Aug. 15, 1944. J. W. DEHN 2,355,908

TELEPHONE SYSTEM

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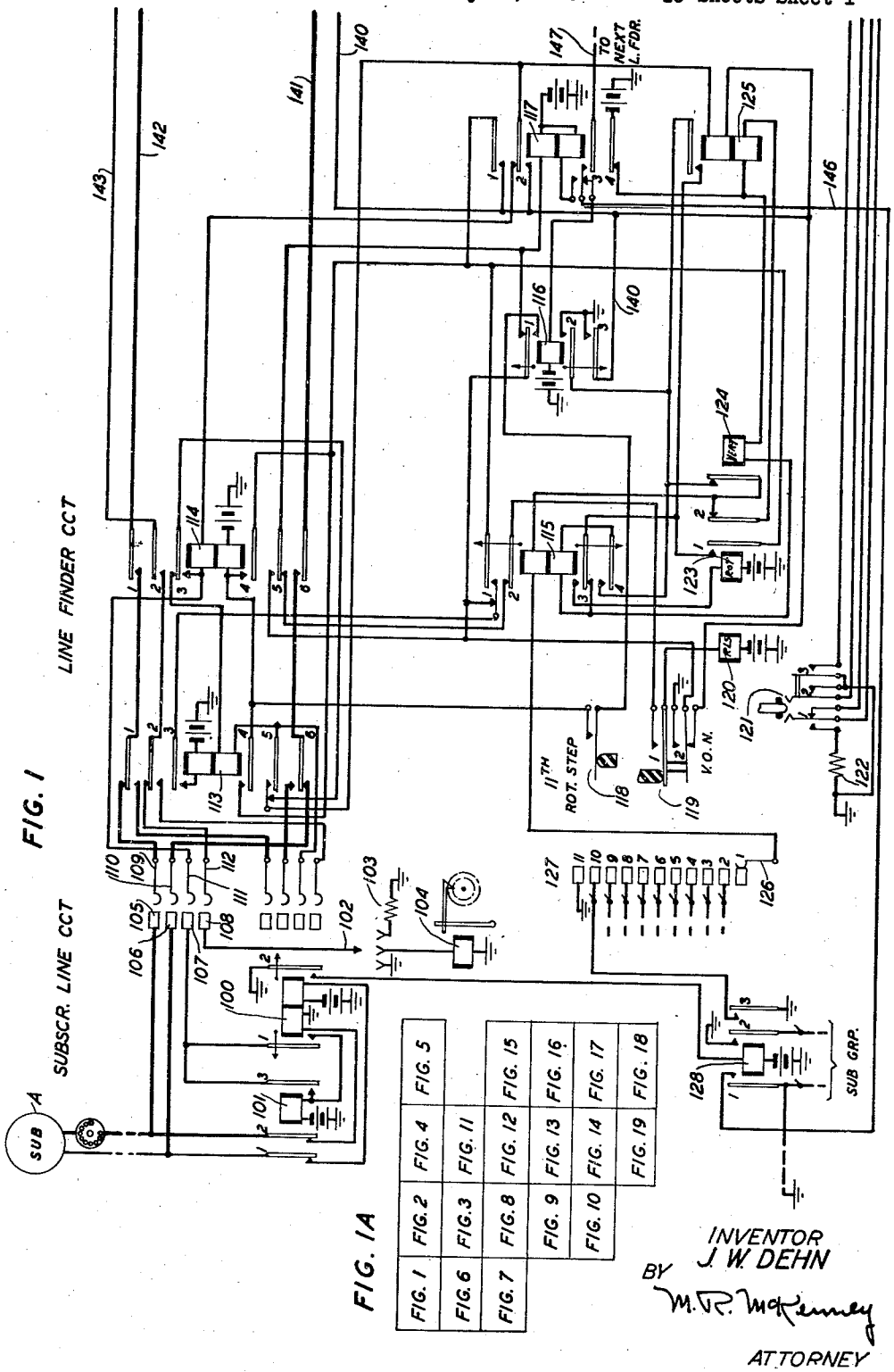

FIG. 1

FIG. 1A

FIG. 1	FIG. 2	FIG. 3	FIG. 4	FIG. 5		
FIG. 6	FIG. 7	FIG. 8	FIG. 9	FIG. 10	FIG. 11	FIG. 12
FIG. 13	FIG. 14	FIG. 15	FIG. 16	FIG. 17	FIG. 18	FIG. 19

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TELEPHONE SYSTEM

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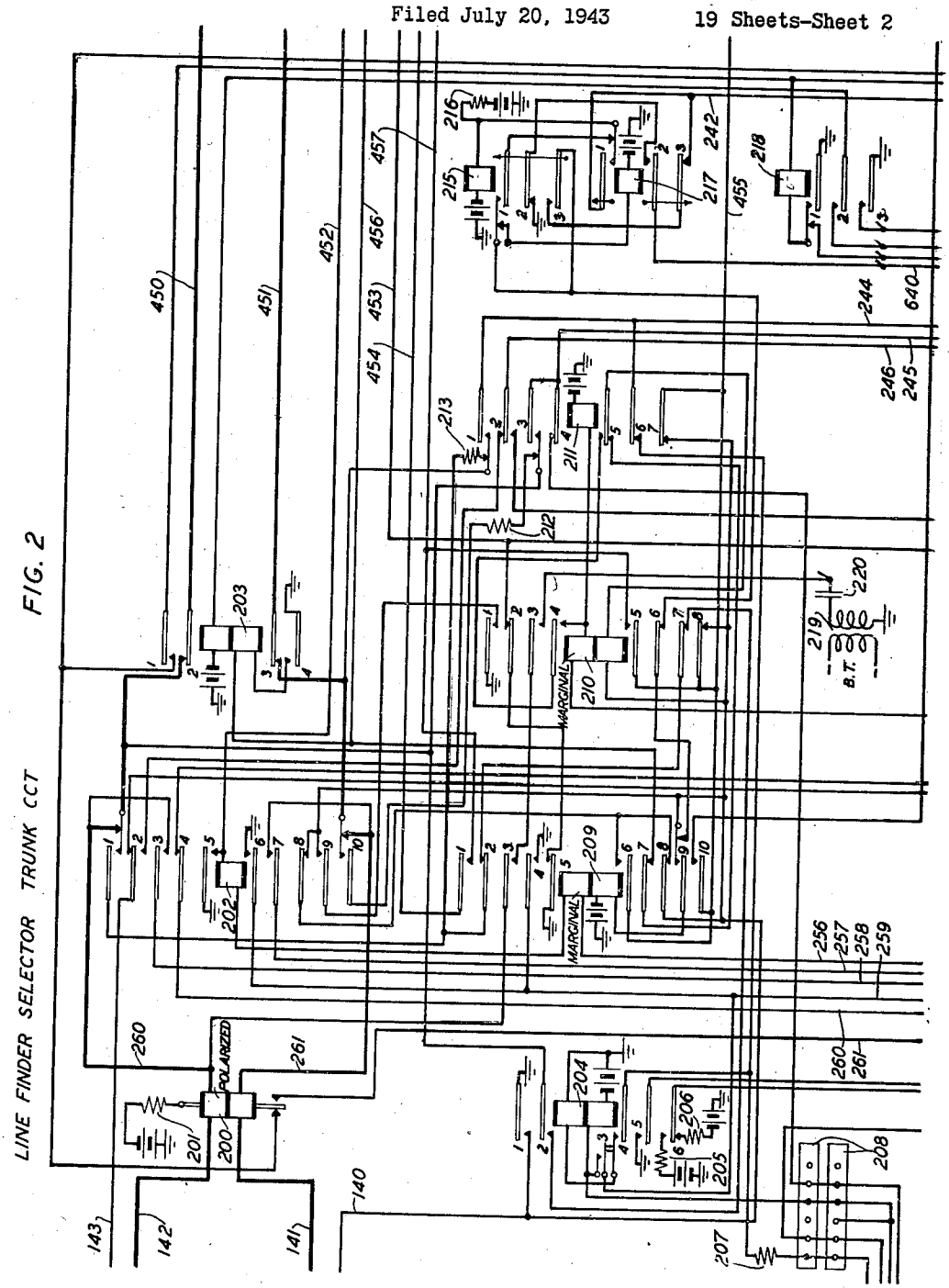

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TELEPHONE SYSTEM

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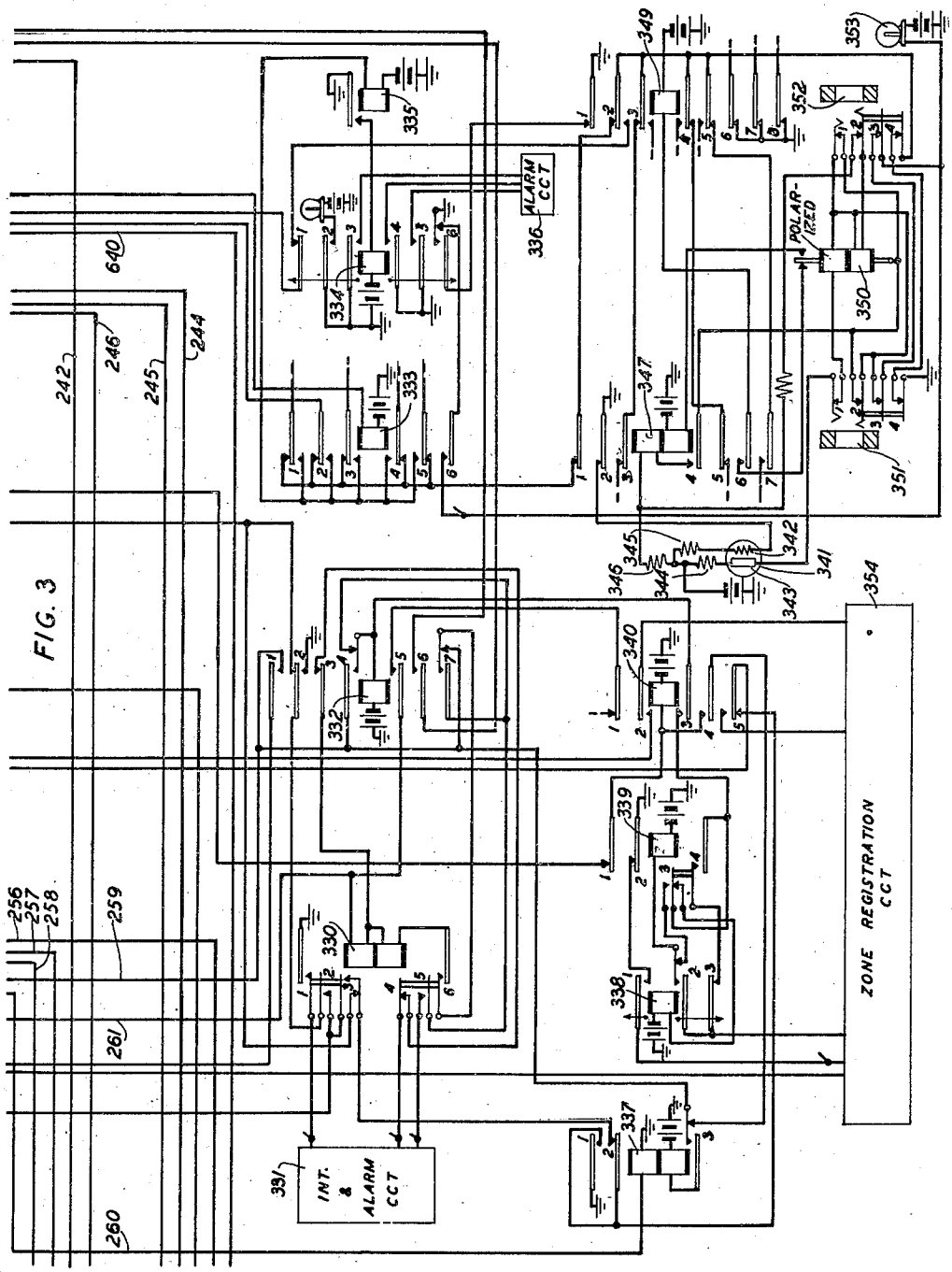

FIG. 3

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TELEPHONE SYSTEM

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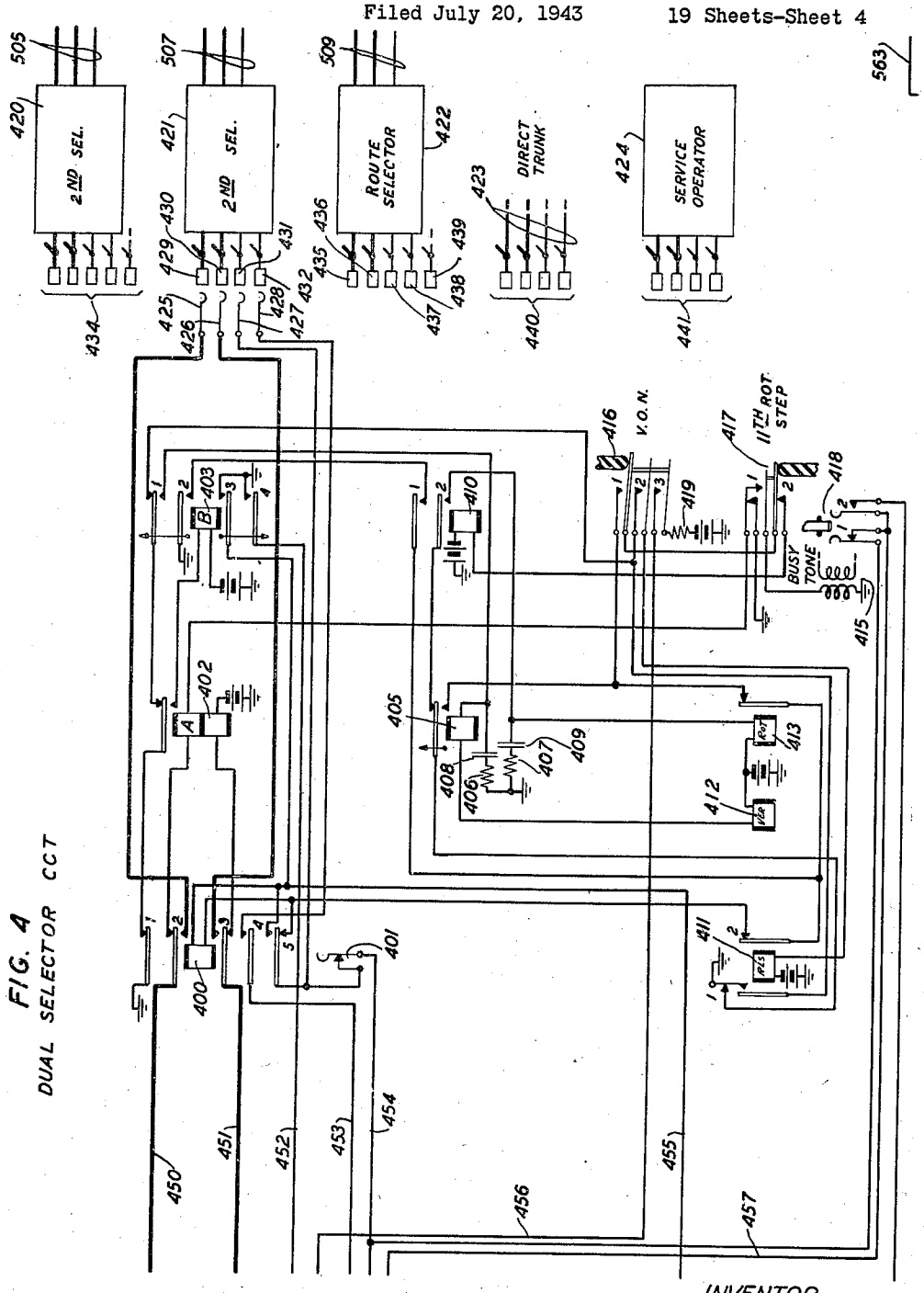

