between plate and ground. This load might be expected to diminish the voltage amplitude at the plate. A very slight drop, however, increases the resistive unbalance of the bridge and thus provides enough grid excitation to supply the load current. It follows that within the power limitations of the tube the voltage amplitude at the plate is practically independent of load. For similar reasons it is quite independent also of battery supply voltages and of tube emission so long as these quantities are adequate to supply the required output without tube overloading.

In addition to load regulation and frequency and amplitude stability, another property of these oscillators is important since it facilitates the mixing of the frequencies in pairs as shown. Each output coil is supplied with its two frequencies by bridging a mixing coil such as 1586 to 1597 between the plates of the appropriate oscillators. This arrangement requires that each oscillator not only supply its own load current but also bypass to ground the load currents of other frequencies which pass through the mixing coils 1586 to 1597. In fact, it may readily be seen that the sum of all by-pass currents through any one oscillator is equal to its own generated output current (peak values to be used in both cases). In order that crosstalk at all six frequencies shall not appear in objectionable amounts, the oscillators must effectively present low impedances to these by-pass currents. The manner in which they do this is readily explained. Suppose the current which is to be by-passed flows in from the load producing a small voltage drop across whatever impedance to ground is offered by the oscillator. This voltage at terminal T of the inductance coil has a frequency well removed from the anti-resonant frequency and thus encounters a low reactance through the anti-resonant circuit. The point represented by terminal S of the inductance coil receives nearly the same voltage which in turn is applied to the grid of the tube. This grid voltage induces the tube to conduct from plate to cathode a current equal to that flowing in from the load. This transmission of the unwanted current through the tube at the expense of only enough voltage drop to energize the grid may be expressed as an effective low impedance to ground. This makes possible the efficient use of power capabilities of the tube, eliminating mismatches or pads

between oscillators and load which would otherwise be required in order to prevent crosstalk.

Two of the output leads **1580** to **1585** are connected to each mixing coil **1586** to **1597** to provide a plurality of different combinations of two frequencies each for transmitting signals of two different frequencies for registering the numerical value of each code.

Key-set

The leads from the mixing coils **1586** to **1597** inclusive extend to the alternating current key-set circuit Fig. 11 for use by the operator in setting registers and to all of the senders of the office for transmitting alternating current pulse signals as shown in the out pulsing circuit, Figs. 29 and 34 of the sender. The use of this source of alternating current of different frequencies will be understood as the connecting circuits are described. The following frequencies are used as an example for signals as given in the table below:

0	700n, 900n
1	700n, 1300n
2	900n, 1300n
3	1300n, 1500n
4	900n, 1500n
5	1100n, 1300n
6	700n, 1100n
7	900n, 1100n
8	1100n, 1500n
9	700n, 1500n

The keys of the key-set **1108** corresponding to the code and numerical digits desired are depressed and send out alternating current signals which consist of different combinations of frequency for each digit as shown. The receiver associated with the sender responds to these signals and causes the code and numerical registers in the sender to be operated as will be described. Before describing the effect of the currents of different frequencies upon the receiving circuit, the operation of the transmitting circuit may be completed by stating that after the code and numerical digits have been transmitted by the operation of a number of keys in the key-set, the operator actuates key **1117** which operates relay **1115** to indicate to the receiver that all code and numerical digits have been transmitter. Relay **1115** in operating locks to ground on contact 1 of relay **1100** as previously traced through contact 7 of relay **1103**. Thus a last combination of current frequency 1500 cycles and 1700 cycles is connected over leads **1136** and **1137** to windings A and B of repeating coil **1105** and are transmitted to the input coil **3200** of the receiving circuit as traced. It will be remembered that the locking circuit for relay **1103** extended through its contact 3 and the contact of relay **1115**. Relay **1103**, however, remains operated while the key **1117** is operated since with this key operated a locking ground is associated through the key contacts and contact 3 of relay **1115** operated, but when this key is released the circuit for relay **1103** is opened causing its release. Since the locking circuit for relay **1115** extends through contact 7 of relay **1103**, the circuit for **1115** is opened shortly after key **1117** is released. The release of these relays is somewhat slow due to the shunt of resistance **1116** on the winding of relay **1103** and consequently the signal current over keys **1136** and **1137** is sustained for a sufficient time to energize the receiving circuit mechanism. The release of relay **1103** restores the position circuit mechanism to normal.

Receiving circuit associated with a sender

When a sender having an alternating current key pulsing receiving circuit associated with it is seized and the call requires the use of the receiving circuit, the sender by operating relay **2805** cuts the "T" and "R" leads **2041** and **2042** through to the trunk and connects battery to the leads **2846**, **2845** and **2844**. Battery over the lead **2846** energizes the bias windings on relays **3261**, **3267** and **3266**. It is also connected to resistances **3244**, **3247**, **3250**, **3253** in preparation for the subsequent operation of the relays **3261**, **3266** and **3267**, and for changes in the screen grid voltage to vacuum tubes **3239** to **3242**. Battery over the lead **2844** energizes the operate (primary) winding of relay **3260**, but the relay remains released because its secondary winding is energized from battery over a path to ground via its contacts, contacts 5 on relay **3270**, contacts and armatures of relay **3255**. The lead **2844** is also connected to the windings of relay **3270** and **3269** in preparation for their subsequent operation. Battery over lead **2845** is connected through the windings of pulse timing relay **3300**, the action of which will be described in connection with sender operations for setting the registers.

Input circuit

The input repeating coil **3200** is a well balanced, shielded coil that is provided to reduce the effect on longitudinal currents, which might cause false operations of the receiving circuit. It is provided with optional wiring arrangements (not shown) which may be wired in different manners depending upon the type of circuit with which the receiving circuit is associated.

The input pad comprising resistances **3201**, **3202**, **3203**, **3204** and **3205** is a means for adjusting the sensitivity of the receiving circuit to the minimum required by the circuit associated therewith, since by keeping the sensitivity as low as possible the likelihood of false operation on speech or noise currents is materially reduced.

By computation from the trunk design data, or by measurement under worst conditions, the maximum attenuation may be determined for all of the types of trunks over which the receiving circuits will have to operate. When making these computations or measurements, the repeating coil at the receiving end should not be included.

Resistances **3206** and **3207** supply a termination for the trunk. It also affords a balanced midpoint to which ground is connected to assist in the removal of longitudinal currents.

Volume limiter

Vacuum tubes **3217** and **3218** and their associated input and output circuits constitute a volume limiter which provides adequate amplification of the alternating current pulses to cause operation of the individually tuned receiving circuits which will herein be known as channels, and which also limits the amplification to such a value that undesired channels will not operate on the transient currents which are generated when the alternating current signals start and stop and when they build up and die down in the filters. The amplification is limited to a lower value at the start of the pulse than at the end, since if chatter of the contacts in keying the signals of different frequencies at the sending end is encountered, the starting transients are

abnormally high. How this reduction of the limited output is accomplished will be explained under the signal present circuit.

The limiting action is obtained by means of the control grid networks 3209 and 3210 which cause the grid bias to become more negative when the alternating current on the grids becomes large enough to cause them to draw current during the positive half waves. When this condition is reached the power output becomes approximately constant regardless of further increases in the grid voltage. The actual point at which limiting occurs is controlled by the voltage on the screen grids and on the cathodes as well as by that on the control grids. The desired value for the screens is obtained from the potentiometer 3280. The potential on the cathodes is obtained from battery through the repeat coil 3211 and a potentiometer arrangement of the resistances 3212, 3213, 3214, 3215 and 3216.

Signal present circuit

The signal present circuit is actuated by the small voltage developed across resistances 3221 in the volume limiter output circuit. This voltage is passed through resistance 3222 and the high-pass filter 3228 which is provided to suppress low frequency noise and speech currents which might cause false operations. The resistance 3222 is connected in series with the filter input in order to build out its terminating impedance to the proper value. The voltage output of the filter, stepped up by the input transformer 3230 is applied to the vacuum tube 3219, which functions as a rectifier by virtue of the resistance 3281 in its control grid circuit. Relay 3259 has its secondary, or bias, winding connected in the plate circuit of the tube, while its primary, or operate, winding is energized by battery through the repeating coil 3211. When there is no alternating current signal present on the grid of the vacuum tube, the plate current flowing through the secondary of the relay is sufficiently large to overcome the effect of the current in the primary and the relay remains normal, but when an alternating current signal appears, the plate current is reduced and relay 3259 operates.

The control grid of the vacuum tube 3219 is held positive in the normal condition by voltage obtained from the potentiometer made up of resistances 3235 and 3236. This positive bias, together with the reduced screen grid voltages obtained by the use of resistances 3282 in the lead to the screen, improves the operation of the circuit and reduces the effect of tube variations. Condenser 3283 is provided to by-pass the alternating current around resistance 3282.

As previously pointed out the limited output of the volume limiter is reduced to a lower value at the beginning of the signal pulse than at the end. This is done in the following way: With the relay 3259 resting on its back contact ground is connected to lead 3284 which increases the voltage drop across resistance 3222. This effectively lowers the plate and screen voltages applied to the limiter tubes which reduces the output of the volume limiter. This also causes an undesired reduction of the non-limiting amplification of the volume limiter, which in turn would reduce the sensitivity of the signal present channel unless corrected. To compensate for this reduction on sensitivity the effective grid bias on the tube 3219 is decreased by an amount sufficient to bring its sensitivity back to normal. Ground on lead 3284 from the back contact of relay 3259 causes an increased voltage drop across resistance 3285, reducing the bias on the tube 3219, and thus increasing its sensitivity. Once relay 3259 leaves its back contact, both the volume limiter and the channel start to return to normal after the short interval required to charge condenser 3286. The rise in limited output of the volume limiter is sufficiently gradual to prevent objectionable transients.

The plate circuit filter consisting of retardation coil 3287 and condenser 3288 serves two purposes: (*a*) it reduced modulation products which might cause the relay 3259 to chatter; and (*b*) it slows up the operate and release times of the relay by delaying the dying down and building up of the plate current in the vacuum tube.

The front contact of relay 3259 goes to the sender or other associated circuit, via lead 3290. The operate (primary) windings of the channel relays 3255, 3256, 3257 and 3258 are also connected to the sender, or other associated circuit, over lead 3291, and since these leads are connected together in the sender at this time, the operation of relay 3259 prepares the operating path for the channel relays. Later, after each digit registration has been completed, the path between leads 3290 and 3291 is opened in the sender or other associated circuit; and if relay 3259 is still operated, further pulsing is blocked by holding this path open until relay 3259 releases and removes ground from lead 3290.

Receiving channels

Six receiving channels A, B, C, D, E and F are used for receiving the signals of six different frequencies from the transmitting mechanism of Figs. 11 and 15. Four of these channels are shown, A, B, E and F. Channels C and D are omitted excepting the channel relays 3272 and 3273 which are diagrammatically shown.

The voltage developed across resistance 3226 is passed through the resistance networks 3223, 3224 and 3225 to the inputs of filters 3227, 3229, 3231, 3232 and other filters for other receiving circuits or channels not shown, which separate the signaling frequencies into channels corresponding to bands of currents of different frequencies. The compensating filter 3289 is provided to improve the characteristics of the 700 and the 1700-cycle filters by simulating the effect which would be produced by adjacent filters below and above them, respectively.

The resistance network ahead of the filters serves a threefold purpose: (*a*) it provides attenuation to afford the desired relationship between the channel sensitivity and the output of the volume limiter, (*b*) it affords a relatively constant impedance termination between the filters and the widely varying output impedance of the limiter; and (*c*) it attenuates transients reflected from the filters.

Each receiving circuit contains a pentode vacuum tube, each of which is provided with a control grid resistance such as 3233 to make the tube function as a detector. The control grids are held positive, and the screen grid resistances such as 3243 and the associated screen grid bypass condensers are provided, to improve the operation of the circuit and reduce the effect of tube variations. The channels contain pulsing relays, designated 3255, 3256, 3257, 3258.

The circuit is so arranged that after the signal has been received over leads 1134 and 1135 the pulsing relays lock operated under joint control

of the sender or other associated circuit and relays **3259** and **3267**.

Receiving circuit lock

The locking action is obtained by means of the vacuum tube circuits. When a channel relay operates, after the plate current flowing through its bias winding has been reduced sufficiently by the incoming alternating current signal, it connects the screen grid of its associated tube to a potentiometer which supplies a much lower voltage than normal. This causes a further reduction in the plate current and prevents it from returning to normal at the end of the alternating current signal, with the net result that the relay is effectively locked up until its operate winding is opened. When two receiving circuit channel relays are operated in this manner they remain up until the sender or other associated circuit opens their operate windings after the digit has been registered; and by holding this path open in the sender or other circuit under the joint control of relays **3259** and **3267** in the receiving circuit the desired registration is obtained whether the incoming alternating current signals are of long or short duration.

The pulsing relays A to F designated **3258**, **3257**, **3273**, **3272**, **3256** and **3255** respectively, have their secondary windings connected in the plate circuits of the correspondingly designated vacuum tubes. Their primary windings are connected in series and obtain battery through repeating coil **3211**. The plate current flowing through the secondary windings of the pulsing relays is in the bias direction. The current in the primary windings is in the operate direction and is of such magnitude that it cannot normally overcome the bias current. When an alternating current signal is applied to the grid of one of the vacuum tubes, however, its plate current is reduced and the associated relay operates. The tertiary uppermost windings of the pulsing relays are also in series and go to the filtered battery from the winding of relay **3255** and to ground through contact of relay **3269** from the winding of relay **3258**. These windings supply a small additional bias to the pulsing relays when the receiver is prepared to receive digits or the signal over leads **1136** and **1137**, but not when it is waiting for the signal over leads **1134** and **1135**. This bias is necessary to insure the release of the relays after they have been locked up on digit codes in the manner just described.

Key pulsing unlocking signal

When the receiving circuit is cut through to a trunk or a key-set circuit at the beginning of a call, there is a brief period during which it may be exposed to speech or noise currents, which, if it were necessary to receive digit pulses, might cause false registrations in the associated sender or key monitoring circuit. To prevent this, the receiving circuit is normally held in a condition wherein digits cannot be registered until after it has been unlocked by the functioning of the signals over leads **1134** and **1135** when relay **1112** operates as discussed in connection with the key-set circuit. This signal is for a relatively long period and must be on for the required time without the presence of the other frequencies. These signals of 1100 and 1700 cycles frequency pass through the corresponding filters to the vacuum tubes and cause the operation of the relays **3273** and **3255**. With both relays operated, ground is removed from the bias winding (secondary) of relay **3260** and from condenser **3274**. Relay **3260** takes about 48 milliseconds to operate, due to the time required for the condensers to charge through the secondary winding of the relay. Upon the release of either relay **3273** or relay **3255** after relay **3260** has operated, ground is applied through its front contact and armature to the windings of relays **3269** and **3270** which operate from battery and lock.

Relays **3270** and **3269** perform the general function of transferring the front contacts of the channel relays A to F from the key pulsing circuit to the A to F leads **3292** to **3297** going to the associated sender, where subsequent operations of the A to F relays **3307** to **3312** in the proper combinations will be registered. Relays **3269** and **3270** also remove the grounds which were being supplied over their back contacts to the vacuum tube sides of resistances such as **3245** in each receiving circuit. With these grounds removed the locking action described and the operation of the checking relays described may take place. In addition, relay **3269** supplies ground to the uppermost tertiary windings of the channel relays A to F as previously discussed.

As previously indicated, it is necessary that signals of frequencies C and F be received for a definite length of time without signals of frequencies A, B, D, or E if the circuit is to unlock. If an impulse of one or more of these frequencies should appear at any time before relays **3269** and **3270** have operated, the corresponding channel relay or relays will operate and apply ground to the terminal of relay **3260** and to condenser **3274**. This restores the full bias current to the relay, releasing it immediately and allows the condensers to discharge rapidly in preparation for a new cycle, with the net result that the circuit remains in the locked condition until frequencies C and F appear by themselves for the necessary length of time.

Signal counting circuit

The alternating current key pulsing codes consist of various combinations of two frequencies sent simultaneously. In the receiving circuit each frequency finds a path through its corresponding filter to the grid of one of the A to F vacuum tubes, **3239** to **3242** being shown, and causes the operation of the associated A to F relay **3258**, **3257**, **3273**, **3272**, **3256** or **3255**. After the operation of relays **3269** and **3270** by a signal, the operation of one or more of the A to F relays has the following results: ground is applied to the corresponding leads **3292** to **3297** going to the sender or other associated circuit; and ground is removed from the vacuum tube sides of the corresponding screen grid resistances. Removing ground from these resistances: reduces the voltage on the screen grids of the associated vacuum tubes and locks up the relays and allows current to flow to the primary windings of the relays **3261**, **3266** and **3267** in an amount almost directly proportional to the number of A to F relays which are operated. Relays **3266** and **3267** cannot function until after the key pulsing signal has been sent over leads **1134** and **1135** because they are in effect short-circuited by the grounds from the back contacts of relays **3269** and **3270** until these relays operate.

The operate and bias currents for relays **3261**, **3266** and **3269** are so proportioned that none of them will operate when a single A to F relay operates; relays **3261** and **3267** will operate when two of the A to F relays operate; and all three operate when three or more of the A to F relays

operate. Relays **3261**, **3266** and **3267** therefore serve to check the incoming signals and to tell the sender or other associated circuit whether it should register a digit 0 to 9 and the final signal in accordance with the grounds on the A to F leads.

Relay **3267**, when operated, removes ground from lead **3298** and applies it to lead **3290** in parallel with ground from relay **3259**, when relay **3259** is operated. Relay **3261**, when operated, removes a short circuit from resistance **3262** and effectively adds this resistance in series with the operate windings of the channel relays A to F by inserting it in lead **3291**. Relay **3261** also supplies ground to lead **3299** via relays **3267** and **3302**.

With the primary windings of relays A to F **3258**, **3257**, **3273**, **3272**, **3256** and **3255** connected through resistance **3263** to ground, the circuit has its full sensitivity, but after relay **3261** operates and cuts in the resistance **3262**, the sensitivity is somewhat reduced. This is done to increase the protection against false operations on transients and cross-modulation which may appear in the unwanted channels.

As previously indicated, the path between the **3290** and **3291** leads is closed in the sender or other associated circuit at the start of each digit, and remains so until the sender or other circuit opens it upon the completion of registration, releasing the channel relays. Once this has occurred, the path remains open and the channel relays remain released until relays **3259** and **3267** both release and remove ground from lead **3290**. The ground from relay **3267** insures that the digit will be registered correctly on short pulses due to the fact that relay **3267** is held up by the locking of the A to F relays as described, while the ground from the relay **3259** insures that there is no double registration in case the incoming alternating current signals are held on longer than the time actually required for registration.

Relay **3266** is provided to allow the circuit to distinguish between correct digit signals, containing two frequencies only at a time, and erroneous signals made up of more than two frequencies. If three or more of the A to F relays should operate, the removal of ground from the vacuum tube sides of the corresponding resistances such as **3243** and **3245** will increase the current to the relays **3261**, **3267** and **3266** to the point where the bias current is insufficient to hold any of them released. Relays **3261** and **3267** function as described above, but they are ineffective because relay **3266** by removing ground from lead **3279** and applying it to lead **3278** tells the sender, or other associated circuit, that the received signal is incorrect.

The operation of a single channel relay by itself merely applies ground to the corresponding lead to the sender, or other associated circuit, where it does no harm because relays **3261** and **3267** have not operated. The removal of ground from the vacuum tube side of only one set of the screen grid resistances does not send enough current to relays **3261**, **3267** and **3266** to cause any of them to operate.

Guard or final signal

The signal over leads **1136** and **1137**, consisting of frequencies E and F 1500 and 1700 cycles is sent out after all the digit codes have been transmitted, but whether it serves any useful purpose or not depends upon the register arrangement provided in the sender or other circuit with which the receiving circuit is associated. In some cases the traffic is such that all calls involve the same number of digits and the sender or other circuit proceeds as soon as the full complement of digits has been received. In other cases the number of digits varies from call to call and it is necessary to indicate when all that are necessary have been registered. This signal serves this purpose, and although it is superfluous in the former case, it is always transmitted in order to avoid operating complications. When the sender or other circuit is arranged to accept this signal, the receiving circuit functions in the same way as on digit pulses except that it grounds the E and F leads **3296** and **3297**. When the sender or other circuit does not require the signal, arrangements are provided to prevent its reception in order that it may not interfere with the progress of the call. In either case battery and ground is subsequently removed to restore the receiving circuit to normal.

Sender registration

As the digit signals are successively transmitted by the toll operator by depressing keys in key-set **1108** according to the code and number for selecting an outgoing trunk and completing a telephone connection, the receiving circuits (Fig. 32) respond for operating two of the pulsing relays A to F upon each operation of a key. Two of relays **3307**, **3308**, **3309**, **3310**, **3311**, **3312** are operated responsive to the actuation of each key, depending upon the frequencies of the two signals transmitted. These relays are operated in the following combinations responsive to the operation of the keys and corresponding action in the receiving circuit which connects ground to leads as shown for operation of the sender registers associated therewith by the steering relays.

Digit	Relays operated	Leads connected to ground potential	Registers operated
0	3307, 3308	2740	
1	3307, 3310	2740, 2741	No. 1.
2	3308, 3310	2740, 2742	No. 2.
3	3310, 3311	2740, 2741, 2742	Nos. 1 and 4.
4	3308, 3311	2740, 2745	No. 4.
5	3309, 3310	2740, 2744	No. 5.
6	3307, 3309	2740, 2741, 2744	Nos. 1 and 5.
7	3308, 3309	2740, 2742, 2744	Nos. 2 and 5.
8	3309, 3311	2740, 2741, 2742, 2744	Nos. 1, 2 and 5.
9	3307, 3311	2740, 2744, 2745	Nos. 4 and 5.
Final	3311, 3312	2740, 2741, 2745	Nos. 1 and 4.

For controlling each pulsing time period relays **3300** and **3301** are provided. The operation of relay **2805** provides a circuit for relay **3300** from battery on contact 3 of relay **2403**, contact 2 of relay **2805**, lead **2845** through its upper winding, resistance **3302** to ground, and through its lower winding over contact of relay **3301**, lead **3298** and contact of relay **3267** to ground. This circuit holds the contact of relay **3300** closed. As previously set forth when relay **3259** in the signal present circuit operates, ground from its contact extends over lead **3290**, contact of relay **3300**, returning to the receiving circuit over lead **3291** to establish a circuit for the pulsing relays so that the ones selected by the keys in key-set **1108** may operate. Normally, as shown above, there are two channels of the receiving circuit actuated to operate two pulsing relays for each digit, which relays also establish circuits for relays **3261** and **3267** and transmit signals to two of the relays **3307** to **3312** as shown in the foregoing table. The operation of relay **3267** removes ground from lead **3298** extending through the lower winding of the pulse timing relay **3300**. A circuit is established for relay **3301** from battery through its

winding and contact, lead 3298, contact of relay 3261, lead 3291, contact of relay 3300, lead 3290, contact of relay 3267 to ground. Relay 3301 then locks over lead 3290 to ground on the contact of relay 3267. The operation of relay 3301 also opens lead 3298 extending to lower winding of the pulse timing relay 3300. When ground is removed from the lower winding of relay 3300 by the operation of relay 3267 condenser 3343 connected to this winding starts to charge, setting up an opposing circuit in the lower secondary winding of relay 3300 which neutralizes the current in the upper primary winding until the condenser 3343 is charged. The current in the lower secondary winding diminishes as the charge builds up in the condenser and, therefore, the energy in the upper primary winding becomes relatively stronger than the energy in the lower secondary winding and at this time the armature of relay 3300 is moved to open its contact. The relay combination 3300 and 3301 and the condenser 3343 are so designed that relay 3300 will not open its contact until sufficient time has elapsed for the operation of the register relays (Figs. 31 and 35) and the operation of the steering relays to advance the pulsing system to the next register. The pulse timing relays 3300 and 3301 release the pulsing relays in the receiving circuit which release the translator relays 3307 to 3312 and relays 3261 and 3267. The release of relay 3267 again places ground on the secondary winding of relay 3300 over lead 3298. This causes relay 3300 to immediately close its contact. Relays 3300 and 3301 are thus operated and released when the signals for each digit are received by the receiving circuit (Fig. 32) for controlling the timing of the circuits established for operating relays 3307 to 3312 and for the setting of the register circuits which are established by the relays 3307 to 3312.