FIG. 4

DUAL SELECTOR CCT

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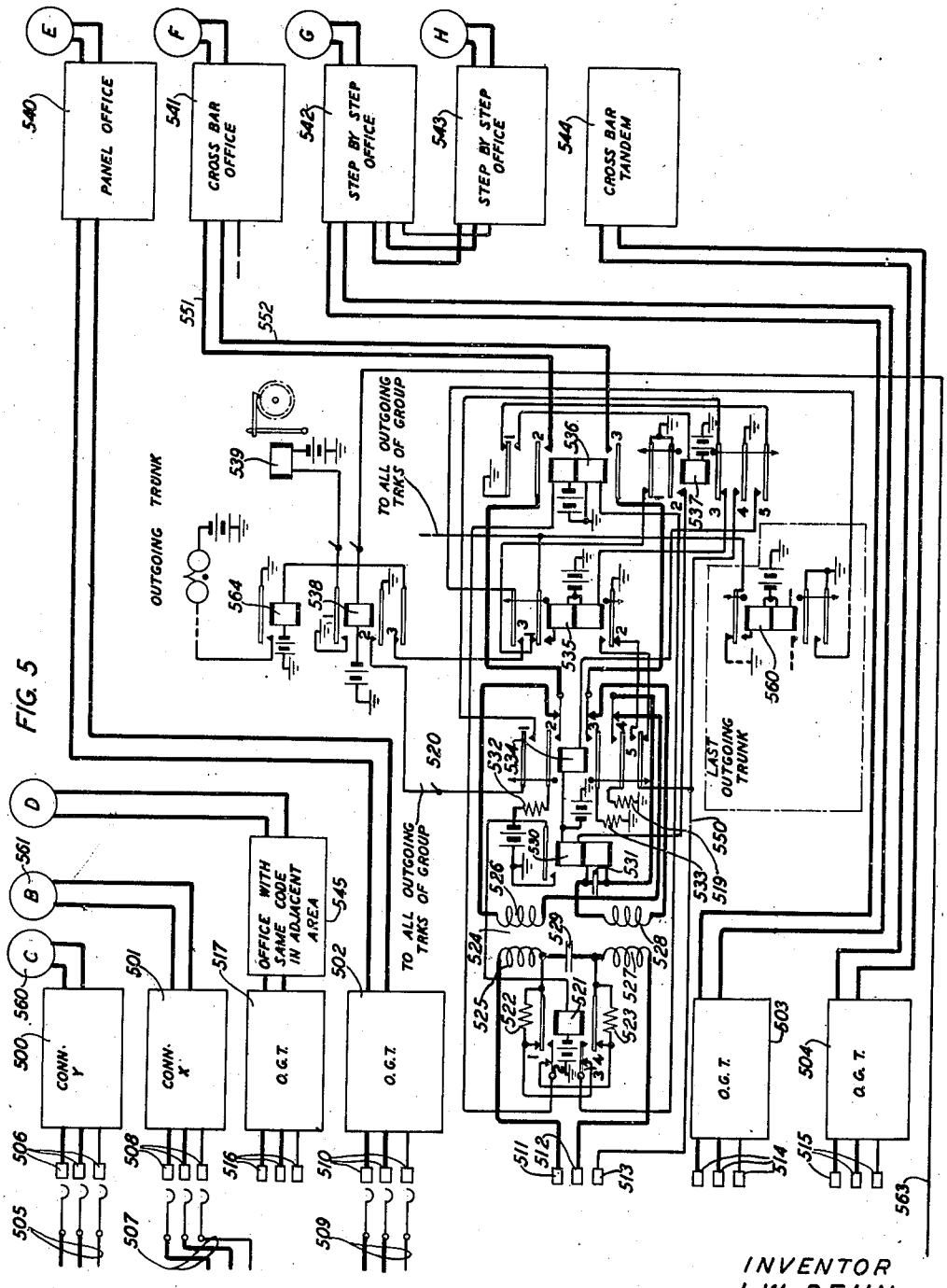

FIG. 5

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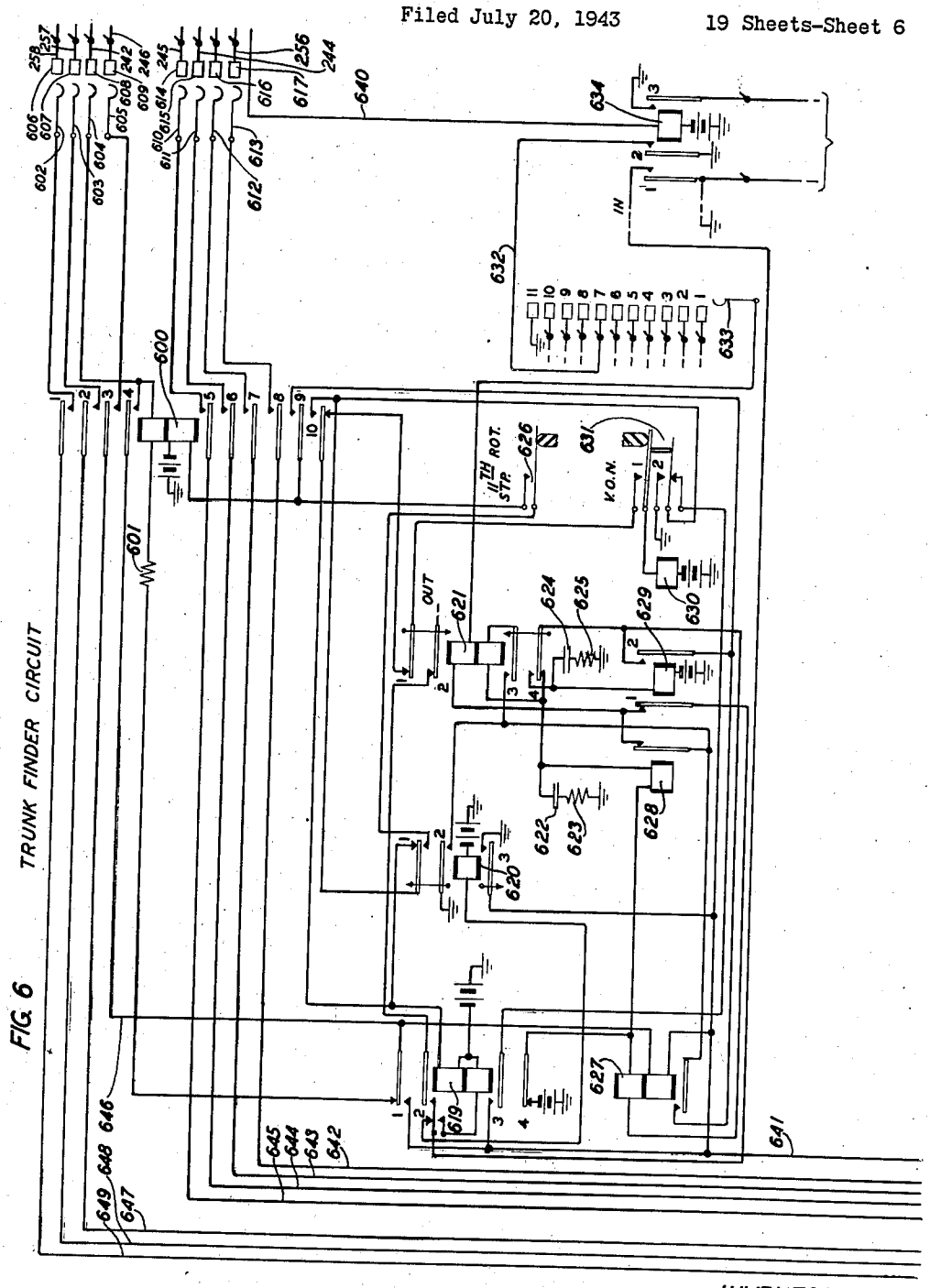

FIG. 6

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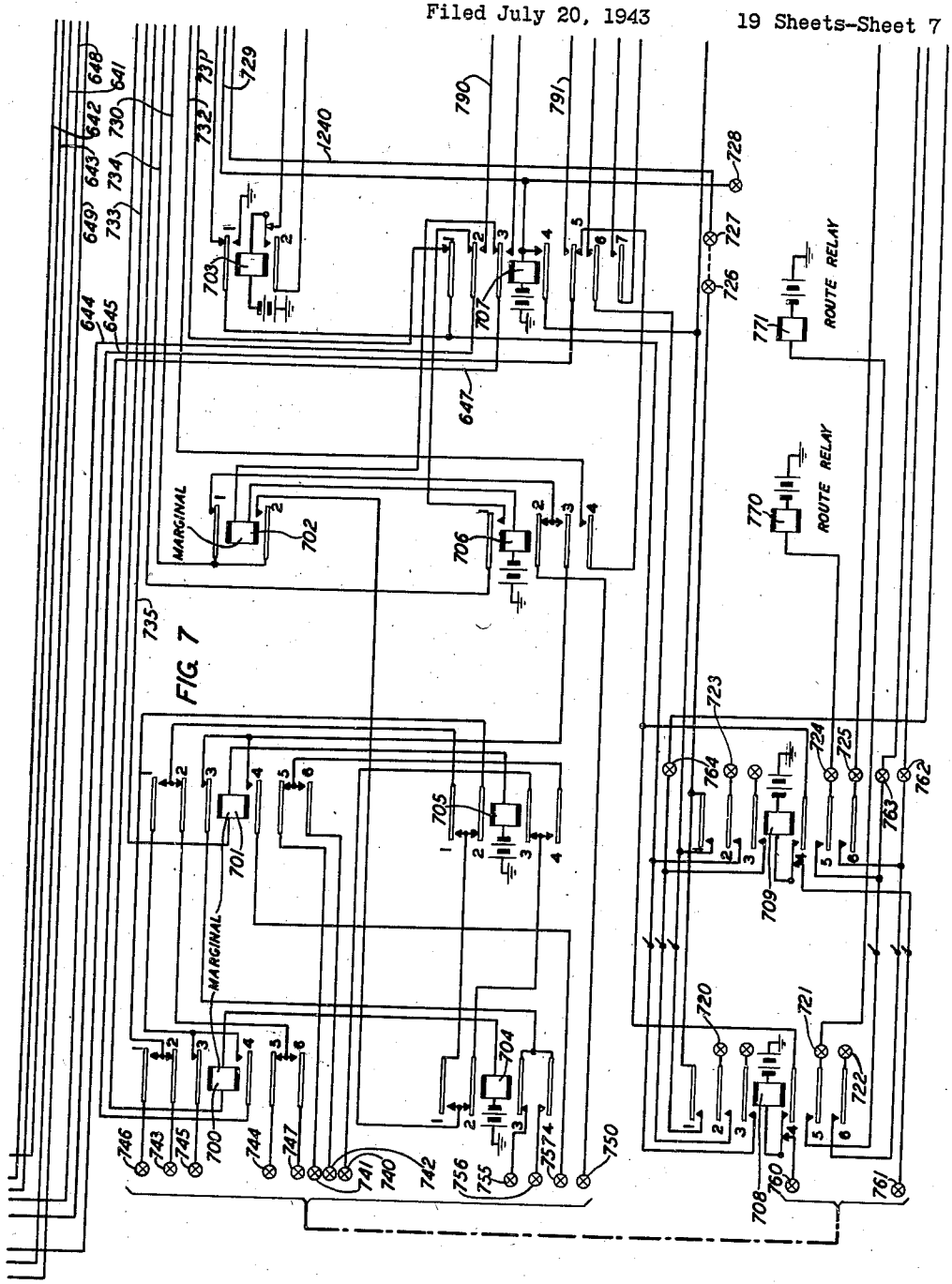

FIG. 7

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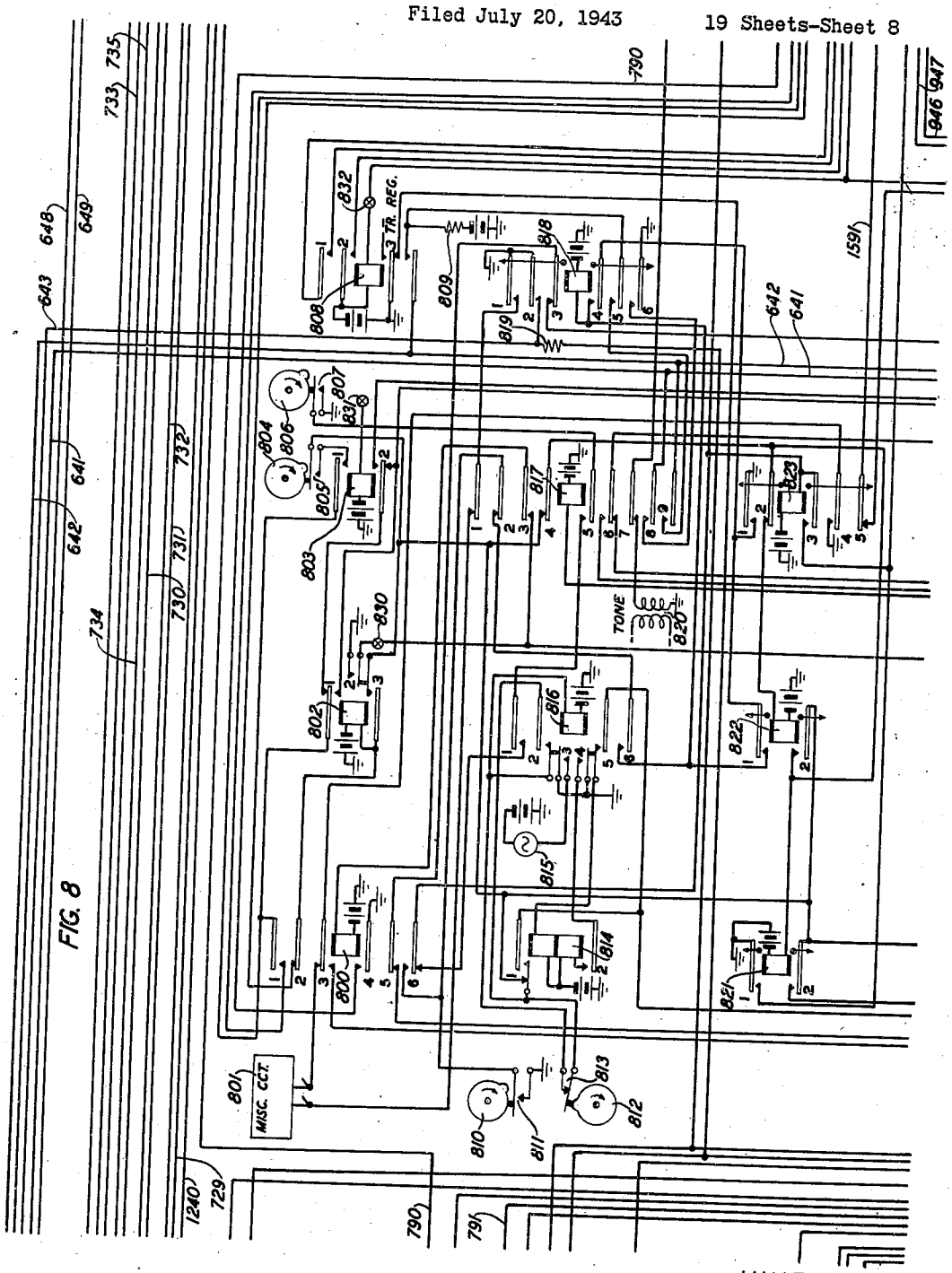