As shown in the foregoing table, the combinations of two relays which are operated for the various digits connect ground to leads 2740, 2741, 2742, 2744 and 2745 extending to the registers and steering circuit shown in Figs. 30, 31 and 35. The steering circuit advances the leads from register to register after each register setting and thus the registers are set in the same manner as herein described under direct current pulsing. It will be remembered that these same leads are connected to the contacts of relays 2404 to 2409 which are operated by direct current pulses for setting the sender registers over these leads. In the different registers the No. 1 register relay is operated when ground is connected to lead 2741, the No. 2 register relay when ground is connected to lead 2742, the No. 4 register relay when ground is connected to lead 2745, and the No. 5 register relay when ground is connected to lead 2744. As shown in the foregoing table two of the above leads are connected to ground for digits 3, 6, 7, 9 and the final digit, and three leads are connected to ground for the digit 8.

Marker selection

In describing the setting of the registers (Figs. 31 and 35) by direct current pulses it was set forth that the connection of ground to lead 2853 by relay 2701 causes the operation of all of the steering relays 3001, 3100, 3006, 3105, 3008, 3113, 3010, 3500, 3012, 3506 and all intermediate steering relays not shown and that these relays are successively released in pairs as each digit is registered. The release of a predetermined number of steering relays establishes a circuit for relay 2508 to obtain the services of a marker, this circuit being established according to the number of digits used for the code. A circuit for marker start relay 2508 is shown extending from both relays 3105 and 3113 to show the method of establishing this circuit over either lead 3132 or 3133, depending upon the arrangement used. Assuming that the circuit for relay 2508 is established upon the release of steering relay 3113, it may be traced as follows. Battery through the winding of relay 2508, lead 2551, contact 1 of relay 3506, contact 2 of relay 3105, lead 3133, contact 3 of relay 2300, contact 3 of relay 2305, lead 2342, contact 2 of relay 3407, lead 3450 to ground on contact 8 of off-normal relay 3000. The operation of relay 2508 releases relay 2506 which was previously operated to ground over lead 3450 to contact 8 of relay 3000. The operation of relay 2508 also establishes a circuit for relay 2500 from battery through the winding of the latter relay, lead 2552, contact 1 of relay 2603, lead 2643, contact 3 of relay 2508, contact of relay 2506, contact 1 of relay 2403, contact 1 of relay 2410, to ground. Relay 2500 connects battery from its contact 1 to the marker connector through contact 4 of relay 2501, lead 2553, contact 1 of relay 2602, contact 1 of relay 2601, to the connector start lead 2645. The sender has access to two connectors, a preferred connector and an alternate connector between the sender and the marker selecting mechanism. If the preferred connector is busy, relay 2601 is operated and the sender automatically uses the alternate connector by associating battery with lead 2646 instead of lead 2645. A connector of this character is disclosed in Figs. 73 and 74 of Patent 2,236,246 to G. V. King et al., March 25, 1941 between the sender and the marker described in this patent. A connector having alternate channels of the character used with this sender is also specifically described in Patent 2,241,016 to G. V. King et al. May 6, 1941. The latter patent illustrates in detail the manner of associating ground in the connector with lead 2647 for operating relay 2601 to battery through contact 2 of relay 2508 and resistance 2507. This immediately gives the sender access to a marker over the auxiliary channel. Upon the selection of a marker, ground is connected to lead 2765 which operates relay 2707 to connect class registration leads 2757 to 2759 from the trunk through the sender to the marker for recording the character of the trunk in the marker. After the class information is registered by the marker, relay 2707 is released.

A call initiated by the call order board operator using the trunk Fig. 20 would have operated relay 3400 as previously described and therefore leads 3440, 3441, 3442 and 3443 are now connected to the marker. Lead 3440 extends ground from contact 1 of relay 2803 which was operated by the trunk circuit to give a long trunk indication. Lead 3441 is for TX call control. Lead 3443 is used by the marker as later described to control the sender mechanism for alternating current out pulsing to a distant office and lead 3442 connects ground to the marker call order relay designated 307 in Fig. 3 for operating this relay to restore the normal functions of the route relay when a trunk code for a group patched for delay call order connection is registered. The code registered in the sender is transferred to the marker in the manner fully disclosed in the aforementioned Patent 2,283,395 to W. B. Strickler. As set forth in this patent, as many as five code registers may be set in the sender but only three registrations are transferred to

the three registers of the marker for the office code. A three-digit office code may be registered in sender registers A, B and C and transferred to the A, B and C registers of the marker. A four-digit code may be registered in the A, B, C, and D registers of the sender and the registrations of the sender registers B, C and D transferred to the marker, with the A registration giving a signal to the marker that a four-digit code has been registered. TX toll calls are registered on five registers in the sender, the first two registers being one and one. Thus the registrations from the A and B sender registers transmit a signal to the marker that a TX code has been registered. The registrations on sender registers C, D and E are transferred to the three registers of the marker. In response to the registrations and signals received by the marker a route relay is operated or controlled as herein described in connection with Figs. 3, 4 and 5 or as disclosed in Patent 2,236,246 to King et al. The registering mechanism for operating the route relays is shown in Figs. 46, 58, 59 and 60 of the latter patent and the route relays are shown in Figs. 47 and 48. Registers are shown in Fig. 6 of the aforementioned Strickler Patent 2,238,395 along with control relays for three-digit, four-digit and five-digit registrations in the sender, relay **618** being operated for a three-digit registration in the sender, **617** for a four-digit registration in the sender, and **616** for a five-digit or TX registration in the sender.

Signals from marker to sender

After the marker has determined from the code registered what type of outgoing call is required and the route relay has been operated, signals are returned to the sender to govern further operations in the sender. The marker transmits this information to the sender by connecting ground to leads according to the following table to operate corresponding relays which are given in this table:

Lead grounded	Relay operated	Type of call
2545, 2861	2501, 2810	Manual call.
2545, 2861, 2546	2501, 2810, 2503	Manual call, long outgoing trunk.
2545	2501	Full selector call, direct current out pulsing.
2545, 3443	2501, 2913	Full selector call, alternating current out pulsing.
2545, 2546	2501, 2503	Full selector call, long outgoing trunk.

Outgoing trunk

Let it be assumed for the sake of the following description that the marker received a code for selecting an outgoing trunk arranged for alternating current pulsing to a distant office having a sender therein arranged to receive alternating current pulses. The marker therefore will connect ground to leads **2545** and **3443** for operating relays **2501** and **2913** according to the above table. A marker for this type of selection is diagrammatically shown in Fig. 21 as marker **2110**. This marker selects a trunk according to the registrations as described in connection with Figs. 3, 4 and 5 and this trunk may be assumed as the outgoing trunk (Fig. 22) which is one of a group of trunks extending to the same distant office. Leads such as **2240** and **2241** from all of the trunks in the group are connected to trunk block relays **2215** and leads such as **2242** and **2243** are connected from the trunk block relays to the marker **2110**. Leads **2242** and **2243** may be common to a number of markers with which a trunk may be associated. The operation of trunk block relays is regulated by the route relay and the block relay control mechanism of the marker as shown in Fig. 49 of the aforementioned Patent 2,236,246 for connecting a particular trunk group with the marker. The marker in selecting an outgoing trunk makes a test of the trunks in the trunk group designated by the route relay and selects an idle trunk if found according to this test. The testing mechanism may be the same as shown in Fig. 38 of the aforementioned Patent 2,236,246 which discloses the leads from this testing mechanism through the trunk block relays to the groups of trunks. A group which as an idle trunk is indicated by ground on lead **2240**. This lead as shown is connected by the block relay to lead **2242** extending to the marker. The marker then tests the leads **2241** extending to the trunks in this group to pick one idle trunk circuit. The absence of ground on lead **2241** denotes that this trunk circuit is idle but the marker also tests lead **2241** for the presence of battery which extends through the upper winding of relay **2219**, contact **5** of relay **2217**, contact **1** of relay **2200**, contact **3** of relay **2216**, thence over lead **2241** and all similar leads of idle trunks through the trunk block relay to lead **2243** extending to the marker. After this test the marker applies ground potential to this lead for operating relay **2219**. The operation of relay **2219** accomplishes the following functions: (1) places ground on lead **2244** to the pad and repeater circuit to control this pad and repeater circuit if a repeater is required, (2) removes ground from lead **2246** and connects battery to this lead, the circuit extending from battery through lamp **2208**, contact **2** of relay **2207**, contact **1** of relay **2219** to lead **2246** which is the M lead of the simplex signaling circuit associated with relay **2218**. This battery connected to the simplex signaling circuit operates a similar relay at the distant office **2230** to advise the distant office that an incoming sender such as **2233** should be connected to this particular outgoing trunk, (3) relay **2219** also operates relay **2217** through its contact **4**, and (4) removes the ground supplied to the group busy lead **2240** so that the group busy mechanism will operate if this is the last idle trunk to be chosen in the group. Relay **2217** locks to ground through its contact **4**. The operation of the signaling relay in the distant office which is the same as relay **2218** associates a ground with automatically regulated mechanism which then returns a signal over lead **2236** to operate relay **2218** which remains operated until such time as the incoming sender **2233** of the distant office **2230** is prepared to receive alternating current pulse signals. The ground from the contact of relay **2218** extends over the E simplex signaling lead **2247** which places a shunt on relay **2216** until such time as the sender **2233** is in readiness to receive pulse signals. Relay **2218** is then released, removing the shunt ground from relay **2216**. The CX signaling mechanism may operate in a manner fully described in Patent 2,133,832 to G. A. Pullis, October 18, 1938.

As soon as the marker has selected the outgoing trunk and made this trunk busy to other markers the connectors **2108** and **2109** are operated in the manner fully described in Patent 2,236,246 and as disclosed in Figs. 15, 25 and 26 of this patent. The location of the frames on

which switches 2100 and 2103 are located is indicated to the marker mechanism and a channel through the secondary switches 2101 and 2102 is found by the operation of the mechanism disclosed in Fig. 30 of Patent 2,236,246. After this channel is found the switches 2100, 2101, 2102 and 2103 are energized, thus connecting the trunk (Fig. 20) with the trunk (Fig. 22). Following this switch controlling operation the marker connects ground with lead 2545 which operates sender relay 2501. The operation of relay 2501 by a signal from the marker connects ground from contact 3 of relay 2810, through contact 1 of relay 2501, contact 2 of relay 2300, upper winding of relay 2710, contact 3 of relay 2709, thence through contacts 1 and 3 of relay 2707 which has been released by the marker. This circuit continues through contacts 2 and 5 of relay 2701 and contacts 1 and 4 of relay 2700 to leads 2350 and 2353 extending to the trunk circuit (Fig. 20). Since relay 2018 is operated this circuit extends over leads 2060 and 2061 through switches 2100, 2101, 2102 and 2103 to leads 2253 and 2254, upper and lower windings of coil 2201, upper and middle windings of relay 2200, contact 2 and winding of relay 2216, resistance 2225 to battery. If at this time the simplex relay 2218 is released indicating that the sender 2233 has been connected to the outgoing trunk, the ground shunt has been removed from relay 2216 and a circuit is established for operating the sender relay 2710. Due to the high resistance of the upper winding of relay 2710 the trunk relay 2216 does not operate at this time. Relay 2710 in operating establishes a circuit for relay 2809 which locks and connects the lower winding of relay 2710 in parallel with its upper winding thus reducing the resistance in the circuit extending to relay 2216. This causes the outgoing trunk relay 2216 to operate which returns a signal to the sender as later described.