FIG. 8

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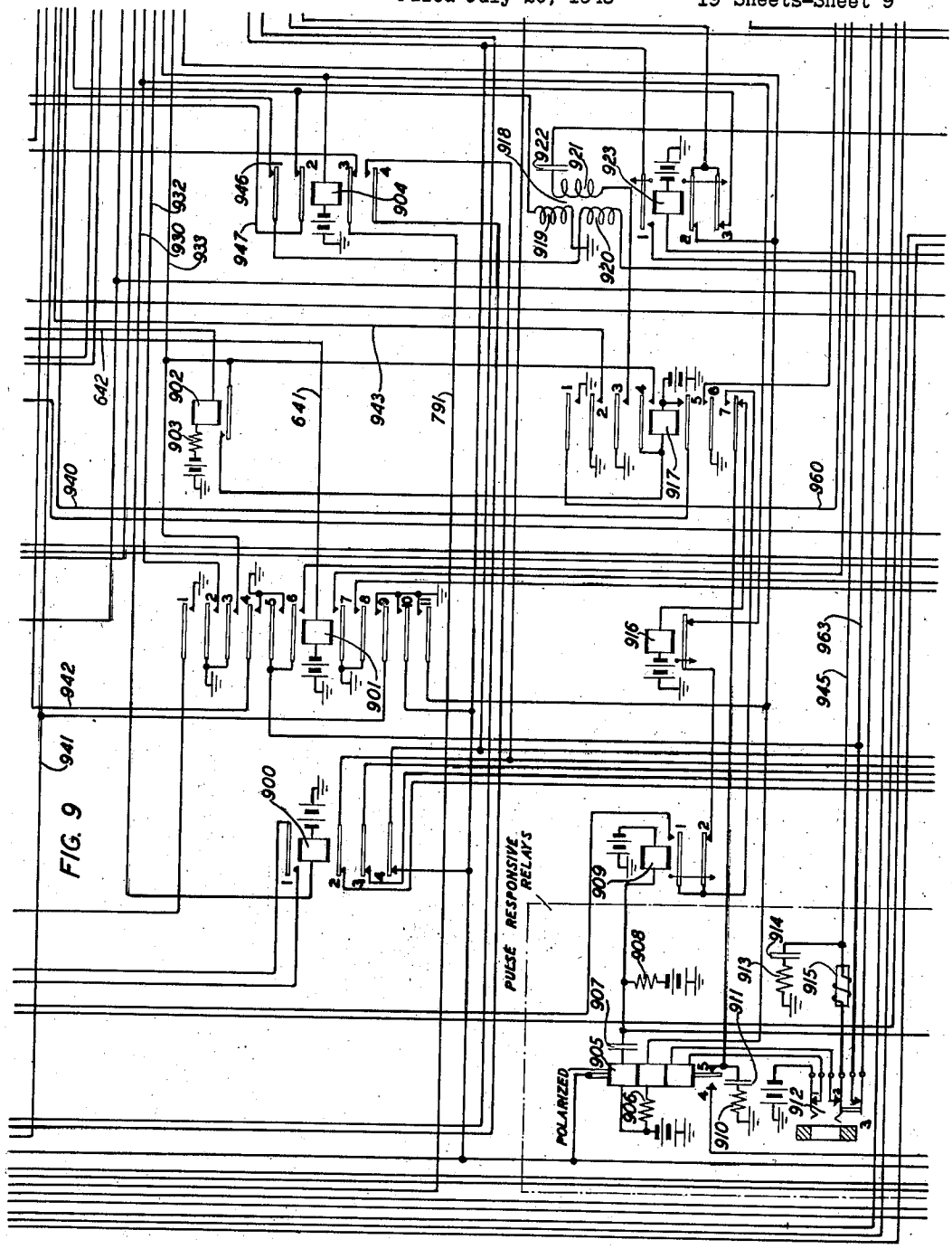

FIG. 9

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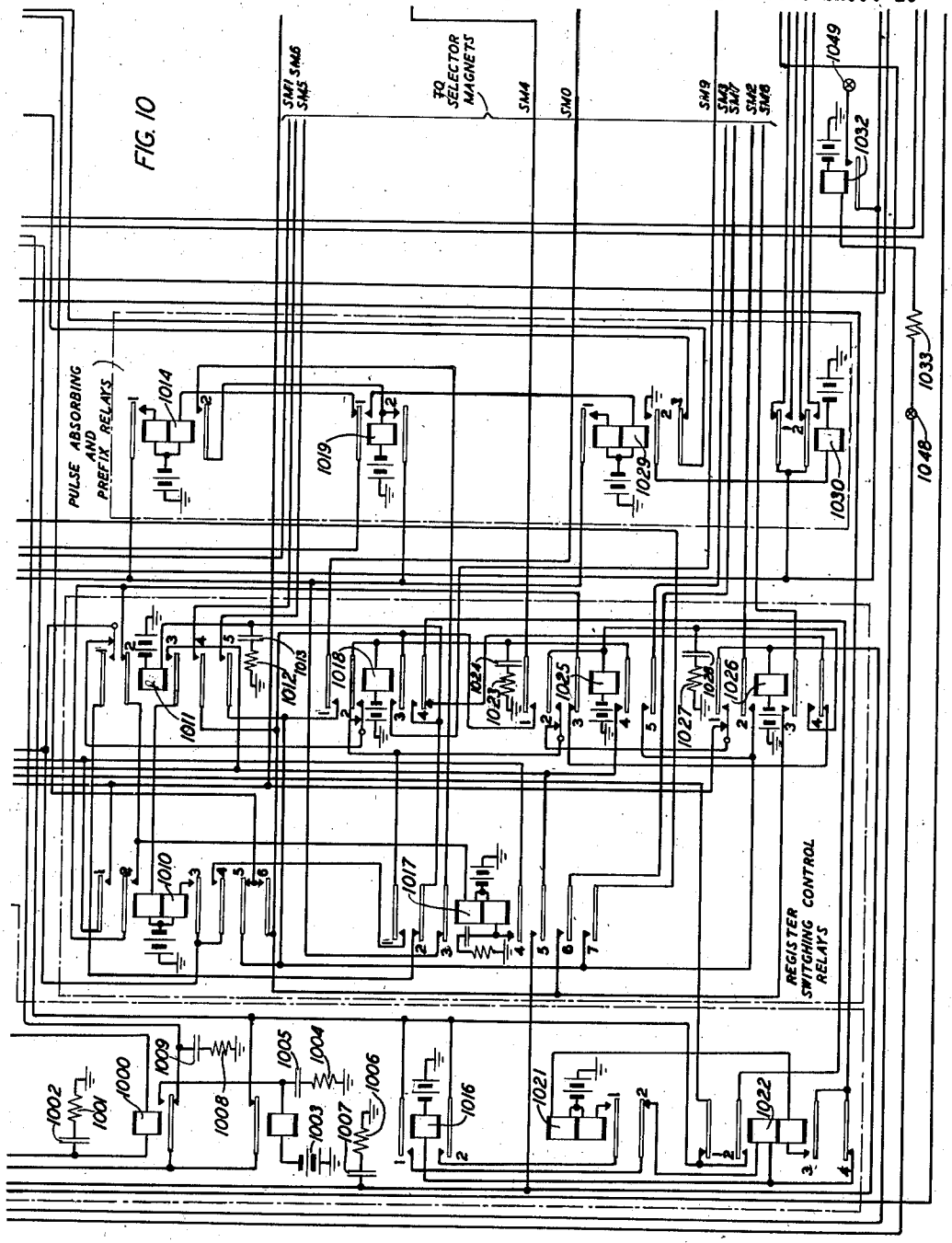
FIG. 10



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TELEPHONE SYSTEM

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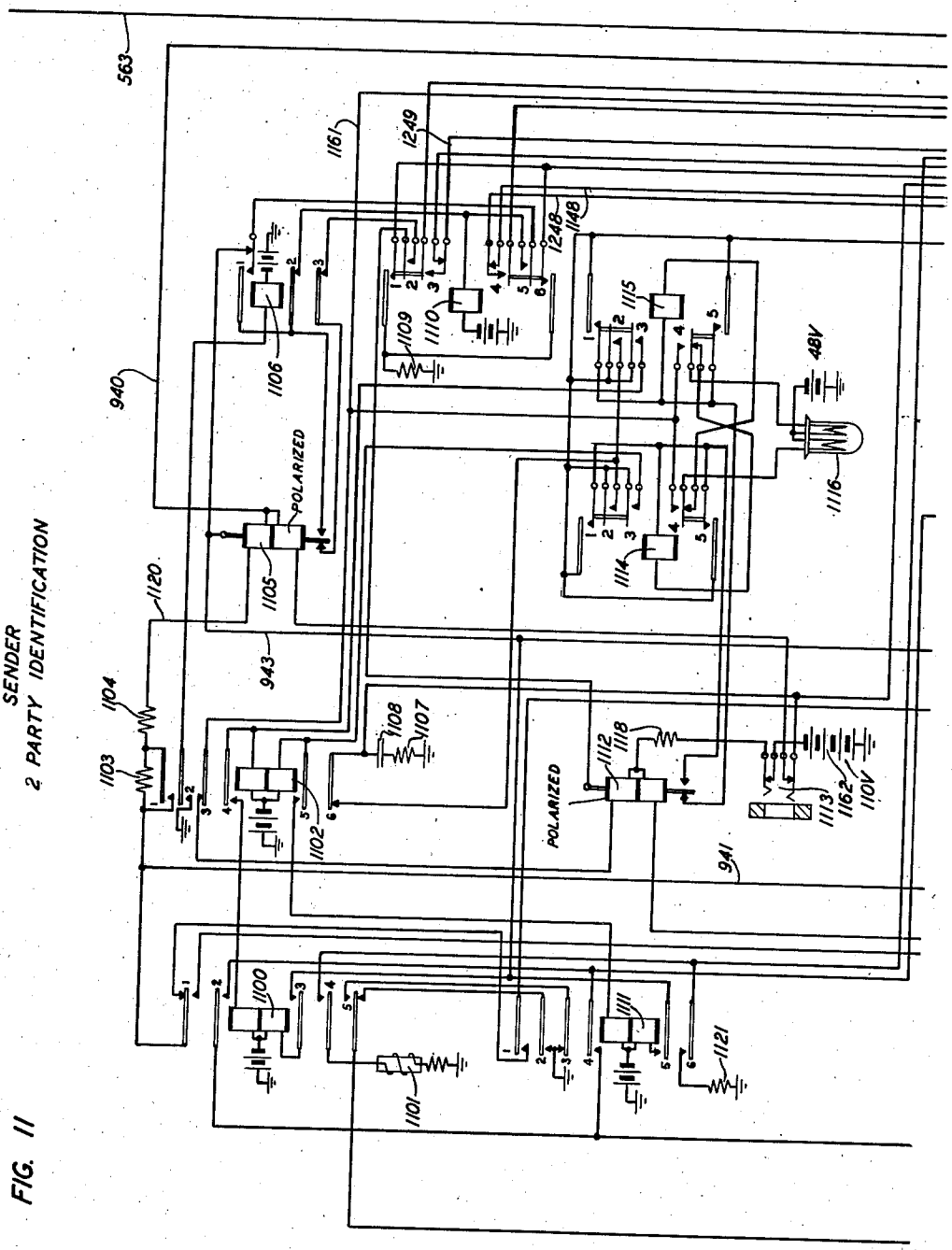