At the time that the switches 2100, 2101, 2102 and 2103 are operated the marker connects ground to lead 2250 which holds relay 2219 operated through contact 5 of relay 2217. This ground also extends through contact 1 of relay 2200, contact 3 of relay 2216 and thence over lead 2241 and lead 2243 to the marker as a signal that the switches have been correctly operated. The marker further indicates to the trunk whether a repeater should be connected in the transmission leads or should not be connected in the transmission leads. If the outgoing trunk is a long trunk and the incoming trunk is a long trunk, indications are given to the marker as disclosed in Patent 2,293,191 to Bush et al. August 18, 1942, and the marker connects a high voltage circuit over leads 2251 and 2252 through the windings of coil 2210, windings of relay 2209, contact 1 of relay 2217 to lead 2245 extending through the repeater switching circuit which causes the selection of a repeater and the inclusion of this repeater in the trunk transmission channels. As previously described the operation of relay 2809 reduces the resistance in series with the trunk relay 2216 causing its operation. Relay 2216 in operating establishes a locking circuit for itself to ground on contact 2 of relay 2217. Lead 2241 extending to the trunk block relays is grounded to indicate the busy condition of the trunk. Relay 2216 opens its operating path which disconnects the circuit of relay 2710 causing its release. The operation of relay 2216 further connects the E simplex lead 2247 through resistance 2214 to the simplex leads 2253 and 2254 for supervisory purposes after the connection is completed. The operation of relay 2216 from the distant office 2230 will transmit a supervisory signal over leads 2253 and 2254 to the originating toll position.

In the table under the subheading "Signals from marker to sender" it is noted that the marker connects ground to lead 2861 for operating relay 2810 when the call is to a manual switchboard. The operation of relay 2810 prevents the operation of relay 2300 to prevent pulses being sent out by the sender if the numerical registers were set. Relay 2810 also causes the operation of relay 2709 and other relays in sequence to release the sender in the manner later described. This would be the condition which would ensue when a long incoming trunk is automatically routed to a 151 trunk Fig. 7A after pulses were transmitted over the incoming trunk for a group which had been made unavailable by patching it to the delay quoting circuit. In this case numerical digits may have been registered in the sender for transmission over the outgoing trunk desired but these pulses should not be transmitted over the 151 trunk to the call order board.

Preparation of sender for out pulsing

The sender is arranged for the transmission of direct current pulses to an outgoing sender with relay 2813 normally released and for the transmission of alternating current pulses to a distant office sender with relay 2813 and other relays operated. The office code registered in the marker and consequently the route relay operated in the marker causes the selection of an outgoing trunk to a distant office in one case arranged for direct current pulsing and in another case arranged for alternating current pulsing, and also controls the sender for transmitting direct current or alternating current pulses by causing certain relays to remain normal or by operating these relays. When the code registered in the marker is for the selection of an outgoing trunk to an office requiring alternating current pulses the marker operates a relay which connects ground to lead 3443 shown in the left upper portion of Fig. 34 which operates relay 2913. A locking circuit is established for relay 2913 through its contact 2, lead 2940, contact 4 of relay 2810, lead 2850, contact 3 of relay 2501 to ground. Relay 2913 establishes an operating circuit for relays 2813 and 2818 which prepares the sender for the transmission of alternating current pulses when other devices in the sender have been operated. It is recognized that the registers and the steering relays must be properly set and that a signal must be received from the outgoing trunk before the transmission of pulses takes place.

In preparation of the pulsing mechanism, relay 2710 is released by the outgoing trunk relay 2216 to show that the distant sender has been connected and is in readiness to receive pulses. The release of relay 2710 causes the operation of relay 2300 in a circuit which may be traced from battery through the winding of relay 2300, contact 2 of relay 2709, contact 1 of relay 2810, contact 2 of relay 2809, contact of relay 2710, thence over lead 2876 to ground on contact 6 of relay 2501. The operation of relay 2300 causes the operation of relay 2700 from battery through its winding, contact 1 of relay 2300, contact 1 of relay 2501, to ground on contact 3 of relay 2810. It will be noted that the circuit for these relays includes a contact of relay 2501 which is operated by the marker after it had completed the connection of

the outgoing trunk to the sender through the cross bar switches (Fig. 21) and also the above circuit includes a contact of relay 2710 after it had been released by the operation of the outgoing trunk relay 2216. With relays 2700, 2813 and 2818 operated, pulse transmission leads are now closed from the distant sender 2233 over the four-wire circuit extending through the outgoing trunk (Fig. 22) the switches (Fig. 21) the incoming trunk (Fig. 20), thence over leads 2350, 2351, 2352 and 2353 extending to the sender circuit, contacts 1, 2, 3 and 4 of relay 2700. Leads 2730, 2731, 2732 and 2733 extend from the inner contacts 1, 2, 3 and 4 of relay 2700 to the repeating coil shown in Fig. 28. Leads 2730 and 2731 extend through contacts 1 and 3 of relay 2813 to windings 2819 and 2820 of the repeating coil. Lead 2732 extends from contact 1 of relay 2709, to contact 2 of relay 2818 and winding 2825 of the repeating coil, and lead 2733 extends from contact 4 of relay 2708, to contact 6 of relay 2818 and winding 2826 of the repeating coil. The output circuit is thus prepared for receiving pulses from the sender for setting the registers in the distant sender 2233.

Steering relays

The steering relay for controlling the transmission of pulses for the first numerical digit is the one immediately following the last steering relay released when these registers are set for the code digits. For this description it will be assumed that the last code digit was registered upon the release of steering relay 3105. As herein set forth the release of relay 3105 establishes a circuit for the marker start relay 2508 over a circuit extending from ground through contact 3 of relay 2300 normal, contact 2 of relay 3105, contact 1 of relay 3506, winding of relay 2508 to battery. The operation of relay 2300 as above noted transfers this ground to lead 2348 which extends through contact 1 of out-pulsing steering relay 3500, winding of out-pulsing steering relay 3112, winding of out-pulsing steering relay 3007 to battery. Relay 3112 in operating connects the contacts of the associated register relays with leads 2870, 2871, 2872 and 2873 and therefore any of the register relays operated will establish a circuit over the associated leads by connecting ground therewith. These leads extend through contacts 4, 5, 6, and 7 of relay 2813, to the windings of out-pulsing digit control relays 2900, 2902, 2904, 2906 and 2907 and therefore the relay or relays in this group operate, which correspond to the operated register or registers associated with the out-pulsing steering relay 3112 or the registers associated with other out-pulsing steering relays progressively operated. Alternating current sources of different frequencies in the oscillator (Fig. 15) are connected to the contacts of the above out-pulsing digit control relays and these relays are now set to transmit the first digit to sender 2233 and will do so as soon as the sender has been completely prepared by connecting the out-pulsing leads to the trunk line.

The operation of out-pulsing steering relay 3007 establishes a circuit for relay 3407 from battery through its winding, lead 3455, contact 2 of relay 3007, contact 8 of off-normal relay 3000 to ground. This ground also establishes a holding circuit for relays 3007 and 3112. Relay 3407 locks to ground on lead 3450. Relays 3408 and 3406 now operate. Relay 3408 operates from battery through its winding, contact 3 of relay 3407, lead 3457, contact 5 of relay 3506, lead 2756, contact 1 of relay 2706, to ground. Extending this circuit through contact 5 of relay 3506 prevents out-pulsing from starting before in-pulsing is finished, since relay 3506 is released after the last digit is registered. Relay 3406 operates from battery through its winding, lead 3458, contact 5 of relay 2810, lead 2888, contact of the polarized pulse timing relay 3401, lead 3459, contact 2 of relay 2914, contact 1 of relay 3407, lead 3346, contact 3 of relay 3000, to ground. As will later be seen, the circuit for relay 3406 depends upon the position of the contacts on pulse timing relay 3401. Relay 3410 operates through a contact of relay 3408 the circuit for which may be traced from battery through the winding of relay 3410, lead 3454, contact 5 of relay 2700, lead 2775, contact 2 of relay 2813, contact 1 of relay 3406, contact 2 of relay 3408, lead 2753, to ground on contact 6 of relay 2701. Relay 3410 locks to ground over lead 2753.

Pulse timing relay

The pulse timing relay 3401 is a non-biased, condenser-timed, polarized relay. It cannot be said to operate or release but it closes its contact 2 when energized in one direction by its primary or lower winding, and closes its contact 1 when energized in the other direction by its primary winding. It remains on either or neither contact when not energized. When current is first closed through the primary winding in either direction its force is neutralized by an opposing current in the secondary or upper winding, the source of which is the charge or discharge of the timing condenser 2919. When the condenser has been charged or discharged current ceases to flow in the secondary winding and the current in the primary winding causes the armature to move from one contact to the other.

The operation of relays 3406 and 3408 establishes circuits for this pulse timing relay, the armature of which moves from one contact to the other under the control of condenser 2919 to operate and release relay 3406 for transmitting the current frequency combinations which operate the receiver mechanism associated with the distant sender 2233. The circuit for relay 3406 was traced through contact 1 of relay 3401 which is the case when the armature is connected to this contact. This is the normal position of the armature after the sender is actuated since condenser 2919 is discharged when ground is associated therewith by the operation of the sender off-normal relays. With the armature connected to its contact 2, a network circuit is established including resistances 3402, 3403, 3404 and condenser 2919. This starts opposing currents in the two windings of the pulse timing relay 3401. At first the effect of the upper secondary winding is stronger and contact 2 is held closed but as the condenser discharges, the current in the secondary winding diminishes until the effect of the lower primary winding becomes stronger. At this time the relay breaks its contact 2 and closes its contact 1 which removes ground through the armature from the network circuit. The flow of current therefore starts in both the upper and lower windings in directions reversed from the directions which formerly existed. At first the effect of the secondary winding is stronger and contact 1 is held closed but as the condenser charges, the current in the secondary winding diminishes until the effect of the primary winding becomes stronger and at this time the relay breaks its contact 1 and closes its contact 2. This cycle continues for timing the transmission of digit pulses until the release of the aforementioned relays.

Transmission of alternating current outgoing pulses

As previously described, relay **3410** operates responsive to the first operation of relay **3406** and in so doing closes the pulsing leads in order to set the distant receiving circuit in preparation for digit pulses. Currents of two frequencies which may be 1500 and 1700 cycles from the current supply oscillators (Fig. 15) are first transmitted over leads **2950** and **2951** through contacts **1** and **3** of relay **2910** with this relay normally released. The circuit extends from leads **2950** and **2951** over contacts **1** and **3** of relay **2910**, leads **3452** and **3453**, through contacts **2** and **3** of relay **3410**, contacts **2** and **3** of relay **3406**, leads **2877** and **2878** to the lower terminal of winding **2824** of the repeating coil **2816** and the upper terminal of winding **2823** of this repeating coil. Currents of both frequencies are transmitted over leads **2732** and **2733** through one of the four-wire channels and over leads **2730** and **2731** over the other four-wire channel. The transmission of these currents over both channels balance the circuit over these channels. The first operation of relay **3406** also connects ground from contact **1** of relay **3410** through contact **5** of relay **2910**, winding of relay **2912** to battery operating relay **2912** and placing a shunt on the winding of relay **2910**. This holds relay **2910** normally released during the transmission of currents over leads **2950** and **2951**. Upon the release of relay **3406** this shunt is removed and relay **2910** operates from ground on contact **3** of relay **2501** over lead **2550**, contact **4** of relay **2810**, lead **2940**, contact of relay **2912**, windings of relays **2910** and **2912** to battery. Both relays **2910** and **2912** remain operated during the transmission of operate pulses. The operation of relay **2910** connects the contacts of out-pulsing digit control relays **2900**, **2902**, **2904**, **2906** and **2907** with the pulsing circuit as traced through the contacts of relays **3406** and **3410** to the windings **2823** and **2824** of the repeating coil. The second and subsequent operations of relay **3406** advances the steering relays (Figs. 30, 31 and 35) to the next register by connecting ground through its contact **4**, contact **5** of relay **2910**, lead **2874**, to the contact of steering relay **3005** and extending to the different steering relays as the out-pulsing progresses from one register to the next associated with the different steering relays. Upon each progressive operation of the steering relays, leads **2870**, **2871**, **2872** and **2873** are opened and advanced to the next register which releases the digit control relay or relays **2900**, **2902**, **2904**, **2906** and **2907** and again operates one or more of these relays for transmitting the next digit each of which are currents of two frequencies for each digit in the following manner:

Digits	Leads	Frequencies of signals
KP signal	2950, 2951	1500-1700

Digits	Relays	Frequencies of signals
0		700-900
1	2900	700-1300
2	2902	900-1300
3	2900, 2902	1300-1500
4	2904	900-1500
5	2906, 2907	1100-1300
6	2900, 2906, 2907	700-1100
7	2902, 2906, 2907	900-1100
8	2900, 2902, 2906, 2907	1100-1500
9	2904, 2906, 2907	700-1500
ST	2900, 2904	1100-1700

The signal that pulsing has been completed is transmitted by the operation of relays **2900** and **2904** as shown in the table which also establishes a circuit for relay **3405** during the time when relay **3406** is operated. The circuit for relay **3405** may be traced from ground on contact **1** of relay **3410**, contact **4** of relay **3406**, contact **7** of relay **2904**, contact **5** of relay **2900**, contact and winding of relay **3405** to battery. Relay **3405** in operating locks to ground on lead **2753** and also opens the lead from contact **2** of the pulse timing relay **3401**. Consequently condenser **2919** remains charged and relay **3401** will cease pulsing with the armature against contact **2**. Relay **3406** therefore remains released.