SENDER
2 PARTY IDENTIFICATION

FIG. 11

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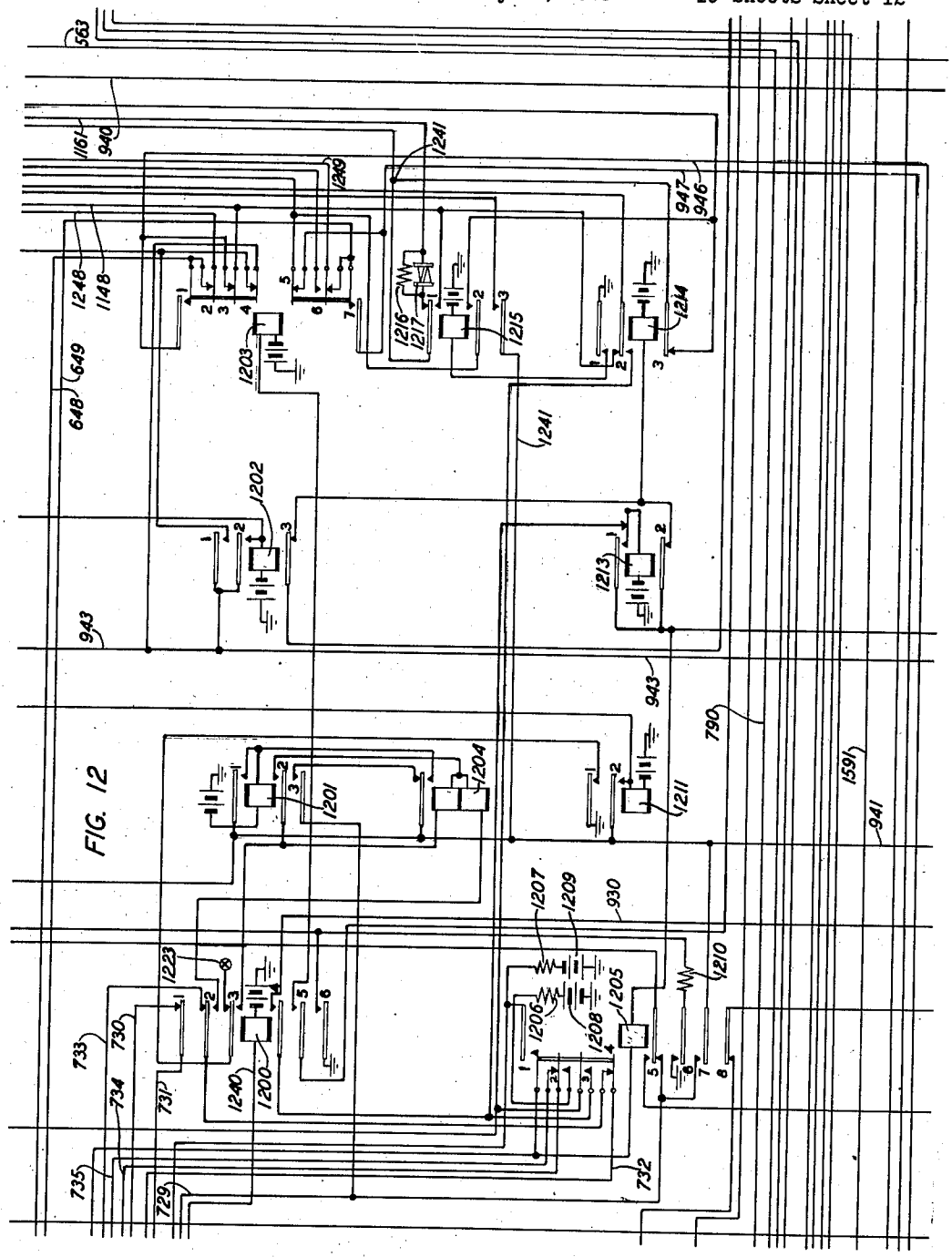

FIG. 12

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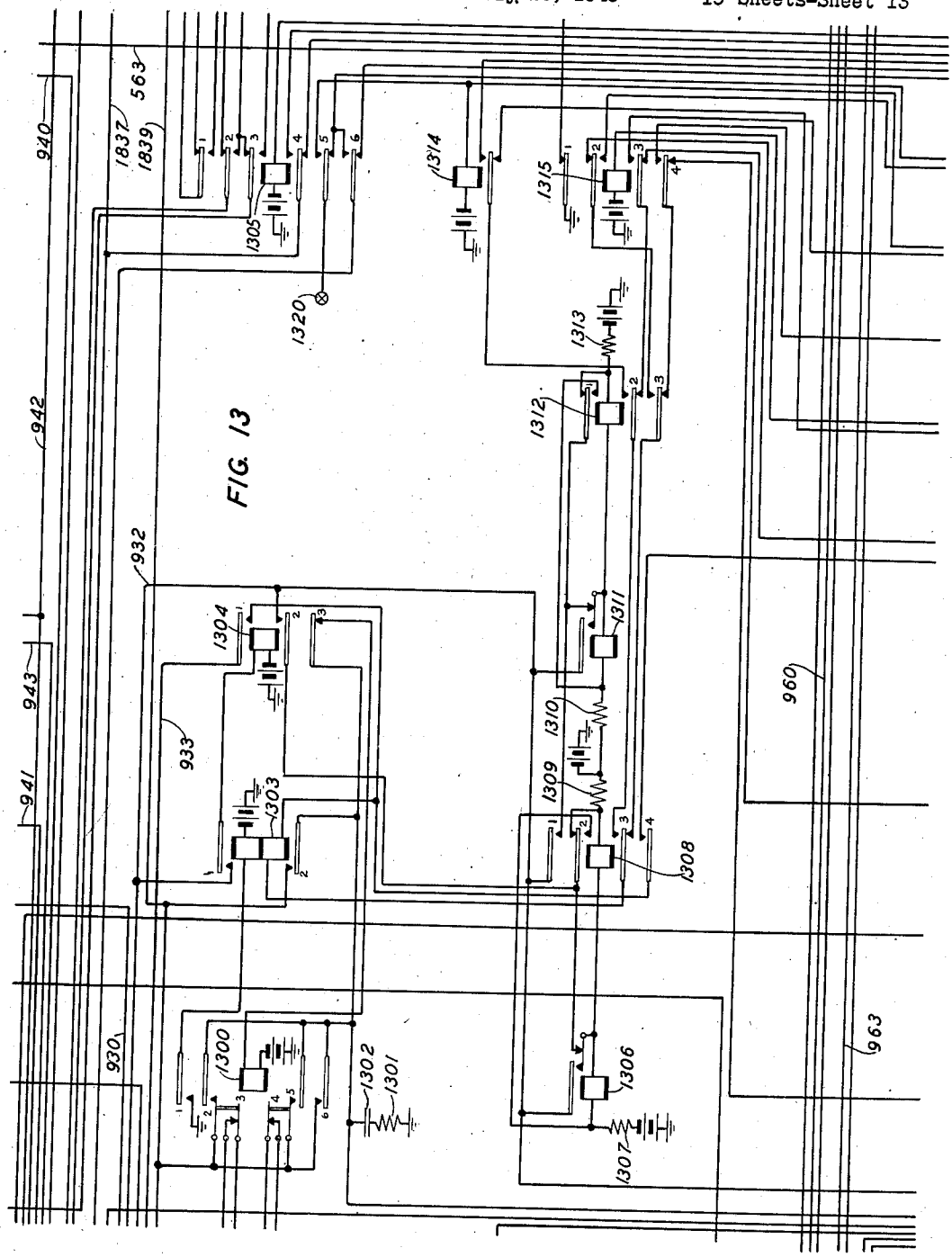

FIG. 13

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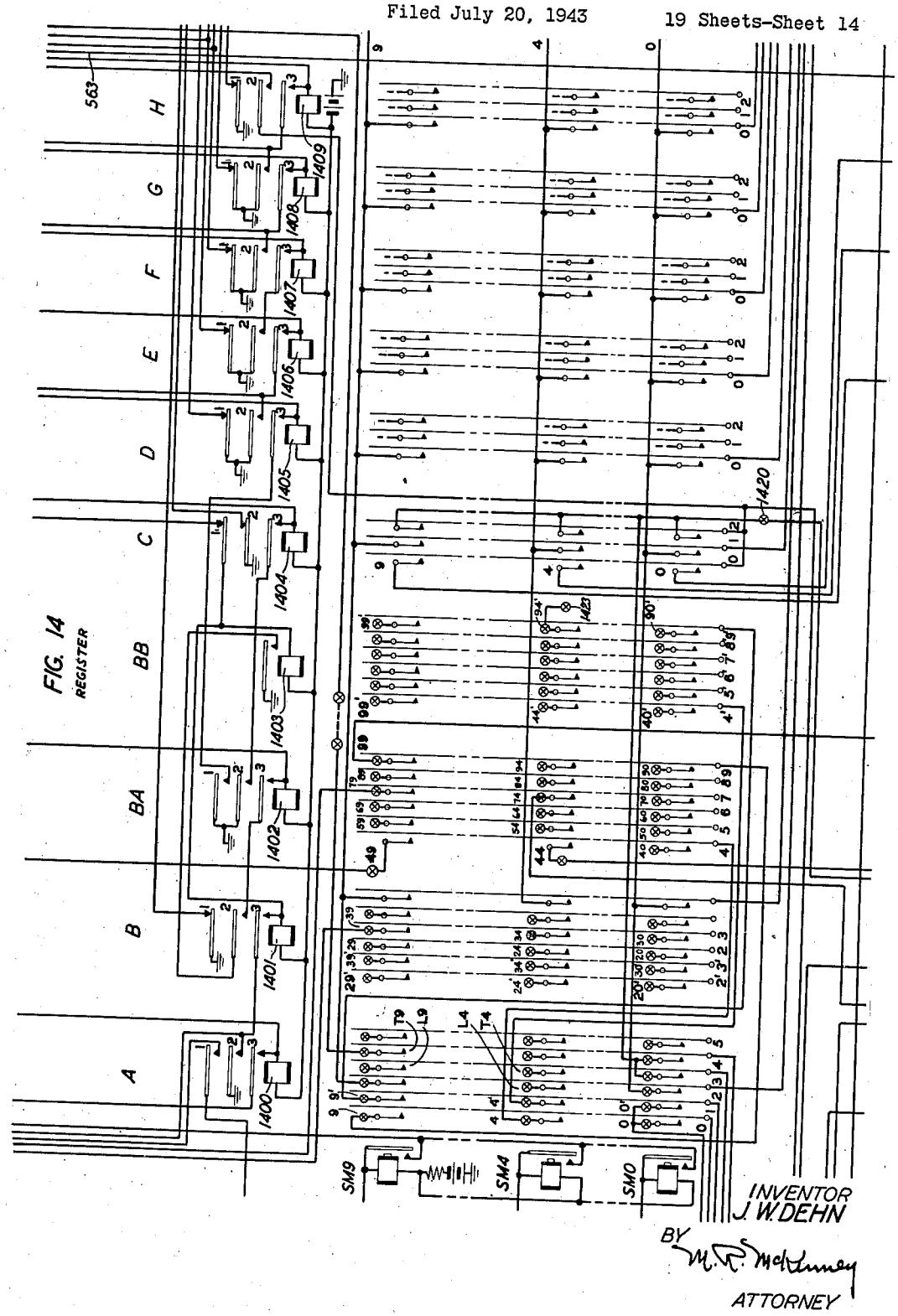

FIG. 14
REGISTER

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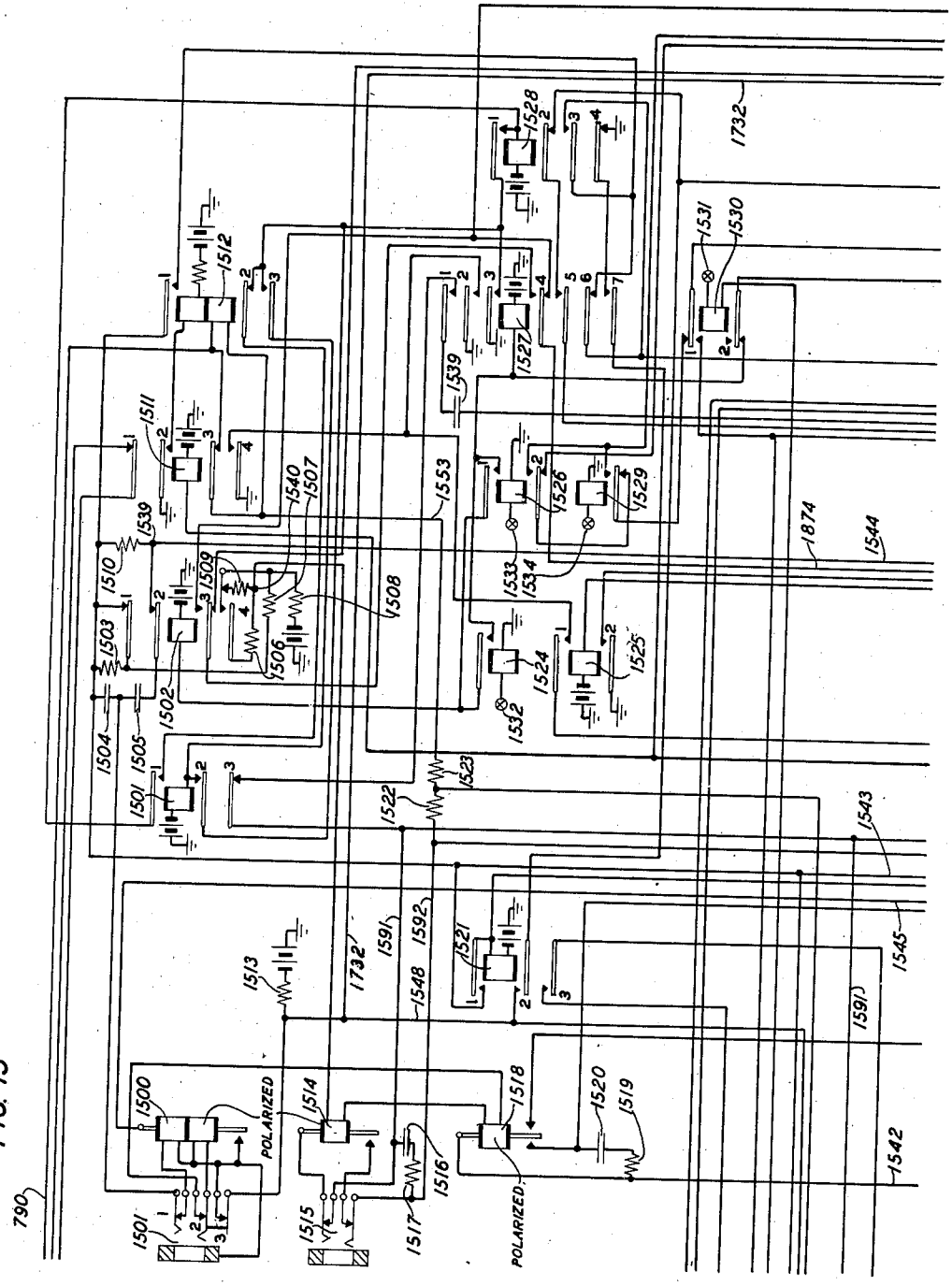

FIG. 15

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TELEPHONE SYSTEM

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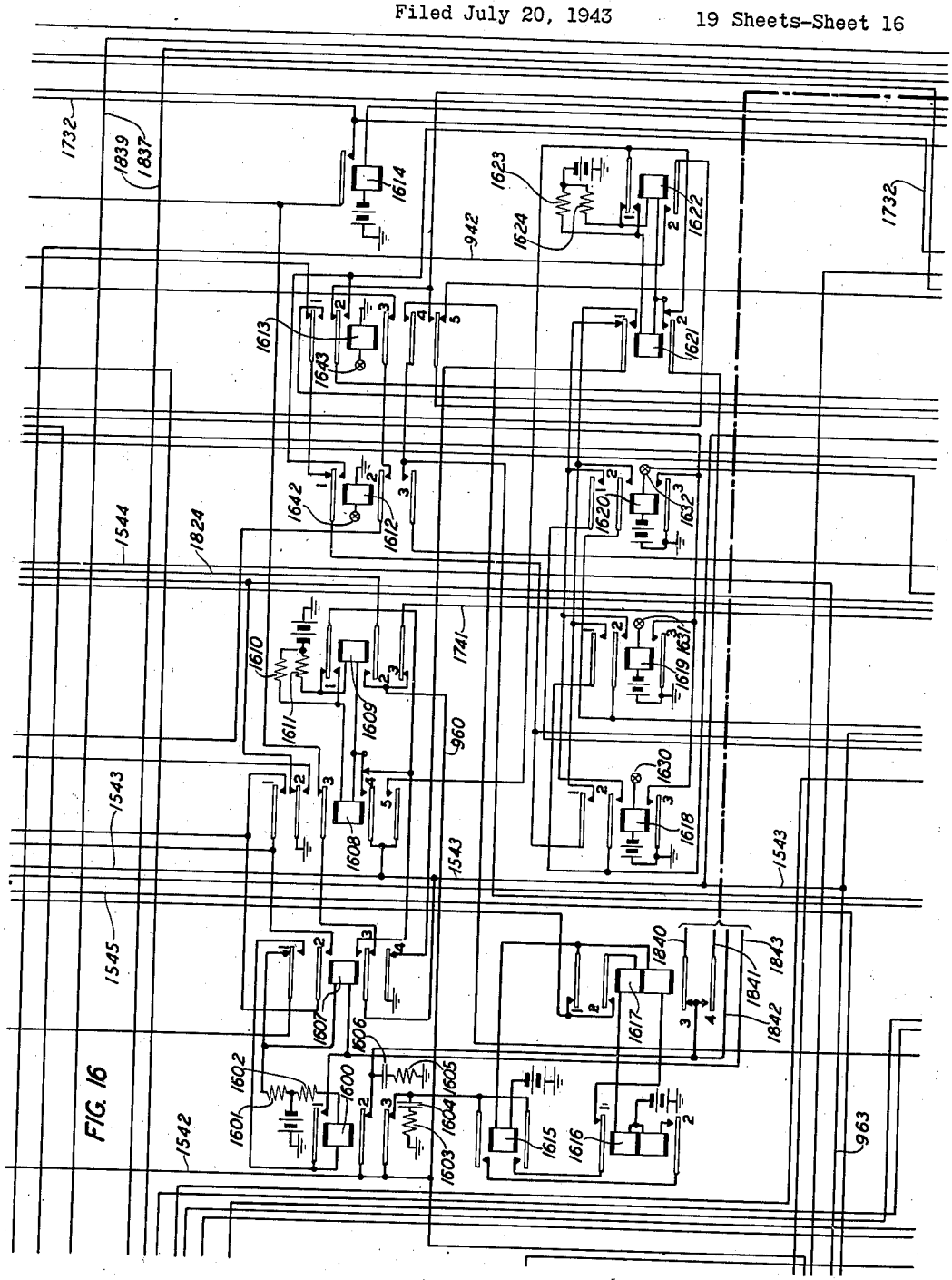

FIG. 16

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TELEPHONE SYSTEM

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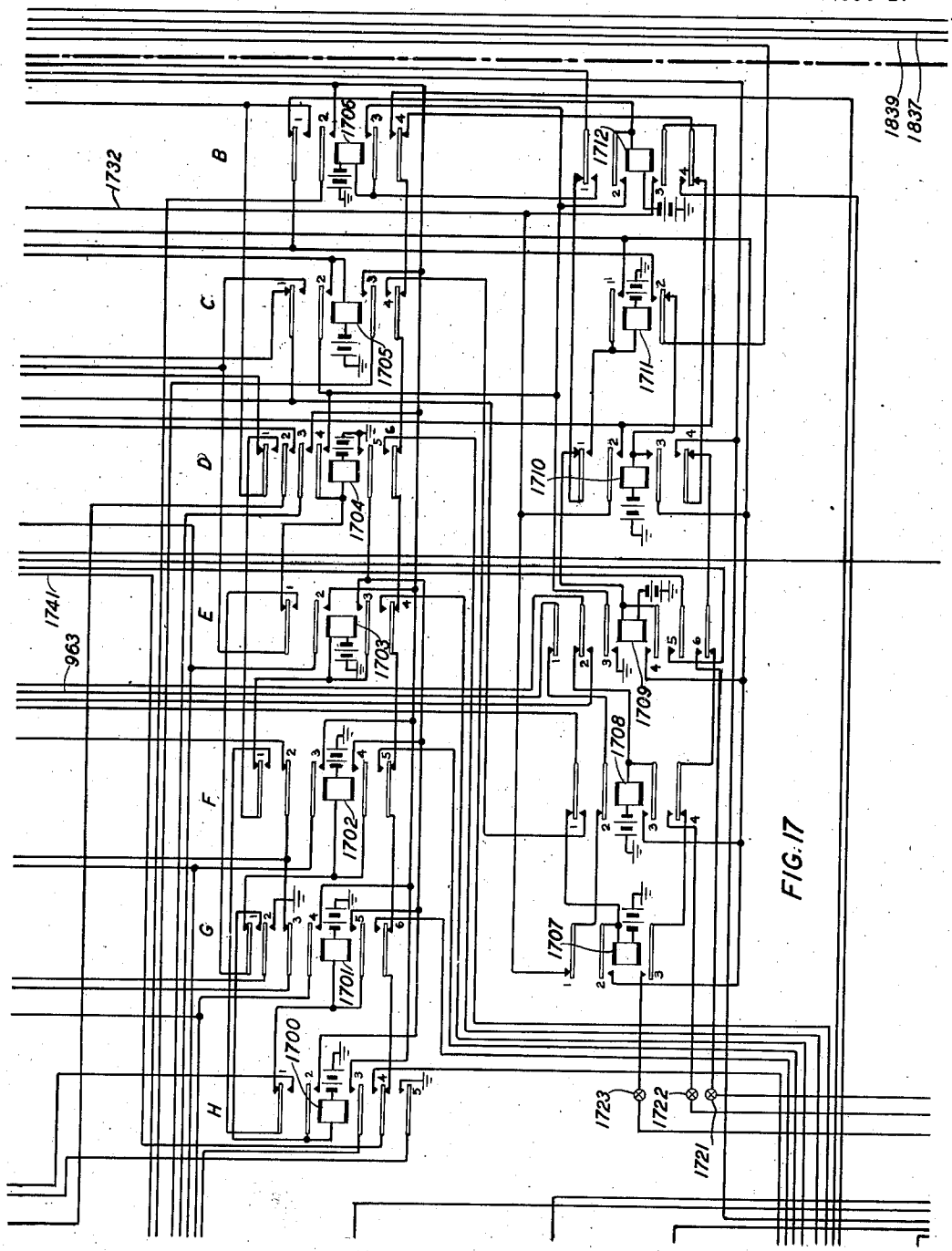

FIG. 17

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TELEPHONE SYSTEM

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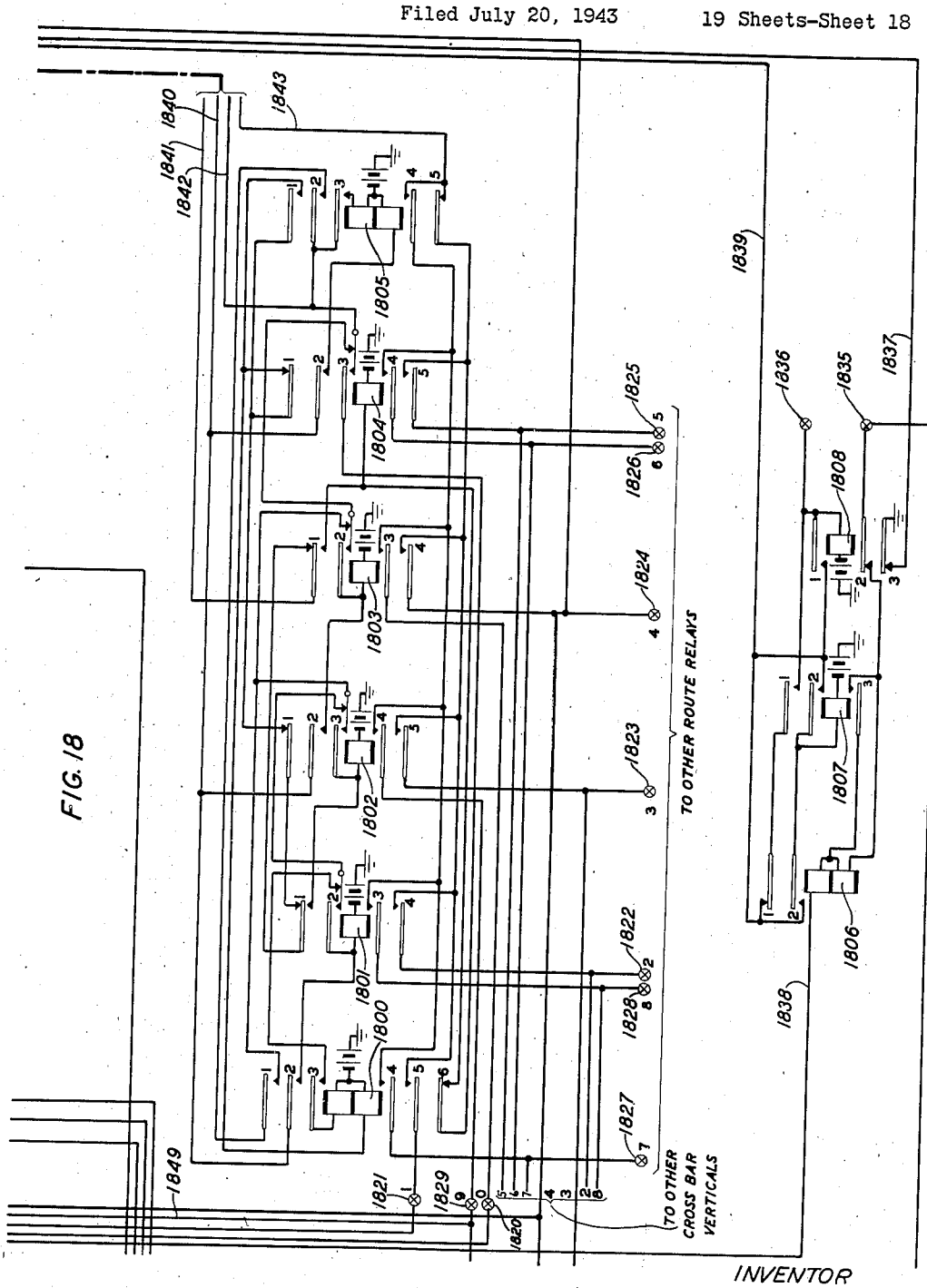

FIG. 18

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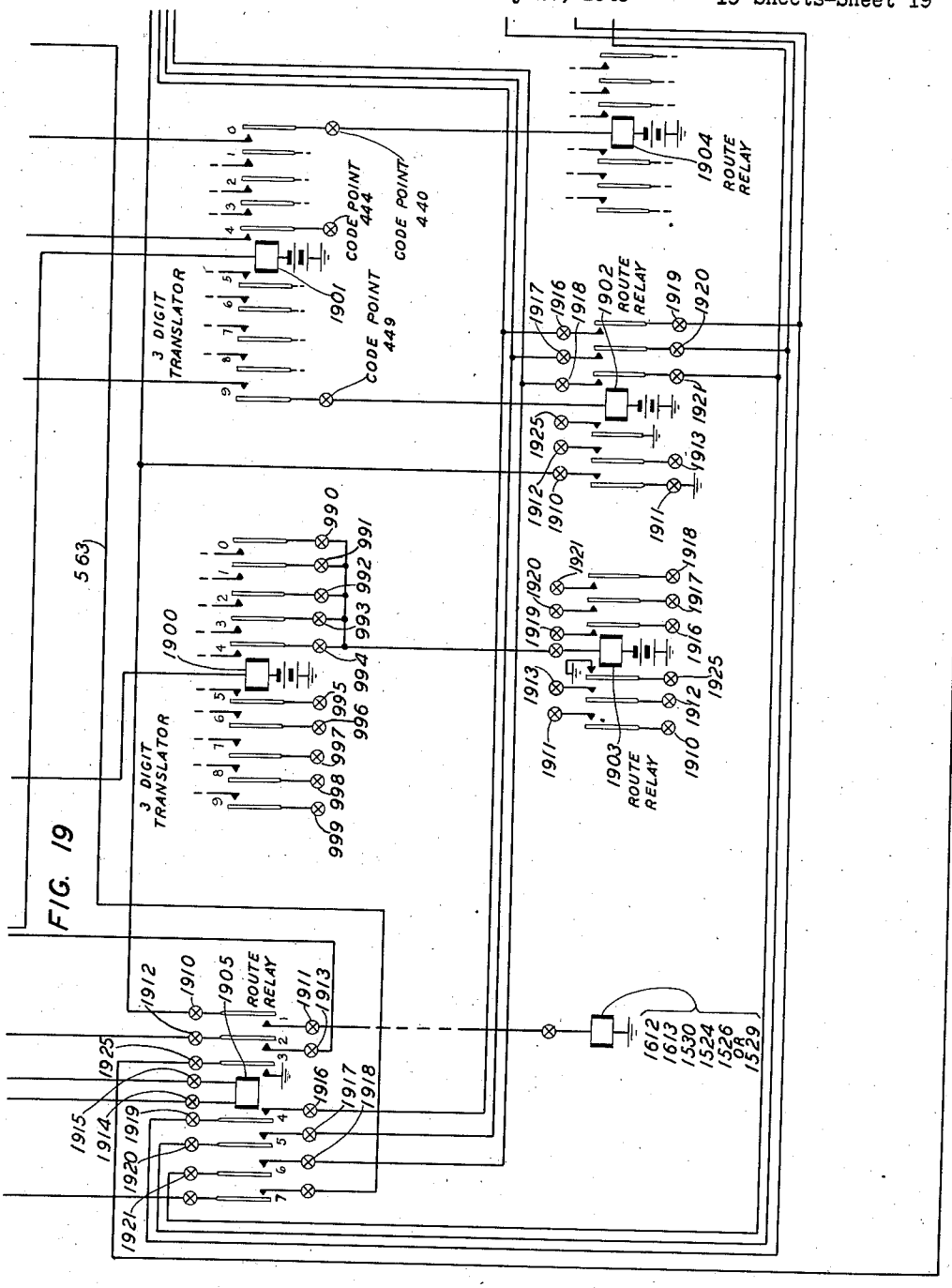

FIG. 19

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Patented Aug. 15, 1944 2,355,908

UNITED STATES PATENT OFFICE

2,355,908

TELEPHONE SYSTEM

Joseph W. Dehn, Great Neck, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application July 20, 1943, Serial No. 495,487

22 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to those in which connections are established by automatic switches.

The object of the present invention is to enlarge the scope and improve the operation of small dial responsive telephone offices.