Sender release

A circuit is thus established for relay **2709** from battery through its winding, contact **4** of relay **2818**, contact **1** of relay **3405**, contact **4** of relay **3406**, contact **1** of relay **3410** to ground. The operation of relay **2709** causes the release of the sender since at this time it may be assumed that all pulses have been transmitted and the services of the sender completed. Relay **2709** establishes a circuit for relay **2708** which locks to relay **2400**. Relay **2708** releases relays **2403** and **2402** and the release of relay **2402** releases relays **3000** and **2502** followed by the release of most of the sender mechanism. Relay **2018** in the trunk circuit is now released which connects the calling operator with the called operator. The release of relay **2502** causes the release of relays **2400**, **2401** and **2708**, completing the release of the sender.

Direct current out pulsing

If the code digits registered in the marker indicate to the marker that direct current pulses are required for operating a distant sender the marker selects an outgoing trunk of the character required and signals this outgoing trunk that an outgoing sender should be selected. This outgoing sender is selected in the manner fully described in patent 2,293,191 to A. J. Busch and F. J. Scudder, August 18, 1942. The marker in this case does not associate ground with relay **2913** and consequently relays **2813** and **2818** remain normal. With relay **2813** normal, leads **2870**, **2871**, **2872** and **2873** associated with the steering relays are connected through contacts **4**, **5**, **6** and **7** of relay **2813** to the windings of relays **3411**, **3412**, **3416** and **3417**. The latter relays are thus operated by the numerical registers which were set by the incoming pulses as herein described under the control of relays **2404** to **2409** inclusive. The output of these relays is ground and battery from high and low resistance as in the following table for setting the registers of the outgoing sender associated with the outgoing trunk.

Lead	0	1	2	3	4	5	6	7	8	9	F
3488	L+	H+	L−	H−	L+	L+	H+	L−	H−	L+	H+
3489				L−	H+	H+	H+	H+	H−	H−	L−

L+ indicates high resistance ground.
H+ indicates direct ground.
L− indicates high resistance battery.
H− indicates low resistance battery.

The combinations of ground and battery through high and low resistances are transmitted for each digit over leads **3488** and **3489** which extend through contacts **3** and **5** of relay **2818** which is normal, thence through contacts **1** and **3** of relay **2910**, leads **3452** and **3453**, contacts **2** and **3** of relay **3410**, contacts **2** and **3** of relay **3406**, leads **2877** and **2878** to the outgoing sender. Lead **2877** extends through contact **7** of relay **2818**, contact

3 of relay 2811, contact 6 of relay 2818, thence over lead 2733, contact 4 of relay 2708, contact 3 of relay 2700, lead 2351 through the incoming and outgoing trunk to the outgoing sender. Lead 2878 extends through contact 1 of relay 2818, contact 1 of relay 2811, contact 2 of relay 2818, thence over lead 2732, contact 1 of relay 2709, contact 2 of relay 2700, lead 2352 over the incoming and outgoing trunk to the registers of the outgoing sender. Relay 3401 operates and releases to time the outgoing digit pulses in the same manner as previously described which operates and releases relay 3406 to transmit these pulses and control the steering relays in the same manner as described for transmitting alternating current pulses. After the pulses have been transmitted for setting the registers a final pulse operates relays 3411 and 3416 which connect ground through contact 1 of relay 3410, contact 4 of relay 3406, contact 3 of relay 3416, contact 2 of relay 3411, winding of relay 3405 to battery which operates relay 3405 in the same manner as it was operated by relays 2901 and 2904. This establishes a circuit for relay 2709 which causes the release of the sender. The operation of the outgoing sender in response to receiving direct current pulses from this sender is substantially the same as fully disclosed in the aforementioned Patent 2,293,191 to A. J. Busch and F. J. Scudder.

For an example of the utility of the sender such as described in connection with the call order board it may be assumed that a call from an operator in toll board 600 was made over the incoming trunk, Fig. 6, that this trunk was automatically connected to the sender 636, which is the same as shown in Figs. 23 to 35, that a trunk code was transmitted by alternating current pulses from a key set in an outward toll position in toll board 600 for setting the registers of the sender 636 and transferred to the registers of marker 700, that the outgoing trunk group according to this code was on delay quotation and that the mechanism of the marker was automatically operated to select a 151 trunk, Fig. 7A, to the call order switchboard and accordingly set the cross bar switches, Fig. 7. The call was answered by the call order board operator, who being aware that an outgoing trunk on delay quotation was required for completing the connection, inserted plug 567 into jack 564 associated with the overflow circuit of this trunk group and found that there was an idle trunk in this group. She thereupon inserts the other cord circuit twin plug into the jacks of a trunk, Fig. 20, which automatically associated another sender, Figs. 23 to 34 therewith. The registers of this sender may then be set by direct current pulses and the registration transferred to the marker 2110, which selects an idle trunk, Fig. 22, signals the sender to transmit alternating current pulses to the sender 2233 for setting the registers of the latter sender and operates the cross bar switches Fig. 21. A connection between the outward toll operator in the distant office 600 and the inward toll operator in office 2230 is thus completed through a call order board cord circuit and two sets of cross bar switches.

Another example of the use of the call order board is where the above-described call reached the call order board operator and an idle trunk in the desired group was not available for use in completing the toll connection. In this case a ticket is written by the call order board operator with information thereon for the selection of an idle trunk to the desired office and information for completing a connection back to an outward delay operator in the calling toll office when an idle trunk is available. If the trunk group is in great demand, the ticket is placed with other tickets for calls to trunks in this group and the call is completed in the order of calls received for trunks in this group. To complete a call of this character, the call order board operator inserts one of the cord circuit twin plugs, Fig. 8, into outgoing jacks of a trunk, Fig. 20, and this causes the selection of a sender, Figs. 23 to 35 and a marker, which selects an idle trunk to the desired office in a manner previously described, using the marker for selecting an idle outgoing trunk to a distant toll office, according to the code registered in the sender by the call order board operator. The other twin plug is then inserted into the outgoing jacks of another trunk, Fig. 20, shown diagrammatically as trunk 758. The code of the office and the number indicating the outward toll delay operator in that office is then keyed by the call order board operator to set the registers of another sender, Figs. 23 to 35, which is designated on the drawings as sender 757. Another idle marker 756 is engaged for selecting an idle outgoing trunk 751 to the originating office 750 and the calling subscriber is connected to the called subscriber in office 2230.

Repeater control

In the first example where a call was completed from the 151 trunk, Fig. 7A, through the call order board cord circuit, and outgoing over the trunk Fig. 20 and Fig. 22, indications are given to automatically responsive mechanism in the call order board position circuit to register the type of trunk connected thereto and this automatic mechanism in the call order board position circuit inserts or removes a voice amplifying repeater. In the description of the 151 trunk circuit, Fig. 7A, it will be remembered that after the switches 701, 702, 703 and 704 connect this trunk, Fig. 7A, to the incoming trunk, Fig. 6, relay 725 is operated by the marker if the incoming trunk from office 600 is a long toll trunk line. Relay 725 locks through its upper winding to ground on contact 4 of relay 728 and connects battery to the simplex circuit leading to the tip and ring springs of jack 723 and the tip and ring conductors of plug 871. This long trunk battery circuit may be traced through resistance 726, contact 2 of relay 725, winding of relay 721, upper and lower windings of retardation coil 722, thence over the tip and ring conductors of the jack 723 and plug 871, contacts 1 and 2 of relay 802, leads 836 and 837, contacts 1 and 2 of relay 1006, contacts 1 and 2 of key 1004, retardation coil 1000, winding of relay 1018, resistances 1027 to ground. Relay 1018 operates in the circuit traced and establishes an obvious circuit for relay 1019. Another circuit is established from battery through resistance 731, contact 4 of relay 729, winding of relay 711, upper and lower windings of retardation coil 706 thence over the tip and ring conductors to jack 724 and plug 870, through contacts 1 and 2 of key 801 and contacts 5 and 6 of relay 802, leads 834 and 835, contacts 4 and 5 of relay 1100 which is released, contacts 3 and 4 of relay 1006 operated, left and right windings of retardation coil 1007, winding of relay 1013, resistance 1026 to ground. Relay 1013 establishes an obvious circuit for relay 1014. The operation of relays 1018 and 1019 indicates to this mechanism that a long trunk is connected to the 151 trunk, Fig. 7A. The operation of relays 1013 and 1014 indicates that it is an incoming trunk that is

connected to this trunk. In this example, the telephone circuit was completed over the trunk, Fig. 20. In the outgoing trunk, Fig. 22, in the description of the sender and the marker, it was shown that the operation of the marker route relay will indicate whether the outgoing trunk is a long trunk or a short trunk. If it is a long trunk, the marker indicates this condition to the sender by operating a relay in the sender and the sender connects ground to lead 2351, Fig. 20, after relay 2018 has been released, which operates relay 2019 indicating that a long outgoing toll trunk line has been connected thereto. This relay is locked through its contact 2 to ground on contact 2 of relay 2021 and also connects battery through resistance 2013 and its contact 1 through the winding of relay 2003, upper and lower windings of retardation coil 2002, thence over the tip and ring conductors of jack 2025 and the tip and ring conductors of the associated plug 820, contacts 1 and 2 of relay 815 operated, thence over leads 845 and 846, contacts 1 and 2 of relay 1009 operated, contacts 1 and 2 of key 1010, left and right windings of retardation coil 1003, winding of relay 1023 and resistance 1024 to ground operating relay 1023. Relay 1023 establishes an obvious circuit for relay 1022.

Since the trunk, Fig. 20, is for outgoing service, no battery is connected over the lower simplex leg and the lower plug 820. Consequently, relays 1016 and 1017 do not operate. It is, therefore, indicated by the relays of Fig. 10 that the call order board position circuit is connected to a long incoming trunk and a long outgoing trunk. Relay 1020, therefore, operates from battery through its winding, contact 2 of relay 1016, contact 3 of relay 1022 to ground on contact 7 of telephone circuit relay 901. Relays 1013, 1014, 1018, 1019, 1020, 1022 and 1023 all remain operated until the connection is completely established and the call order board operator restores her talking key 803. This releases relays 802, 815 and the telephone circuit relay 901. It will be remembered that relay 1020 is operated to ground on contact 7 and relay 901 but relay 1020 is slow in releasing and between the time that relay 901 and relay 1020 are released a circuit is established for causing the selection of the repeater which is later inserted into the transmission circuit of the outgoing trunk, Fig. 22. For this purpose 130-voltage positive battery 1062 is automatically extended through lamp 1015, contact 2 of relay 1020, contact 1 of relay 1022, contact 1 of relay 1019, contact 4 of relay 1014, contact 3 of relay 1016, contact 2 of relay 1022, thence over lead 849, contact 6 of relay 901, lead 849, contact 8 of relay 815 which remains locked over lead 832 to ground on contact 3 of relay 1020 until this relay releases. This circuit thus extends over the sleeve of the lower plug and the sleeve of jack 2026, contact 6 of relay 2020, resistances 2010 and 2012, contacts 1 and 2 of relay 2011, upper and lower windings of retardation coil 2015, contacts 4 and 5 of relay 2018, leads 2062 and 2063 through the cross bar switches, leads 2251 and 2252, upper and lower windings of coil 2210 and relay 2209, contact 1 of relay 2217, contact 3 of relay 2202, contact 2 of relay 2213, lower winding of relay 2213 to ground operating relay 2213.