A feature of this invention consists in a full automatic switching office for small dial areas in a telephone exchange system in which all telephone connections are under the control of a sender which is automatically connected to calling lines responsive to the removal of the receiver in a calling subscriber's station, the sender being arranged to register the digits dialed for all telephone codes whether for a local subscriber or a subscriber in another office area and for governing the selection of means to be connected to a first selector for positioning the brushes of said first selector, the sender in response to digits of a local code dialed by the calling subscriber causing the operation of means for connecting the first selector to the calling subscriber's station dial for controlling said first selector and in response to digits of a code of an office in another office area causing the operation of means in the sender for connecting the first selector to the sender pulsing mechanism for controlling said first selector.

Another and related feature consists in an arrangement of control relays responsive to the operation of routing relays for omitting the transmission of certain digit pulses for one type of office and transmitting said digit pulses for another type of office.

Another and related feature consists in a combination of digit responsive relays arranged to absorb a single first digit "1" from the calling subscriber's station when not followed by a second digit 1 and arranged to cause the registration of two successive digits 1—1 from the called subscriber's station, the latter registration consisting of a prefix to one of two codes when two offices having the same office code may be dialed by a calling subscriber and consequently controlling the routing of the telephone connection.

Another and related feature consists in a sender releasing mechanism under the control of a timing device which times each interval between digits dialed, allowing a predetermined time interval for the first pulse of a digit to follow the last pulse of a preceding digit, with means operated at the termination of this predetermined time interval for releasing the sender.

Another and related feature consists in means in a sender under the control of route relays for controlling the speed of transmitting digit pulses from sender pulsing mechanism to the pulse responsive mechanisms of distant offices.

Another and related feature consists in means in a sender under the control of route relays for transmitting slow speed pulses for digits to operate step-by-step selectors for selecting an outgoing trunk to a distant office and high speed pulses for digits to operate registers in the sender of the distant office.

Another and related feature consists in a simplified three-digit code translator for an automatic switch controlling sender for routing calls to various office areas.

Another and related feature consists in progressively operable mechanism variably combined with the sender routing devices independent of the code registers of the sender for controlling the number of digits transmitted by the sender pulsing mechanism for selecting a trunk connection and for controlling the number of pulses which constitute each of said digits.

Another and related feature consists in the sender control of faulty outgoing trunk circuits connected to the sender by a switch for completing a trunk connection, said outgoing trunk having lock-out means operable by the sender for removing said outgoing trunk from service when the trunk is not responsive to pulses for completing a connection to a distant office.

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:

Fig. 1 illustrates a subscriber's station connected over a line conductor to line mechanism including terminals of a group of line finders, one line finder being shown in this figure;

Figs. 2 and 3 illustrate a line-finder selector trunk circuit permanently connected to the line finder of Fig. 1;

Fig. 4 illustrates a dual selector or first selector permanently connected to the line-finder selector trunk circuit of Figs. 2 and 3; Fig. 4 also diagrammatically illustrates two local office second selectors, a route selector, a direct trunk connection and a service operator's selector, all of which may be selected by the dual selector of Fig. 4;

Fig. 5 illustrates an outgoing trunk circuit having a lock-out device, diagrammatically illustrates other outgoing trunks which may have lock-out devices of the same character, and diagram-

matically illustrates the different types of offices reached from subscribers' lines connected to this fringe office, which are shown as panel offices, cross bar offices, step-by-step offices and cross bar tandem offices;

Fig. 6 illustrates a trunk finder circuit;

Figs. 7 to 19 inclusive illustrate the mechanisms of the sender which may be divided into units as follows:

Fig. 7, class recording mechanism;

Fig. 8, timing and sender release mechanism;

Figs. 9 and 10, pulse responsive mechanism from the dial in calling subscribers' stations;

Figs. 13 and 14 illustrate a cross bar switch register and control mechanism for the register which is operable responsive to the termination of digits dialed by the calling subscriber;

Figs. 11 and 12 illustrate mechanism for identifying stations on party lines;

Fig. 19 illustrates variously connected route relays and when taken in combination with Figs. 10 and 14, illustrates the three-digit translator mechanism;

Figs. 15, 16, 17 and 18 illustrate the mechanism for transmitting pulses to control telephone connections as registered by the calling subscriber.

General Description

The telephone office illustrated herein uses step-by-step switches throughout for finder equipment selectors and connectors. An exception to this resides in the cross bar switches for the sender register. It is an automatically operable office which may be used as an attended or an unattended office in small dial areas adjacent to and on the fringe of larger dial office areas. This office will, therefore, be known herein as a fringe office in order to distinguish it from other step-by-step offices to which connections are made over outgoing trunks. Connections may also be made from this fringe office to panel and cross bar offices.

The offices to which connections are made from the fringe office may be of the following character. The local step-by-step second selectors and connectors and the step-by-step offices 542 and 543 and trunking connections between these offices may be of the character fully described in "Automatic Telephony" by Smith and Campbell, second edition, published in 1921. The panel office 540 may be of the character disclosed and described in Patent 1,862,549 to R. Raymond and W. J. Scully, June 14, 1932. The cross bar office 541 may be of the character disclosed and described in Patents 2,235,803 to W. W. Carpenter, March 18, 1941 and 2,232,371 to J. W. Dehn and O. Myers, February 18, 1941. The tandem cross bar office 544 may be of the character disclosed and described in Patent 2,281,636 to W. B. Strickler, May 5, 1942.

The fringe office mechanism is organized for rapid operation with the mechanism in groups which normally serve particular groups of lines. The line finder of Fig. 1, the line finder selector trunk circuit of Figs. 2 and 3 and the dual selector circuit of Fig. 4 are permanently connected together. This is one of a group of such circuits serving a group of lines. A trunk finder circuit, Fig. 6, is permanently connected to a sender, and other trunk finder circuits are permanently connected to other senders. A trunk finder subgroup including a plurality of trunk finders and senders is common to a subgroup of line finders, trunks and dual selectors. The removal of the receiver in a calling station actuates a line finder, Fig. 1, which immediately establishes a start circuit for actuating a trunk finder circuit, Fig. 6 attached to a sender so that the line finder is hunting for the calling line at the same time that the trunk finder circuit is hunting for the line-finder selector trunk circuit, Figs. 2 and 3, which is permanently connected to the hunting line finder. When both the line finder has found the calling line and the trunk finder circuit has found the line finder selector trunk circuit connected with this line finder, the sender is energized and immediately associated with the calling subscriber's line by the energization of equipment in the line finder selector trunk circuit. Dial tone is transmitted to the calling subscriber's station by the sender and in response, the subscriber dials the code of the office in which the called line is located. The office mechanism may, therefore, be described as divided into units, each unit having a group of line finders and associated equipment for a group of lines which they serve. This equipment has a trunk finder and sender group normally associated therewith, energized in response to all calls from this group of lines. If the first finder and associated sender are busy, a different trunk finder associated with the different sender is actuated for association with the calling line and the unit of equipment associated therewith. This is also true of the line finder equipment in order that the mechanism of the office may operate in a flexible manner.

In response to the removal of the receiver in a subscriber's station, a line relay such as relay 100 is energized which actuates the line finder group relay, such as 120. This energizes relay 110 of the line finder Fig. 1 to establish a start circuit for this line finder and a start circuit for the trunk finder circuit, Fig. 6. The line finder, Fig. 1, hunts for the calling line and at the same time the trunk finder, Fig. 6, hunts for the line finder selector trunk circuit, Figs. 2 and 3, which is connected to the line finder hunting for the line. Thus no selectable links or connectors are used for a connection between the calling subscriber's lines and the sender which consequently is established in a very short interval of time. Relay 114 of the line finder, relay 202 of the line finder selector trunk and relay 600 of the trunk finder circuit are operated, thus connecting the calling subscriber's line with the sender "L" relay 905 which follows the dial pulses transmitted by the calling subscriber.

A record is immediately made by the sender of the class of service to which the calling subscriber is entitled. For this purpose, the mechanism shown in Fig. 7 is connected to the class designating mechanism of the line and if the calling subscriber is not entitled to the service dialed by the subscriber, a tone is transmitted to the subscriber by automatic equipment after the code digits are received by the sender.

The first selector Fig. 4 known herein as the dual selector because of its dual functions, is not under normal conditions connected to any type of pulsing device until after the code digits have been registered in the sender. Relay 202 disconnects the dual selector from the line and sender but as soon as the office code has been recorded by the sender, means is operated under the control of the sender registering equipment for selecting one of two methods or means for operating the dual selector circuit. If the call is for a subscriber in the fringe office, termed herein a local subscriber, the sender causes the release of

relay 202 in the line finder selector trunk circuit as soon as the code digits have been completely dialed thus connecting the dual selector pulse responsive mechanism to the calling subscriber's line and dial over the tip and ring conductors. The A relay 402 of the first or dual selector follows the dial pulses of the next digit after the last code digit dialed by the calling subscriber which connects the brushes of the dual selector with the second selector 420 or 421 and subsequent digits operate the second selector and connector to make connection with a local subscriber. The second selectors 420 and 421 represent two offices which may be reached by the dual selector, Fig. 4. These two offices may have separate names but are usually in the same area and thus are connected to the terminals associated with the first selector. As soon as relays and the code register switches are energized in the sender responsive to the dialing of a local code which causes the connection of the calling subscriber directly to the first selector, other mechanism in the sender is energized to cause the immediate release of the sender and the release of the trunk finder circuit, Fig. 6, from the line finder selector trunk circuit, Figs. 2 and 3, thus preparing the sender for seizure by another calling subscriber.

When the office code dialed by a calling subscriber and registered by the sender indicates an outgoing trunk is required for extending the connection to an office such as panel office 540 or cross bar office 541, the sender remains connected to the calling subscriber's line period. As soon as the office code has been registered, the sender controls the operation of relays in the line finder selector trunk circuit, Figs. 2 and 3, so that the first or dual selector is connected through the contacts of these relays to the sender out-pulsing mechanism instead of being connected to the calling subscriber's line as above described. When sufficient digits have been recorded by the sender, pulses are transmitted by the sender pulsing mechanism through the relay contacts in the line finder selector trunk for positioning the first or dual selector, Fig. 4. The first digits transmitted by the sender cause the selection of an outgoing trunk to the wanted office according to the code registered in the sender by the calling subscriber. Thus the sender automatically determines what pulsing means shall be used for operating the dual selector under control of the sender registers responsive to the dialing of the code digits. The dual selector is therefore not positioned until its operating path has been determined by the sender.

If the code dialed by the calling subscriber is that of a distant step-by-step office, the sender transmits a maximum of three digits to cause the dual selector and subsequent selectors to find a trunk to the desired step-by-step office. The thousands, hundreds, tens and units digits dialed by the calling subscriber are registered in the sender and subsequently are transmitted by the sender as four numerical digits as soon as the outgoing trunk has been found. These digits actuate two selectors and a connector at the distant step-by-step office.

If the distant office is a panel or cross bar office, the sender does not immediately transmit the digit pulses as is the case to a step-by-step office, but waits for a signal from the trunk circuit at the distant office indicating that the trunk has been attached by means of a link to a subscriber's sender in the distant office. This signal is given by a reversal of current over the trunk from the distant office to the sender equipment in the fringe office. After this signal has been transmitted, the fringe office sender transmits digits covering the office code and numerical digits and also stations digits, if they are required. These are registered by the sender in the distant panel or cross bar office. After the completion of registrations by the sender of a panel or cross bar office, a signal is transmitted to the fringe office sender which causes the disconnection of the trunk finder and the fringe office sender which may now restore to normal. At this time, the fringe office sender operates a relay in the line finder selector trunk circuit causing the connection of the calling subscriber A to the mechanism of the distant office which controls the connection of the called subscriber with the calling subscriber A.

If the code dialed by the calling subscriber corresponds to an operator's trunk reached by the first selector, the sender dials the correct number of digits required to cause the dual selector, Fig. 4, and possibly subsequent selectors to find one of the wanted trunks to this operator's position. The sender then causes the mechanism of the line finder selector trunk to function for connecting the calling subscriber's line to this operator's position circuit over the selected trunk circuit and automatically disconnects itself from the trunk connection. If the operator's trunk extends to another office, such as a tandem cross bar office, the trunk to the connecting office is selected by the operation of the dual selector by the sender in the fringe office and when the sender in the distant office is connected to the trunk, the fringe office sender transmits digits into the tandem cross bar sender for selecting an operator's position circuit in that office, thereafter connecting the calling subscriber to the trunk extending to the tandem cross bar office and causing the disconnection of the fringe office sender from the trunk connection.

The class of service to which the calling subscriber is entitled is determined by connecting leads 647, 644 and 645 extending from the line mechanism to marginal and non-marginal relays in Fig. 7. The line terminals 108 are variably connected as shown in Fig. 1, for indicating the class of service for individual lines. For example, if the line lead connected to terminal 108 is open, this generally indicates that a restricted line is calling. If this terminal is connected to ground through a high resistance, a coin line is calling. Other classifications are transmitted over leads 644 and 645 for responsive action of the class relays under the control of line group indications or off-normal post springs. The relays of Fig. 7 are automatically responsive to the class of service indications to guide the sender in its functions. When the calling subscriber is connected to a two party line, a two party identification test is necessary. Other devices are operated in the sender to indicate what routes the line is permitted to call and to indicate what charge should be made where different lines are charged different rates and to select one of a plurality of routes where there is more than one route provided for the same code dialed by the calling subscriber.

In case the call is from a two party message rate or extended scope subscriber's line, the sender makes a party line test to identify which party is calling. This test is made at the completion of the first digit and the result of the test is employed by the sender for controlling the energization of mechanism in the line finder selector trunk circuit, Figs. 2 and 3, and for energizing zone registration circuit equipment. In certain instances,

one routing may be required over one trunk line for a call to a given destination from a coin line subscriber and a different routing may be used for a trunk connection to the same destination if the call is from a non-coin line. Two route relays are provided for this service and the selection of the correct route relay is determined by the class indication which causes the operation of relays, such as relays 708 and 709, to connect different route relays to the registers of the sender circuit depending upon the nature of the calling subscriber's line.

The relays of Figs. 9 and 10 control the registration of digits dialed by the calling subscriber. The L relays 905 and those shown in the left margin of Fig. 10 follow the pulses of the dial for progressively operating the register switch controlling relays which form circuit combinations to operate the register switch select magnets 0 to 9. The mechanism of Fig. 13 is progressively operated as the digits are dialed for operating the register switch hold magnets corresponding to the digit dialed. The first or A digit is registered on the A verticals of the register switch. The second or B digit is registered on the B, BA or BB verticals depending upon the number or letter dialed. These three verticals will be known herein as the B register. The third or C digit is registered on the C vertical and remaining digits are registered in successive order.

It will be noted that duplicate numbers are shown on the A and B verticals such as 9—9', 20—20' etc., which are provided for duplicate codes in nearby offices which may be dialed by the subscribers of either office or another office. One of these codes is designated a 1—1 code and a prefix of two digits 1—1 is dialed by the calling subscriber before the code digits are dialed. For example, the code letters of nearby offices may both be designated WA and a connection to a subscriber in one office could be made by dialing WA followed by numerical digits and to a subscriber in the other office by dialing 1—1 WA followed by numerical digits. Since WA dialed by a subscriber would be registered as 92, the one office code relay is connected to the 92 register vertical code contact and the other office code relay is connected to the 92' register vertical code contact and a circuit for operating these code relays is established over a circuit controlled by either the absence of the 1—1 prefix or the dialing of the 1—1 prefix by the subscriber. If the office code 92 represents the code of the local office and therefore the incoming call is for another local subscriber in the same office, the code point or contact on the register switch is connected to mechanism for releasing relay 202 of the line finder selector trunk and restoring the sender as previously described instead of to a route relay. The two digits 1—1 dialed as the prefix to a code causes the operation of four relays 1014, 1019, 1029 and 1039 for designating the routing of the telephone connection. For example, the routing shall be determined by the connection to the 92' register contact instead of the 92 register contact. The first digit 1 operates relay 1014 and between digits relay 1019 is operated. The second digit 1 operates relay 1029 which locks and operates relay 1039.

A single digit 1 is absorbed by this relay combination and a special operating circuit arrangement of the pulse 1 switch control mechanism. It is recognized that the numeral 1 is not used for an office code, since very often there is an unintentional movement of the switchhook by the calling subscriber when starting a call which would cause a single pulse to be transmitted to the sender pulsing mechanism. In the present sender, either accidental or unintentional single pulses cause the operation of the pulse 1 relay 1017 and relay 1014. Under this condition, relay 1017 is not locked in position and therefore relay 1017 immediately releases and the single digit 1 is absorbed and not recorded by the A code register switch. The second digit 1 operates relays 1029 and 1039 as outlined, but a third digit 1 or third and fourth digits 1 would be absorbed since relay 1017 would merely operate and again release after the prefix 1—1 relays are locked in position.

The sender is arranged for use in two-digit, three-digit or three two-digit dial office areas. The A, B, BA and BB register verticals are used for a two-digit code and a simplified translator is used for translating three-digit codes. This translator comprises the use of the A, B, BA, BB and C verticals of the register combined with three-digit translator relays having their windings connected to the contacts of the B verticals and their contacts connected to the contacts of the C register vertical. This translator is arranged to operate the three-digit translator relay responsive to the first digit registered on the A register verticals, and the second digit registered on the B, BA or BB verticals. A circuit is then established through one contact of this three-digit translator relay responsive to the registering of the third digit on the C register vertical. The circuit established through the contact of the three-digit translator relay operates a route relay connected to this contact. This translator will be later described in detail.

A simplified arrangement is shown for controlling the transmission of pulses from the pulsing equipment of the sender to establish a connection to a distant office. Each route relay has its contacts connected to sender equipment which automatically controls the number of digits to be transmitted by the pulsing mechanism of the sender for selecting an outgoing trunk of the correct routing and also controls the number of pulses in each digit used for the selection of this outgoing trunk. This arrangement controls the number of digits to be dialed to the distant office and the number of pulses in each digit and the rate of speed in pulsing these digits. The arrangement for controlling the number of digits and the number of pulses in each digit automatically controlled by the route relay, comprise a plurality of relays connected to the contacts of the route relay which automatically controls the position in a group of progress relays for starting the first digit. Under this method of controlling the number of digits by mechanism variously connected to the contacts of the different route relays, no time is lost in absorbing digits not required for routing the call since the digits not required are omitted by merely skipping certain positions in the mechanism governing the progressive out pulsing of the digits. For example, if only one digit is required for selecting an outgoing trunk, the third relay is actuated and the first two relays remain ineffective. In this manner any of the out pulsing digit control mechanisms may be used or skipped. In order to control the number of pulses in each digit transmitted by the sender, a plurality of the contacts of the route relay are cross-connected to contacts on a plurality of relays which are successively operated as pulses are transmitted and also

connected to the mechanism governing the progressive out pulsing of these digits. These relays are operated in combinations so that when the number of pulses have been transmitted by the sender, according to the cross-connection, a circuit is established for operating another relay which opens the pulsing circuit.

As above outlined, the office code dialed by a calling subscriber operates the cross bar switch register for the selection of means for controlling the first or dual selector which in the case of an outgoing call to another office is the sender out-pulsing mechanism, regulated under the control of the selected route relay for selecting an outgoing trunk to the designated distant office. The outgoing trunk has relays therein which respond to the pulses of each digit and also to the termination of the digit pulses, for regulating the operation of step-by-step switches in a distant step-by-step office or for causing the registration of the code and numerical digits in the sender of a cross bar or panel office. Should a fault occur in a trunk of a group of trunks extending to a particular office and particularly in a small group of trunks in an unattended office, serious delays may result if the fault is of a character to prevent completing a telephone connection. A new arrangement of cooperation between a sender and a faulty trunk circuit is, therefore, provided to lock the trunk circuit out of service, transmit a tone to the calling subscriber and release the sender therefrom when a sender cannot complete a telephone connection beyond the trunk circuit. The arrangement embodies a lock-out control circuit common to the trunks of a group which is automatically energized over a lead from the sender and at the same time the sender controls the individual trunk connected thereto so that the mechanism common to the group of trunks is effective as operated by the sender for locking this individual outgoing trunk circuit out of service.

Detail Description

Incoming call

It was previously indicated in the general description that a line finder, a line finder selector trunk and a dual selector are permanently connected together as shown in Fig. 1, illustrating a line finder, Figs. 2 and 3 illustrating a line finder selector trunk and Fig. 4 illustrating a dual selector circuit. Each sender has a trunk finder circuit permanently connected thereto as shown in Fig. 6, illustrating a trunk finder connected to the sender, Figs. 7 to 18. Thus a call from a subscriber set at subscriber station A, Fig. 1, energizes line relay 100 when the receiver is removed from the switchhook which energizes the line-finder subgroup start relay 128 controlling the association of the line with a line finder of a line finder group serving a particular group of lines. There are a plurality of relays 128 and a plurality of other chain relays in the usual form for selecting the line finder to serve the calling line, the selected line finder having a line-finder selector trunk and a dual selector connected thereto. Relay 128 connects ground to a segment of the commutator 127 and also associates ground with the start circuit for the line finder. This start circuit may be traced from contact 1 of relay 128, contact 3 of relay 117, winding of relay 116 to battery which energizes relay 116. Relay 116 establishes a circuit for relay 125 and the vertical magnet 124 which starts the line finder in search of the calling line. Relay 116 also establishes a start circuit for the trunk finder, Fig. 6. The start circuit for the trunk finder may be traced from ground on contact 3 of relay 116, conductor 140, contact 9 of relay 209, contact 6 of relay 210, contact 1 of relay 215, winding of start relay 217 to battery. Relay 217 operates to establish a circuit for subgroup start relay 634 of Fig. 6 which may be traced from battery through the winding of relay 634, conductor 640, contact 2 of relay 217, contact 2 of relay 215 to ground. The operation of relay 634 establishes a circuit for relay 620 of the trunk finder which energizes the trunk finder vertical magnet. The start circuits for both the line finder, Fig. 1, and trunk finder, Fig. 6, have been initially established to show that the two finder circuits are operated at the same time, the line finder for selecting the calling line and the trunk finder for selecting the line finder selector trunk circuit of Figs. 2 and 3 which is connected to the line finder actuated for selecting the line.

Line finder

Returning to the line finder, the operation of relay 116 establishes a circuit for stepping relay 125 which may be traced from ground on contact 2 of relay 116, contact of vertical magnet 124, contact 2 of rotary magnet 123, lower winding of relay 125, contact 4 of relay 117 to battery. The vertical magnet 124 is energized from ground through contact 2 of relay 116, contact of relay 125, contact 3 of relay 115, winding of vertical magnet 124 to battery through contact 4 of relay 117. Brush 126 is thus elevated until it reaches ground on segment 10 of commutator 127 which is connected to ground on contact 3 of relay 128. A circuit is thus established for relay 115 through its upper winding, contact 2 of rotary magnet 123, lower winding of stepping relay 125, contact 4 of relay 117 to battery. This holds relay 125 in an operated position to prevent further stepping. Relay 115 transfers the locking circuit for relay 113 not as yet established from the off-normal ground on contact 2 of vertical off-normal 119 to a circuit which is grounded for each operation of the rotary magnet to prevent locking relay 113 if it should operate during the stepping of the brushes. Relay 115 is made slow in operating to give a short time interval between the last vertical step and the first rotary step. The operation of relay 115 also transfers the stepping circuit from the vertical to the rotary magnet. The circuit for the rotary magnet 123 may be traced from battery through its winding, contact 3 of relay 115, contact of relay 125, contact 2 of relay 116 to ground. The rotary magnet steps the shaft and brushes until one of the sleeve wipers reaches the terminal which is connected to battery through the winding of the cut-off relay 101 in the line circuit. A circuit for relay 114 is thus established from battery through the winding of cut-off relay 101, contact 1 of relay 100, sleeve terminal 107, brush 111, winding of relay 114, contact 2 of relay 117, upper winding of relay 125, to ground on contact 3 of relay 116. Relay 114 is sufficiently operated in series with the winding of relay 125 to close its contact 4. Relay 125 is held operated to prevent further stepping. Relay 114 in establishing its contact 4, closes a circuit from battery through its lower winding, contact 1 of the rotary magnet 123, contact of relay 125 to ground on contact 2 of relay 116. This completely operates relay 114

to close the leads from the line circuit to the line-finder selector trunk circuit, Fig. 2, and establishes a circuit for operating relay 117 which may be traced from battery through the upper winding of relay 117, contact 5 of relay 114 to the off-normal ground. The operation of relay 117 connects the sleeve lead 140, and ground from contact 3 of relay 116 to the line circuit, establishes a locking circuit for relay 114, opens the multiple chain circuit to other finders and transfers the start lead 146 from relay 116 to the lower winding of relay 117 and to the outgoing start lead 147 which is well understood in line-finder groups of this character. The operation of relay 117 also in opening its contact 4 removes battery from the lower winding of relay 125, the winding of relay 115 and the vertical magnet 124. The upper winding of relay 125 is short-circuited through contact 2 of relay 117. The circuit for relay 116 is also open but this relay is made slow to release in order to hold a ground on the sleeve lead during the time required by the dual-selector to connect ground to this sleeve lead. As described later in detail, the operation of relay 114 connects the windings of the dual selector A relay 402 with the line which operates relays 402 and 403. Relay 403 connects ground to the sleeve lead 455 which extends through trunk relay contacts to the line-finder sleeve lead 140. This ground supplies a locking circuit for relay 114.

Trunk finder

As previously stated, the trunk finder circuit, Fig. 6, is energized by relay 116, Fig. 1, when this relay operates to cause the simultaneous hunting of both finders. The operation of relay 634 places ground on a segment of commutator 632 and energizes relay 620 to operate a vertical magnet of this finder. Relay 620 connects ground to the sleeve lead 641 extending through the sender and connects ground to its contact 2, contact of vertical magnet 628, contact 1 of rotary magnet 629, upper winding of relay 627, to battery through contact 4 of relay 619, thus operating relay 627. In certain instances, multiple finders are used and the operation of relay 620 transfers the start lead of the multiple finder directly to its second choice finder. Ground on the sleeve lead from either finder also operates relay 619 of the multiple finder transferring the in-start lead of the finder not in use to the out-start lead on the relay 620 which is released. When either finder is off normal, the vertical off-normal springs open the sleeve leads and connect ground to the sleeve of the normal finder to hold it until the finder in use has returned to normal.

Relay 627 in operating energizes the vertical magnet 628 and steps the shaft upward one step placing the commutator brush on the first segment. The circuit for the vertical magnet may be traced from ground through contact 2 of relay 620, contact of relay 627, contact 4 of relay 621, winding of vertical magnet 628 to battery through contact 4 of relay 619. When brush 633 steps to the first terminal, the vertical off-normal springs are open and the circuit for relay 627 is open. Relay 627 releases which releases the vertical magnet to reclose the circuit for relay 627. This continues as the brush is moved in an upward direction until brush 633 reaches the segment which is connected to ground through contact 2 of relay 634. The circuit is thus established to energize relay 621 through its upper winding, upper winding of relay 627 to battery on contact 4 of relay 619. This holds relay 627 in an operated position to prevent further stepping. Relay 621 is slow operating to give a short time interval between the last vertical step and the first rotary step since the rotary magnet is energized by the operation of relay 621. The circuit for the rotary magnet may be traced from battery through the winding of rotary magnet 629, contact 4 of relay 621, contact of relay 627 to ground on contact 2 of relay 620. The rotary magnet sets the shaft and brushes in a rotary motion until the sleeve wiper reaches the terminal which is connected to battery through the winding of relay 215 of the line-finder selector trunk circuit. The sleeve circuit and the circuit for relay 215 may be traced from battery through the winding of relay 215, contact 1 of relay 217, which was operated by relay 116, thence over lead 242 to sleeve terminal 609, brush 604, upper winding of relay 600, resistance 601, contact 1 of relay 619, lower winding of relay 627 to ground on contact 3 of relay 620. Relay 215 is operated and relay 600 is partly operated in series with relay 215 and the lower winding of relay 627 to ground on contact 3 of relay 620. Relay 600 is operated sufficiently to close its contact 9 and relay 627 is held operated to prevent further stepping. Upon the closure of contact 9, relay 600 is fully operated over a circuit from battery through its lower winding and contact 9, contact 2 of the rotary magnet 629, contact of relay 627, contact 2 of relay 620 to ground. The operation of relay 215 releases relay 217 which establishes a locking circuit for relay 215 to ground on sleeve lead 455. The operation of relay 215 and the release of relay 217 also connects ground from sleeve lead 455 through contact 3 of relay 215, contact 3 of relay 217 to sleeve lead 242 extending to the trunk finder circuit and as later explained to the sender. The operation of relay 600, connects leads 642 to 649 inclusive, from the sender to the line-finder selector trunk circuit, Figs. 2 and 3 and to the line finder Fig. 1. Relay 600 also establishes a circuit for relay 619 traced from battery through the upper winding of relay 619, contact 10 of relay 600 to ground on the vertical off-normal contact 631. Relay 619 in operating connects the sleeve lead 641 of the sender to the sleeve lead of the line-finder selector trunk circuit. This sleeve lead may be traced from sleeve lead 242 and terminal 608 of the line finder selector trunk through brush 604, contact 4 of relay 600, lead 646, contact 1 of relay 619 to lead 641 which is the sleeve lead in the sender. A locking circuit is established for relay 600 to the sleeve circuit traced from battery through the lower winding of relay 600, contact 9 of relay 600, contact 3 of relay 619 associated with the sender sleeve conductor 641 and through contact 1 of relay 619 associated with the sleeve conductor of the line-finder selector trunk circuit to ground. The operation of relay 619 transfers the in-start lead to the out-start lead in the usual manner well known in the art. This relay also removes battery from relays 627 and 621 releasing these relays. The lower winding of relay 627 is also short-circuited by the operation of relay 619. Relay 620 is released but is slow to release for holding ground on the sleeve lead during the time required by the trunk to connect ground to the sender sleeve lead, as will be later described.