Relay 2213, as shown in the copending application of B. McKim, Serial No. 550,071, filed Aug. 18, 1944, when operated causes the insertion of voice amplifying repeaters in both the upper and lower channels of the transmission circuit to improve transmission on the connection over a long incoming and a long outgoing toll line.

In the second example, two connections were completed over outgoing trunk circuits, one in each direction to the calling toll office and the called toll office over trunks as shown in Fig. 20 and Fig. 22. Let it be assumed that both offices required long trunks and consequently the relay 2019 for both connections is operated. From the foregoing it will be seen that relays 1018, 1019 and 1022 and 1023 are thus operated, but relays 1013, 1014, 1016 and 1017 are not operated. In setting up these two connections the marker being aware that the trunks are long from an indication given by the route relay, will insert voice amplifier repeaters in both the outgoing trunks, Fig. 22, extending to both offices. Since only one voice amplifying repeater is required, it is desired that the one of these voice amplifying repeaters be removed and consequently when the talking key 803 is restored positive 130-volt battery 1062 through lamp 1015 is connected through contact 2 of relay 1020, contact 1 of relay 1022, contact 1 of relay 1019, contact 3 of relay 1014, contact 2 of relay 1019, thence over lead 1033 through contact 3 of relay 901, lead 833, contact 8 of relay 802, lead of plug 870 and jack 2026, which operates the relay 2213 as previously described, if it were not already operated. Also a negative 130-volt battery 1064 is connected through resistance 1021, contact 1 of relay 1020, contact 4 of relay 1014, contact 3 of relay 1016, contact 2 of relay 1022, thence over lead 1049, contact 6 of relay 901, lead 849 through contact 8 of relay 815 through the repeater switch in circuit for automatically removing the repeater from the transmission circuit, as shown in the aforementioned application, Serial No. 550,071.

On calls of the above character completed by a call order board operator the cord circuit, Fig. 8, is used as a link in the four wire transmission circuit through the cross bar telephone office with relays 802 and 815 released for the duration of the conversation between the two subscribers, except when supervisory signals are answered by the call order board operator. A signal from the toll office 2230 is received over the composite signaling circuit lead 2235 and 2236, which operates the composite signal relay 2218 and connects ground to the E lead 2247. This ground extends through contact one of relay 2216, resistance 2214, upper two windings of relay 2200, upper and lower windings of retardation coil 2201 and thence over leads 2253 and 2254, contacts of the cross bar switches to leads 2060 and 2061, contacts 1 and 2 of relay 2018, upper and lower windings of retardation coil 2001, contacts of relay 2003, resistances 2007 and 2008, contact 3 of relay 2021, winding of relay 2004 to battery, which operates the latter relay. The operation of relay 2004 opens the circuit through the upper low resistance winding of relay 2000, which illuminates the cord circuit lamp 812. The intermittent opening and closing of the above composite signal circuit would cause lamp 812 to be flashed. This lamp is normally extinguished over the circuit through the upper and lower windings of relay 2000 to ground during the connection of the cord circuit to an active line. The cord circuit supervisory lamp 809 is flashed in the same manner as described for lamp 812.

In response to a signal of this character the call order board operator actuates the talking key 803 which associates the telephone circuit,

Fig. 9, with the conductors of the lines by energizing relays 802 and 815.

The operation of monitoring key 804 bridges the monitoring leads from the telephone circuit, Fig. 9, across the four wires of the two channels for listening to conversations between subscribers without lowering the transmission characteristics. It will be noted that leads 841, 842, 843 and 844 extend to the telephone circuit over leads 1041, 1042, 1043 and 1044. Leads 1041 and 1042 extending through hybrid coil windings 927 and 928, leads 1043 and 1044 extending through hybrid coil windings 924 and 925. For monitoring service relay 931 is operated and relay 901 remains normal. Relay 931 is operated from battery through its winding, contact 2 of relay 901, lead 840 and contact 5 of the monitoring key 804. The monitoring coils of the telephone set are by the operation of relay 931 connected with the two channels of the transmission circuit.

The call order board operator on such occasions can signal either the calling or the called operator by energizing key 801 or 816. These keys may be operated and released to send a signal to the operator in the distant office. The operation of key 816 connects battery over the tip and ring conductors, contacts 6 and 7 of relay 2018, contacts 2 and 3 of relay 2022, upper and lower windings of retardation coil 2016, winding of relay 2014, resistance 2011 to ground which operates relay 2014. The operation of the latter relay connects ground through resistance 2005, contact 1 of relay 2014, upper winding of retardation coil 2015, contact 5 of relay 2018 to lead 2063 in the direction of the called office. The operation of relay 2014 also connects battery through resistance 2006, contact 2 of relay 2014, lower winding of retardation coil 2015, contact 4 of relay 2018 and thence over lead 2062 in the direction of the called office. These circuits extend through the contact of the cross bar switches thence over leads 2251 and 2252, upper and lower windings of retardation coil 2210 and through the upper and lower windings of relay 2209 operating the latter relay. The operation of relay 2209 connects ground through its contact 1, winding of relay 2207 to battery which operates relay 2207 to open the circuit from battery through lamp 2208, contact 2 of relay 2207, contact 1 of relay 2219 to the M lead 2236 of the composite signaling circuit extending to the toll office 2230. A relay, the same as 2218, in the office 2230, is released by the operation of relay 2207. In the distant office 2230, this signal either flashes a lamp or applies ringing current depending upon the character of the circuits in the distant office. The circuit for key 801 is the same as described for key 816 and operates a similar composite signal circuit as shown in Fig. 6 connected with the distant toll office 600.

A disconnect signal in the call order switchboard is received by extinguishing lamps 809 and 812 in a manner previously described. Removal of the plug 820 from jacks 2025 and 2026 causes the release of relay 2000. The release of relay 2000 causes the release of relay 2020 which automatically releases the relays of the trunk circuit which were locked to these two relays. Removal of ground from lead 2064 by the release of relay 2021 restores the hold magnets of the cross bar switches to normal and also removes ground from lead 2250 in the trunk circuit, Fig. 22, which causes the release of relay 2219, which was locked to ground on lead 2250. The release of relay 2219 opens the composite signaling circuit to battery through lamp 2208 and permits the operator in the office 2230 to disconnect. Relay 2219 also releases the switch in repeater circuit by removing ground from lead 2244. This relay also removes the discharge path of condenser 2237 and allows the potential in this condenser to build up to a point where the ionic tube 2221 fires. This produces a current in the main gap, which is in series with the primary upper winding of relay 2217. This relay is differentially connected, and since the flux due to the current in the upper primary winding is in opposition and slightly greater than that in the secondary lower winding, relay 2217 is released. This extinguishes the tube 2221 and releases relay 2216, which restores the circuit to normal and permits the circuit to give an idle indication over the lead 2241 to the trunk block relay. Relay 2216 in releasing also restores ground to the group busy lead 2240, also extending to the trunk block relay. The time provided by the action of the ionic tube timer is sufficient to insure the release of the circuit at the distant incoming end before the circuit can be reseized.

Delayed calls completed by cordless operators

It was previously set forth that there are periods when the call order board is not occupied by a complement of operators and that under this condition special cordless positions are used to handle delayed calls. It was set forth that under this condition key 550 is operated to automatically transfer 151 circuit request calls to a 121 trunk, Fig. 13, which terminates in the cordless switchboard instead of in jacks before the call order board operators. It was set forth that a delayed call ticket is written by the regular cordless operator who receives the call and when the call order board is not occupied the ticket is sent to this special cordless operator having twin four-wire trunk circuits, trunks A and B as shown in Fig. 17 connected to two channels of the cordless position mechanism, Fig. 18, such as shown in Figs. 55, 56, 65, 66, 71 and 72 of the aforementioned Patent 2,236,246 to G. V. King, J. B. McKim and O. Myers, March 25, 1941. The symmetrical trunks shown in the left-hand and right-hand positions of Fig. 17 are used by this special cordless operator for completing two connections, one over an outgoing trunk to a toll office which previously attempted to complete a call and found all of the trunks busy and another connection over the other one of these trunks to an outgoing trunk, when idle, to the desired toll office.

The special cordless toll position for completing delayed toll calls has only one sender 1832 permanently connected to the position mechanism and, therefore, the registers of this sender and a marker are first set for calling the operator in one toll office over one of the four-wire trunks, trunk A or trunk B, Fig. 17, and again for calling the operator in the other toll office over the other one of the four-wire trunks such, for example, as for calling operators in offices 1600 and 1905. With the exception of condenser 1734 and relay 1713 the mechanism of the left and right trunks, A and B, is the same. Let it be assumed, for example, that one cordless position channel, such as shown in Fig. 55 of the aforementioned Patent 2,236,246, is connected to trunk A and that another cordless position channel of the same character in the said position is connected to the trunk B. The automatically operable mechanism of the cordless position circuit enables the release of the channels from the position circuit

when the connection has been completed. Manually operable position keys may be used for the release and the connection of either channel at the option of the operator.

The special cordless position operator may first use the mechanism shown in Fig. 17, trunk A, for completing a call to the distant office 1600 or complete the connection in reverse manner using the mechanism shown in Fig. 17, trunk B, first and then the trunk A. For this description it will be assumed that the cordless operator first completes a connection to the office 1600 using the mechanism of trunk A and consequently she will first operate key 1812 which establishes an obvious circuit for the operation of relay 1803 from ground through the contact of the key. The operation of relay 1803 extends the ground from key 1812 through the winding of relay 1715 to battery operating the latter relay. Ground associated with contacts 5 and 6 of relay 1715 extends over leads 1744 and 1745 through the filament of lamps 1813 and 1815 to battery, lighting both lamps. Relay 1803 extends ground through its contact 1, contact 7 of relay 1800, filament of lamp 1814 to battery lighting the latter lamp. The operation of relay 1715 connects ground through its contact 3, contact 5 of relay 1700 to the sleeve lead of the cross bar switches. This relay also connects the windings of relay 1709 through its contact 2 and the winding of relay 1712 to battery for later signaling service. Relay 1806 is operated from battery through resistance 1810, winding of relay 1806, contact 3 of relay 1803, continuity contact 2 of relay 1806 to ground. Relay 1806 in operating establishes a locking circuit to ground on its contact 2. The operation of relay 1806 establishes a circuit through its contact 1 for relays 1800 and 1801 and the operation of relay 1801 establishes an obvious circuit for relay 1802. The operation of relays 1800, 1801 and 1802 connects the trunk A through a channel of the cordless operator's position which now operates in the manner fully described in the aforementioned Patent 2,236,246. Ground from the position circuit is connected over lead 1735 for operating relays 1700 and 1708.

The special cordless operator now takes the ticket earlier written for this call and operates her keys for setting the registers of the position sender 1832. The pulses from the special cordless operator's key set are not sent over the trunk conductors for setting the sender registers in the manner described for the call order board but are sent from the position keys directly into the sender as disclosed in the aforementioned patent to G. V. King, J. B. McKim and O. Myers. The code of a trunk to office 1600 is registered and also the number of the operator in the office 1600 which initiated this call. The code registration is transferred to the marker 1607 which selects outgoing trunk 1601 in the same manner as previously described and operates cross bar switches 1602, 1603, 1604 and 1605 for connecting the outgoing trunk 1601 to the trunk A, Fig. 17. A four-wire telephone circuit shown in Patent 2,294,237 to J. B. McKim, August 25, 1942, is included in the position circuit and is connected to leads 1738, 1739, 1740 and 1741 for talking to this operator in office 1600. This telephone circuit may be connected to leads 1746, 1747, 1748 and 1749 for monitoring. At this time the special cordless operator advises the operator in the toll office 1600 that she is preparing to complete the telephone call as requested. The sender 1832 and the marker 1607 and relays 1700 and 1708 are released.

If the trunk 1601 selected by the marker is a long trunk to a distant office the route relay operated in marker 1607 provides an indication to the cordless operator's position operating a relay in that position which associates ground with conductor 1737 extending through contact 5 of relay 1708, winding of relay 1714 to battery, operating relay 1714. The latter relay locks through its contact 1 to ground on contact 3 of relay 1715. As will be shown later, a signal is transmitted from this relay for indicating that a long trunk has been connected to the trunk A, Fig. 17.

Key 1842 may now be operated for associating the mechanism of trunk B with the cordless position mechanism. The channel B, Fig. 18, is the same as channel A. The operation of key 1842 establishes a circuit for a relay the same as relay 1803 which operates to establish a circuit for relay 1765. The latter relay establishes circuits for lamps 1833 and 1835 and the relay like 1803 establishes a circuit for lamp 1834. The circuit for relay 1807 is established from battery through resistance 1811, winding of relay 1807, thence through contact 3 of the relay the same as 1803, contact 2 of relay 1807 to ground on contact 2 of relay 1806. The operation of relay 1807 connects ground to a lead for operating two relays the same as relays 1800 and 1801 and a circuit is then established for a relay the same as relay 1802. Ground is connected with relays 1750 and 1758 over lead 1775 from a position circuit for operating the latter two relays. The winding of relay 1762 is connected through contact 2 of relay 1765 to the winding of relay 1759 for later signaling purposes. The special cordless position operator again uses the position sender 1832 for registering the code of the trunk 1904 in order to establish a connection with the office 1905. This sender transfers the registration to marker 1906 and the marker selects outgoing trunk 1904 and operates the cross bar switches for connecting this outgoing trunk to trunk B of Fig. 17.

Assuming that the trunk to office 1905 is a long trunk, the route relay operates a long trunk relay in the marker for recording this indication. At this time the indication is transferred from relay 1714 that the trunk to office 1600 is also a long trunk. When two long trunks are used for a connection of this character a voice amplifying repeater is required for good transmission. The long trunk indicating circuit from relay 1714 may be traced from ground through its contact 2, contact 2 of relay 1758, lead 1779, winding of relay 1830 to battery. This relay locks and associates ground through the sender to the marker over an LIT lead 1831 substantially the same as lead 3440 shown in Fig. 34 of the sender accompanying this application. This indication plus the indication from the route relay that the trunk to office 1905 is a long trunk causes the marker to respond in a manner fully described in Patent 2,293,191 to A. J. Busch and F. J. Scudder, August 18, 1942, for inserting repeaters in the transmission circuit between the trunk 1904 and the line extending to the distant office 1905. After the operation of relay 1830, relays 1750 and 1758 are operated so that the marker and sender may transmit signals through the position circuit to the outgoing trunk 1904 which is selected by the marker 1906. As shown in the above-mentioned patent to Busch and Scudder, the signal for selecting a repeater operates a relay in the outgoing trunk 1904 and this relay causes the selection of the voice am-

plifying repeater. The indication that the trunk 1904 is a long trunk to a distant office is also transmitted by the marker to the position circuit which associates a ground with lead 1777 for operating relay 1764. Relay 1764 establishes a locking circuit for itself through its contact 1 and contact 5 of relay 1750 to ground on contact 3 of relay 1765. It will be remembered that relay 1765 is also locked to a ground on contact 2 of relay 1713. The connection of this delayed call by the special cordless operator may be only one connection over a trunk of the trunk group having trunks the same as 1904. The special cordless operator may have a number of calls written on tickets for trunks to office 1905 and consequently when the conversation has been completed over the trunk between offices 1905 and 1600, this special cordless operator may wish to use the same outgoing trunk connected to the incoming trunk B, Fig. 7, for another call in the manner described for completing such calls from the call order board. When no other calls to either the office 1600 or 1905 are waiting for completion the special cordless operator connects ground to lead 1743 to operate relay 1713 which causes the release of both trunks A and B of Fig. 17 and the mechanism of the channels, Fig. 18.

What is claimed is:

1. In a telephone system, an automatic switching office, a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks to said other offices in groups according to the code designations of said other offices, means responsive to code pulses over an incoming trunk from one of said offices for automatically routing said incoming trunk to an idle outgoing trunk in a trunk group having said code designation, a manually operable switchboard in said automatic switching office, means for making the outgoing trunks of a group unavailable for automatic selection by incoming trunks from said other offices and for automatically routing an incoming trunk to said switchboard responsive to the code of said unavailable trunk group having been pulsed into said automatic switching office, and means in said switchboard for routing said incoming trunk to an idle trunk in said unavailable group.

2. In a telephone system, an automatic switching office and a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks to said other offices in groups according to the code designations of said other offices, means responsive to code pulses over an incoming trunk from one of said other offices for automatically routing said incoming trunk to an idle outgoing trunk in a trunk group having said code designation, a manually operable switchboard in said automatic switching office, special trunks associated with said switchboard, means for making the outgoing trunks of a group unavailable to incoming trunks from said other offices and for automatically routing an incoming trunk to a special trunk associated with said switchboard responsive to the code of said trunk group having been pulsed into said automatic switching office, and means in said switchboard for connecting said special trunk to another one of said special trunks and for transmitting the code pulses of said unavailable group over said other special trunk for routing said incoming trunk to an idle outgoing trunk in said unavailable group.

3. In a telephone system, an automatic switching office, a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks to said other offices in groups according to the code designations of said other offices, means responsive to a call from one of said offices for automatically routing said calling trunk to an idle outgoing trunk in a trunk group having the wanted designation, means for making the outgoing trunks of a group unavailable for automatic selection, a delay quotation circuit, means responsive to calls from certain of said other offices for said unavailable group of trunks for automatically routing the calling trunk to said delay quotation circuit, a manually operable switchboard for completing telephone connections, and means responsive to calls from certain of said other offices for said unavailable group of trunks for automatically routing the calling trunk to said switchboard.

4. In a telephone system, an automatic switching office, a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks to said other offices in groups according to the code designations of said other offices, means responsive to a call from one of said offices for automatically routing said calling trunk to an idle outgoing trunk in a trunk group having the wanted designation, means for making the outgoing trunks of a group unavailable for automatic selection, a delay quotation circuit, means responsive to calls from certain of said other offices for said unavailable group of trunks for automatically routing the calling trunk to said delay quotation circuit, a manually operable switchboard, means responsive to calls from certain of said other offices for said unavailable group of trunks for automatically routing the calling trunk to said switchboard, and means in said switchboard for completing a call from the calling trunk to an idle trunk in said unavailable group of outgoing trunks.

5. In a telephone system, an automatic switching office, a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks to said other offices in groups according to the code designations of said other offices, means responsive to a call from one of said offices for automatically routing said calling trunk to an idle outgoing trunk in a trunk group having the wanted designation, means for making the outgoing trunks of a group unavailable for automatic selection, a delay quotation circuit, means responsive to calls from certain of said other offices for said unavailable group of trunks for automatically routing the calling trunk to said delay quotation circuit, a manually operable switchboard, means responsive to calls from certain of said other offices for said unavailable group of trunks for automatically routing the calling trunk to said switchboard, means in said switchboard for quoting the time of delay in completing the telephone connection over a trunk in said unavailable group and later completing a connection to the calling party and the called party when an idle trunk in the unavailable group is obtainable.

6. In a telephone system, an automatic switching office and a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks in groups according to the code designations of said other offices, means responsive to code pulses over an incoming trunk from one of

said other offices for automatically routing said incoming trunk to an idle outgoing trunk in a trunk group having said code designation, a manually operable switchboard in said automatically switching office, special trunks associated with said swtichboard, means for making the outgoing trunks of any of said groups unavailable for automatic selection by incoming trunks from said other offices and for automatically routing an incoming trunk to one of said special trunks responsive to the code of an unavailable trunk group having been pulsed over said incoming trunk, a signal circuit in said switchboard connectable with any group of outgoing trunks for flashing one of a plurality of signals to indicate that there are idle trunks in the group so connected, and means in said switchboard for connecting said special trunk with another special trunk and for transmitting the code pulses of an unavailable group for routing said incoming trunk through said special trunks to an idle trunk in the unavailable group originally pulsed over said incoming trunk.

7. In a telephone system, an automatic switching office and a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks in groups according to the code designations of other offices, route relays for each group of outgoing trunks, means responsive to code pulses over an incoming trunk for operating a route relay for causing a selection of an idle outgoing trunk in a group having said code designation, a manually operable switchboard in said automatic switching office, a group of special trunks associated with said switchboard, means for making groups of the outgoing trunks to certain of said other offices unavailable for automatic selection by incoming trunks from said other offices, special route relays for routing calls to said special trunks, means responsive to pulses over a calling incoming trunk representing the code of an unavailable trunk group for automatically operating said special route relay for selecting an idle special trunk to said switchboard and for automatically connecting it to said calling incoming trunk, and means in said switchboard for selecting another one of said special trunks and for operating the route relay of said unavailable trunk group for selecting an idle outgoing trunk in said group and for connecting it to said other special trunk thus connecting said incoming trunk to a selected idle outgoing trunk in the group of the desired code designation.

8. In a telephone system, an automatic switching office and a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks to said other offices in groups according to the code designation of said other offices, devices having route relays for each group of outgoing trunks, means responsive to code pulses over an incoming trunk for operating a route relay, testing means in each of said devices, means responsive to the operation of said route relay for connecting the trunks of a group corresponding to the code pulse designation with said testing means for the selection and operation of an idle trunk in said group, means responsive to the selection of said outgoing trunk for connecting it to the calling incoming trunk, a manually operable switchboard in said automatic switching office, special trunks in groups associated with said switchboard, means for making groups of outgoing trunks to certain of said other offices unavailable for automatic selection by incoming trunks from all of said other offices, special route relays for routing incoming calls to said special trunks, means responsive to pulses over an incoming calling trunk representing the code of an unavailable trunk group to prevent the connection by said devices of the trunks of said group with their testing means and for operating a special route relay for connecting the trunks of said special group with its testing means for the selection of an idle special trunk to said switchboard, and means in said switchboard for operating a device to connect the trunks of said unavailable group with its testing means for selecting an idle outgoing trunk and for connecting said idle outgoing trunk of the unavailable group with said calling incoming trunk.

9. In a telephone system, an automatic toll switching office, other offices including near and distant offices, said automatic toll switching office having short and long incoming trunks from said other offices and outgoing trunks in groups according to the code designations of said other offices, means in said automatic toll switching office responsive to code pulses over an incoming trunk from said other offices for automatically routing said incoming trunk to an idle outgoing trunk in a group having said code designation, means for making overloaded groups of said outgoing trunks unavailable for automatic connection to short and long incoming trunks responsive to code pulses over said incoming trunks, a delay quotation circuit, special trunks, means for automatically rerouting short incoming trunks to said delay quotation circuit responsive to the code of an unavailable group being pulsed for receiving a quotation of the time delay in completing a toll connection to the trunks of said unavailable group, means for automatically rerouting long incoming trunks over an idle one of said special trunks responsive to the code of an unavailable group being pulsed, and means to connect the special trunk so connected to an idle trunk in said unavailable group.

10. In a telephone system, an automatic switching office and a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks in groups according to the code designations of said other offices, testing means, means responsive to code pulses over a calling incoming trunk from one of said other offices for automatically connecting the outgoing trunks of a group having said code designation with said testing means for selecting an idle one of said trunks and for connecting it to said calling incoming trunk, means for making the group of outgoing trunks having said code designation unavailable for automatic connection to calling incoming trunks, special trunks in groups, means responsive to said unavailable group of code pulses over a calling incoming trunk to said automatic switching office for automatically connecting the trunks of said special group with said testing means for selecting an idle special trunk and for connecting it with said calling incoming trunk, means in said special trunk to indicate said connection, a second testing means, and means for connecting the trunks of said unavailable group with said second testing means for selecting an idle one of said unavailable trunks and for connecting it to said calling incoming trunk through said special trunk.

11. In a telephone system, an automatic toll switching office, other offices including near and distant toll offices, said automatic toll switching office having short and long incoming trunks from said other offices and outgoing trunks in groups according to code designations of said other offices, overflow trunks for each group of trunks, trunk testing means, means responsive to code pulses over a calling incoming trunk for automatically connecting the trunks of a group having said code designation with said testing means, means in said testing means to route an incoming trunk to an overflow trunk responsive to finding all trunks in said group busy, devices in said overflow trunk to first transmit a busy trunk signal and second an idle trunk signal over said calling trunk when a trunk in this group becomes idle while the incoming trunk is connected thereto, overloaded groups of trunks, a delay quotation circuit, special trunks, means for connecting said delay quotation circuit to the overflow trunks of one or more overloaded groups of trunks for disconnecting said busy and idle signaling devices, and for making the trunks of said overloaded groups unavailable for automatic test and connection to calling incoming trunks, means operated by said last means for automatically rerouting short incoming trunks calling for said unavailable groups through said overflow trunks to said delay quotation circuit and for automatically rerouting long incoming trunks calling for said unavailable group to said special trunks, and means for connecting said special trunks to an idle trunk in the unavailable group desired for completing the toll connection.

12. In a telephone system, an automatic switching office and a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks in groups according to the code designation of said other offices, senders and markers, means responsive to the selection of an incoming trunk and the transmission of pulses thereover for setting registers in a sender and a marker, route relays in said marker for each trunk group, means responsive to a particular code registration in a marker for operating a particular route relay for selecting an idle outgoing trunk in a group of trunks having said code designation and for connecting said outgoing trunk to said incoming trunk, means in said marker to signal the connected sender whether to transmit switch controlling pulses over said outgoing trunk and the character of said pulses, a manually operable switchboard in said automatic switching office, special trunks incoming to and outgoing from said switchboard, route relays in said markers for said special trunks incoming to said switchboard, means for making the outgoing trunks of a particular code designation unavailable to incoming trunks from said other offices, means responsive to the registration of the code of said unavailable trunk group in a sender and marker for operating a route relay for selecting an idle special incoming trunk to said switchboard and for signaling the connected sender not to transmit switch controlling pulses thereto, means in said switchboard for connecting said special trunk to another special trunk outgoing from said switchboard which causes the connection of a sender and a marker to said switchboard, and means in said switchboard for transmitting code pulses to operate registers in the connected sender and marker to select an idle trunk in said unavailable outgoing trunk group.

13. In a telephone system, an automatic switching office and a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks in groups according to the code designations of said other offices, register senders capable of receiving direct current or alternating current pulses for setting the registers and capable of transmitting direct current or alternating current pulses for controlling other switching mechanism, means responsive to the actuation of an incoming trunk for automatically selecting one of said senders, markers having code registers, means responsive to either direct current or alternating current pulses over an incoming trunk for setting the registers of a sender, means in an actuated sender for selecting an idle marker and for setting its registers according to the pulses transmitted over the incoming trunk, means in said marker for selecting an idle outgoing trunk in a group having said code designation and connecting the incoming trunk to said outgoing trunk, means in said marker for signaling the sender whether to transmit direct current or alternating current pulses over said outgoing trunk for setting other switch control mechanisms, a manually operable switchboard, special trunks associated with said switchboard, means for making the outgoing trunks of a group unavailable for selection by said markers responsive to the setting of its registers from pulses over an incoming trunk and for automatically causing said marker to select one of said special trunks to said switchboard and for signaling the connected sender not to transmit any switch controlling pulses, means in said switchboard for making connection with said special trunk for answering the call, means in said switchboard for connecting said special trunk to another special trunk which automatically selects one of said senders, means in said switchboard for operating the registers of said sender according to the code of said unavailable group of trunks, means in said sender for selecting a marker and transferring said code to the registers of said marker, means in said marker automatically operated by said last special trunk for causing said marker to select an idle outgoing trunk in said unavailable group and for connecting said outgoing trunk in said unavailable group to said last special trunk, and means in said marker for signaling the connected sender whether to transmit direct current pulses or alternating current pulses over the conductors of said outgoing trunk for setting other switch controlling mechanism.

14. In a telephone system, an automatic switching office and a plurality of other offices, said automatic switching office having four-wire incoming trunks from said other offices and four-wire outgoing trunks in groups according to the code designations of said other offices, means responsive to code pulses of an incoming trunk from one of said other offices for automatically routing said incoming trunk to an idle outgoing trunk in a group having said code designation, a manually operable switchboard in said automatic switching office, special four-wire trunk circuits having two transmission channels terminating in jacks in said switchboard, position circuits in said switchboard having cords with multicontact plugs for connection to the two transmission channels of said special four-wire trunks, means for making the

outgoing trunks of a group unavailable to incoming trunks from said other offices and for automatically routing an incoming trunk to one of said special trunks responsive to the code of said unavailable trunk group having been pulsed into said automatic switching office, means for answering said incoming call by inserting a plug into a jack of said special trunk, and means for completing a connection to an idle trunk in said unavailable group by inserting the other plug of said position cord circuit into another special trunk and pulsing the code of said unavailable trunk group.

15. In a telephone system, an automatic switching office, a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks to said other offices in groups according to the code designations of said other offices, overflow trunks individual to each group of outgoing trunks, means for automatically routing a calling incoming trunk to an overflow trunk when all of the trunks in a group are busy, a manually operable switchboard, a delay quotation circuit terminating in said switchboard, means for connecting the overflow trunk individual to an overloaded busy trunk group to said delay quotation circuit and for making the trunks of said group unavailable to calling incoming trunks, said calling incoming trunks being automatically routed over the overflow trunk to said delay quotation circuit for informing the calling operator of the amount of delay in completing connections to the outgoing trunks of said unavailable group, and means operable in said switchboard for causing the selection of an idle outgoing trunk in said unavailable group of trunks for completing delayed telephone connections.

16. In a telephone system, an automatic switching office, a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks to said other offices in groups according to the code designations of said other offices, overflow trunks individual to each group of outgoing trunks, means for automatically routing a calling incoming trunk to an overflow trunk when all of the trunks in a group are busy, a manually operable switchboard, a delay quotation circuit terminating in said switchboard, means for connecting the overflow trunk individual to an overloaded busy trunk group to said delay quotation circuit and for making the trunks of said group unavailable to calling incoming trunks, said calling incoming trunks from certain of said other offices being automatically routed over the overflow trunk to said delay quotation circuit for informing the calling operator of the amount of delay in completing connections to the outgoing trunks of said unavailable group, special trunks terminating in jacks and signals in said switchboard, means responsive to calls from certain of said other offices for a trunk in said unavailable group of trunks for automatically routing said called trunk to an idle special trunk to said switchboard, means operable in said switchboard for making connections with said special trunk, and means in said switchboard and operable therefrom for causing the selection of an idle outgoing trunk in said unavailable group of trunks and for causing the connection of said idle outgoing trunk through said switchboard to said special trunk for completing the telephone connection.

17. In a telephone system, an automatic switching office, a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks to said other offices in groups according to the code designations of said other offices, overflow trunks individual to each group of outgoing trunks, means for automatically routing a calling trunk to an overflow trunk when all of the trunks in a group are busy, a manually operable switchboard, a delay quotation circuit terminating in said switchboard, means for connecting the overflow trunk individual to an overloaded busy trunk group to said delay quotation circuit and for making the trunks of said group unavailable to calling incoming trunks, said calling incoming trunks from certain of said other offices being automatically routed over the overflow trunk to said delay quotation circuit for informing the calling operator of the amount of delay in completing connections to the outgoing trunks of said unavailable group, special trunks terminating in jacks and signals in said switchboard, means responsive to calls from certain of said other offices for a trunk in said unavailable group of trunks for automatically routing said calling trunk to an idle special trunk in said switchboard, a cord circuit and a telephone circuit in said switchboard for answering said call by the insertion of one cord circuit plug into the jack of said special trunk, a pulsing circuit in said switchboard, register senders, means for selecting an idle outgoing trunk in said unavailable group by inserting the alternate plug of said cord circuit in the jack of another one of said special trunks and by transmitting pulses over the conductors of said latter special trunk for setting the registers of a sender according to the code of said unavailable trunk group, and means responsive to the selection of said idle outgoing trunk for connecting it through said two special trunks and said cord circuit to said calling trunk.

18. In a telephone system, an automatic switching office, a plurality of other offices, said automatic switching office having four-wire incoming trunks in two transmission channels connected to lines from said other offices and four-wire outgoing trunks in two transmission channels connected to lines to said other offices in groups according to the code designations of said other offices, a switchboard having a position circuit in each position, a register sender, a double four-wire trunk circuit connected to said position circuit having a switch connected to each end, and means in said switchboard for setting the registers of said sender for connecting four-wire outgoing trunks to each end of said double trunk circuit for establishing a telephone connection between two of said other offices over the two transmission channels of said four-wire trunk circuits.

19. In a telephone system, an automatic switching office, a plurality of other offices, said automatic switching office having four-wire incoming trunks in two transmission channels connected to lines from said other offices and four-wire outgoing trunks in two transmission channels connected to lines to said other offices in groups according to the code designations of said other offices, a switchboard having a position circuit in each position, a double four-wire trunk having a switch connected to each trunk and connections to four-wire channels in said position circuit, a register sender for said switchboard position, means in said position for setting the registers of said sender for connecting a four-wire outgoing trunk to one switch of said double trunk circuit, and again setting the registers of

said sender for connecting another four-wire outgoing trunk to the other switch of said double trunk for establishing a telephone connection between two of said other offices over the two transmission channels of said trunk circuits.

20. In a telephone system, an automatic switching office, a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks to said other offices in groups according to the code designations of said other offices, means responsive to code pulses over an incoming trunk from one of said offices for automatically routing said incoming trunk to an idle outgoing trunk in a trunk group having said code designation, means for making the outgoing trunks of a group unavailable for automatic selection by incoming trunks from said other offices, a manually operable switchboard in said automatic switching office, and means in said switchboard for routing an incoming trunk to an idle trunk in said unavailable group.

21. In a telephone system, an automatic switching office, a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks to said other offices in groups according to the code designations of said other offices, means responsive to code pulses over an incoming trunk from one of said offices for automatically routing said incoming trunk to an idle outgoing trunk in a trunk group having said code designation, means for making the outgoing trunks of a group unavailable for automatic selection by incoming trunks from said other offices irrespective of their busy or idle condition, manual operators' positions in said automatic switching office, and means under the control of said manual operators' positions for routing incoming trunks to idle trunks in said unavailable group.

22. In a telephone system, an automatic switching office and a plurality of other offices, said automatic switching office having incoming trunks from said other offices and outgoing trunks to said other offices in groups according to the code designation of said other offices, devices having route relays for each group of outgoing trunks, means responsive to code pulses over an incoming trunk for operating a route relay, testing means in each of said devices, means responsive to the operation of said route relay for connecting the trunks of a group corresponding to the code pulse designation with said testing means for the selection and operation of an idle trunk in said group, means responsive to the selection of said outgoing trunk for connecting it to the calling incoming trunk, manual operators' positions in said automatic switching office, means for making groups of outgoing trunks to certain of said other offices unavailable for automatic selection by incoming trunks from all of said other offices, means responsive to pulses over an incoming calling trunk representing the code of an unavailable trunk group to prevent the connection by said devices of the trunks of said group with their testing means, and means under the control of said manual operators' positions for operating a device to connect the trunks of said unavailable group with its testing means for selecting an idle outgoing trunk and for connecting said idle outgoing trunk of the unavailable group with a calling incoming trunk.

BURTON McKIM.
OSCAR MYERS.