The operation of relay 114 in the line-finder circuit immediately after the line is found, as previously described, connects the tip and ring line conductors through the line-finder selector

trunk, Fig. 2, to the dual selector circuit, Fig. 4, connected thereto. A circuit is thus established for the dual selector circuit "A" relay 402. The circuit for relay 402 may be traced from battery through its lower winding, contact 3 of relay 400, conductor 451, contact 3 of relay 203, contact 10 of relay 202, lower winding of polarized relay 200, contact 6 of relay 114, contact 6 of relay 113, brush 110, terminal 106, subscriber's station A, terminal 105, brush 109, contact 1 of relay 113, contact 1 of relay 114, conductor 142, upper winding of polarized relay 200, contact 1 of relay 202, contact 2 of relay 203, conductor 450, contact 2 of relay 400, upper winding of relay 402, contact 1 of the 11th rotary step springs 417 to ground. The operation of relay 402 establishes an operating circuit for the "B" relay 403 from battery extended thereto through a permanent signal circuit, winding of relay 403, contact of relay 402 to ground on contact 1 of relay 400. The operation of relay 403 connects ground from its contact 3 to its sleeve conductor 455 which extends through contact 8 of relay 211 in parallel with contact 8 of relay 210 to sleeve conductor 140. This ground associated with the line-finder circuit establishes a locking circuit for relay 114 which may be traced from conductor 140 through contact 1 of relay 117, contact 4 and winding of relay 114 to battery. It will be remembered that relay 116 is slow in releasing which maintains ground on conductor 140 until relay 403 of the dual selector is operated to associate ground with this sleeve lead.

The operation of relay 403 also connects ground from its contact 4 to conductor 452. At this time the trunk finder circuit, Fig. 6, should have found the line-finder selector trunk circuit, Figs. 2 and 3, and thus the following circuit is established for operating relay 202 which disconnects the "A" relay from the subscriber's line and the sender. This circuit may be traced from ground on conductor 4 of relay 403, over conductor 452, winding of relay 202, upper winding of relay 209, conductor 256, terminal 617, brush 613, contact 8 of relay 600, conductor 642 which extends into the sender and through the winding of sender relay 902, resistance 903 to battery. Relay 202 operates in the circuit traced but relay 209 does not operate at this time. Relay 902 also operates but the result of the operation of the latter relay will be deferred for the moment. The operation of relay 202 establishes a holding bridge for the "A" relay 402 in the dual selector circuit to prevent the release of this "A" relay. It will be recognized that the vertical magnet of this first selector is not energized at this time since the "A" relay has not been released after the operation of the "B" relay 403 to establish a circuit for the vertical magnet and therefore this selector remains normal until it is later connected to a pulsing circuit. The holding bridge may be traced from battery, through the lower winding of relay 402, contact 3 of relay 400, contact 3 of relay 203, contact 1 of relay 211, resistance 213, contact 1 of relay 202, contact 2 of relay 203, conductor 450, contact 2 of relay 400, upper winding of relay 402 to ground on contact 1 of the 11th rotary step springs 417. A second bridge in multiple with this bridge may be traced from conductor 450, contact 2 of relay 203, contact 3 of relay 211, resistance 212, contact 10 of relay 202, contact 3 of relay 203 to conductor 451. The operation of relay 202 connects the tip and ring leads 141 and 142 from the subscriber's line to the sender. These leads may be traced through contacts 3 and 7 of relay 202 over conductors 258 and 257 through terminals 606 and 607, brushes 602 and 603, contacts 1 and 2 of relay 600, conductors 649 and 648 to the sender party line testing mechanism and pulsing circuit which will be described later.

If all senders are busy and the calling subscriber does not wait for dial tone the subscriber might incorrectly dial before relay 202 has operated. Under this condition relay 402 follows the pulses dialed by the subscriber "A" which operates the vertical magnet upon the release of relay 402. The circuit for the vertical magnet 412 may be traced from battery through its winding, winding of relay 405, contact 1 of relay 403, contact of relay 402 to ground on contact 1 of relay 400. Relay 403 is slow to release and remains operated during the pulsing periods of relay 402. Relay 405 is also operated and remains operated during the series of pulses. When the switch shaft steps off-normal relay 410 operates under the control of relay 405 from battery through its winding, contact of the 11th rotary step springs 417, contact 1 of vertical off-normal springs 416, contact of relay 405 to ground on contact 1 of the release magnet 411. Relay 410 locks to ground on contact 2 of relay 403 from battery through resistance 419 and contact 3 of the vertical off-normal springs 416 is connected to conductor 456 which extends to the line-finder selector trunk circuit, Fig. 2, through contact 7 of relay 209, contact 6 of relay 211, lower winding of relay 210, contact 8 of relay 210, sleeve lead 455, contact 3 of relay 403 to ground which operates relay 210. Relay 210 in operating connects this sleeve ground through its contact 5, thence over conductor 457, contact 1 of springs 418, conductor 454, contact 401 to sleeve brush 427. The release of relay 405 after the digit is dialed energizes the rotary magnet stepping the brushes to the first terminal on the selected level. The circuit for the rotary magnet may be traced from battery through the rotary magnet, contact 2 of relay 410, contact of relay 405 released to ground on contact 1 of the release magnet 411. The ground placed on the sleeve brush 427 by the line-finder selector trunk circuit creates an indication to the dual selector that all trunks are busy and consequently the dual selector brushes rotate to the eleventh terminal which connects the all-trunks-busy tone to the subscriber's line from tone transformer 415 through contact 1 of the 11th rotary step springs 417, winding of relay 402, thence over the tip conductor to the subscriber's station. The subscriber is thus notified to again dial the desired number. The operation of relay 210 in the line-finder selector trunk circuit, in addition to connecting ground to lead 454 and the sleeve of the dual selector brush, also opens the circuit extending to start relay 217 which extends through contact 6 of relay 210 and, therefore, if a subscriber dials prematurely relay 217 is not operated and a sender is not selected.

Sender

Let it be assumed that relay 202 is operated in the usual manner as described, which establishes a circuit for relay 902 in the sender. Relay 902 establishes a locking circuit for relays energized over circuits which may now be described, resulting from a connection of the line finder with the calling line, the connection of the trunk finder, Fig. 6, with the line-finder selector trunk, Figs. 2 and 3, and the operation of relay 202 after

the dual selector relays A and B have operated. Ground is connected to the sender sleeve lead 641 from contact 3 of relay 620 as soon as the trunk finder is energized which is later replaced by ground through the contacts of relay 619 before relay 620 releases. This ground extending over conductor 641 through the winding of the sender off-normal relay 901 to battery operating the latter relay. Relay 901 supplies ground circuits to the sender mechanism and provides operating and holding circuits for various relays. Relays 900, 916, 1514 and 1518 are operated in response to the operation of relay 901. Also, as soon as relay 902 is operated in response to the previously traced circuit through the trunk and the dual selector a circuit is established for relay 917 from battery through its winding, contact of relay 902 to ground on contact 3 of relay 901. The circuit for relay 900 may be traced from battery through its winding, contacts 3 and 2 of relay 923, contact 11 of relay 901 to ground. Relay 916 is only operated if relay 917 has not been previously operated. The circuit for relay 916 may be traced through contact 7 of relay 917, contact of polarized relay 905 to ground on contact 10 of relay 901. When on the abandoned call relay 916 is operated, it is released as soon as relay 917 operates. The utility of relay 916 will be explained later in connection with abandoned calls. Outward pulsing relays 1514 and 1518 are operated and held operated over the following circuit until the correct time for transmitting pulses over an outgoing trunk connection. Battery extends through potentiometer resistances 1508 and 1509 to the negative terminal of the winding of relay 1514 thence to the negative terminal of the winding of relay 1518, positive terminal of lower winding of relay 1500, conductor 1732, contacts of relays 1707, 1708 and 1709, conductor 963 to ground on contact 5 of relay 901. This current as noted is in the proper direction for operating relays 1514 and 1518 but not in the proper direction for operating pulsing relay 1500.

As previously traced, the operation of relay 202 connects the tip and ring conductors from the subscriber's station through the line-finder selector trunk circuit and the trunk finder circuit to conductors 648 and 649 of the sender. Ring conductor 648 extends through contact 2 of relay 1203 over conductor 1248, contact 4 of relay 1110, conductor 1148, contact 3 of relay 1203, conductor 946, contact 1 of relay 904, winding 920 of tone coil 918, retard coil 915, contact 2 of jack 912, lowermost winding of L relay 905, contact 1 of jack 912 to battery. The tip lead 649 extends through contact 6 of relay 1203, conductor 1249, contact 3 of relay 1110, contact 5 of relay 1203, conductor 947, contact 2 of relay 904, winding 919 of tone coil 918 to ground. The tone coil is energized by the operation of relay 917 from ground through its contact 3, winding 921 of tone coil 918, condenser 922, contact 3 of relay 1029, contact 8 of relay 1205, contact 7 of relay 817 to the tone source transmitted through induction coil 820. The dial tone is thus transmitted to the subscriber who then begins dialing the code. This tone circuit is opened by relay 817 after the first digit is dialed or by relay 1029 after a first prefix digit "one" is dialed.

Dial pulses

As the dial is manipulated by the subscriber each open period of the dial contact releases the L relay 905 and each closed period of the contact of the dial reoperates the L relay 905. This L relay 905 is not provided with a retractile spring but current through the tertiary winding is in the direction to release the relay so that when the dial contact opens the line winding the tertiary or biasing winding will cause the relay to release. The condenser associated with the primary winding is used to hold the relay operated when a retardation coil is inserted in the line at a private branch exchange. Condenser 907 associated with the secondary or uppermost winding helps the L relay 905 to give good pulses from its contacts even though the pulses received over the line may be faulty. When the front contact 4 of relay 905 opens, condenser 907 discharges through the secondary winding. The current is in the direction to release the relay so that even though the line winding is closed again in a very short time or a transient oscillation occurs in the line due to the charging of a subscriber's set, the relay armature is held against contact 5 for a short interval. This interval is longer than the duration of the line oscillation so that false operation of relay 905 is prevented. Relay 909 is operated from battery through its winding, winding of relay 1000, contact 4 of relay 905 to ground through contact 10 of relay 901. Relay 909 will release only if the subscriber opens the line for a relatively long interval by abandoning the call. Relays 1000 and 1003 operate and release with L relay 905 and are required to provide the equivalent of additional contacts on the L relay 905.

It was set forth in the foregoing that relays 1000 and 1003 operate each time the L relay 905 operates. The circuit for relay 1000 may be traced from battery through resistance 908, winding of relay 1000, contact of relay 905 to ground on contact 10 of relay 901. The circuit for relay 1003 may be traced from battery through its winding, contact of relay 1000 to ground on contact 10 of relay 901. Relay 923 operates when relay 1000 is released after the first pulse dialed by the subscriber. It will be recognized that the L relay 905 is held operated over the line loop until the first opening of the dial contacts and thus relays 1000 and 1003 are also held operated. The circuit for relay 923 may be traced from battery, through its winding, contact of relay 1000 released to ground on contact 10 of relay 901. Relay 923 is a slow-releasing relay and remains operated during the dialing of the pulses for each digit. At the end of a train of pulses for a digit the L1 relay 1000 will remain operated for a relatively long time while the calling subscriber is preparing to dial the next digit and, consequently, relay 923 will release. Relay 900 is controlled by the back contact 3 of relay 923 so that it is operated while relay 923 is released and it is unoperated while relay 923 is operated. The purpose of relays 923 and 900 will be apparent in the description of the operation of relays which control the cross bar switches shown in Fig. 14.

The pulse responsive relays are relays 905, 1000, 1003, 1016, 1021 and 1022. These relays are energized in the following manner: When relay 905 releases for the first pulse of a digit its back contact closes a circuit for operating relay 1016 traced from battery through the winding of relay 1016, contact 4 of relay 1022, contact 3 of relay 818, contact 5 of relay 800, contact 1 of relay 909, contact 7 of relay 917, contact 5 of relay 905, contact 10 of relay 901 to ground. When relay 905 reoperates on the closed period of the next pulse relay 1022 operates and relay 1016 remains locked in position. The circuit for doing this may be traced from battery through the winding of relay 1016,

upper winding of relay 1022, contact 2 of relay 1021, contact 1 of relay 1016, contact 1 of relay 923, contact 10 of relay 901 to ground. Upon the next release of relay 905 relay 1021 is operated and relay 1022 remains operated but relay 1016 is released. Relay 1021 is energized from battery through its upper winding, lower winding of relay 1022, contact 3 of relay 1022, contact 3 of relay 818, contact 5 of relay 800, contact 1 of relay 909, contact 7 of relay 917, contact 5 of relay 905 to ground through contact 10 of relay 901. It is apparent that the circuit for relay 1016 is opened through contact 2 of relay 1021 when the latter relay operates. Upon the next operation of relay 905 relays 1021 and 1022 are released since the operating circuit for both relays extends through the contact of relay 905. If additional pulses are received the cycle of operation is continued in the manner described for relays 1016, 1022 and 1021. The above operation is repeated for each two pulses.

Register switch control relays

The first operation of relay 1022 operates the one pulse relay 1017 in the group of switch controlling relays. The circuit for relay 1017 may be traced from battery through its upper winding, contact 2 of the pulse 5 relay 1011, contact 3 of pulse 3 relay 1025, contact 4 of pulse 2 relay 1026, contact 4 of pulse 4 relay 1018, contact 2 of relay 1022, contact 1 of relay 923, contact 10 of relay 901 to ground. The release of relay 1022 on the second dialing pulse operates the pulse 2 relay 1026 which releases the pulse 1 relay 1017. The circuit for relay 1026 may be traced from battery through its winding, contact 5 of relay 1017, contact 3 of relay 900, contact 1 of relay 1022 released, contact 1 of relay 923 to ground on contact 10 of relay 901. The third pulse dialed, as above described, again operates relay 1022 which establishes a circuit for the pulse 3 relay 1025 which releases the pulse 2 relay 1026. The circuit for relay 1025 may be traced from battery through its winding, contact 4 of relay 1026 operated, contact 4 of relay 1018 released, contact 3 of relay 1022 operated, thence through contact 1 of relay 923 to ground on contact 10 of relay 901. When relay 1022 again releases in response to the fourth pulse the pulse 4 relay 1018 is operated which releases the pulse 3 relay 1025. The circuit for relay 1018 may be traced from battery through its winding, contact 4 of relay 1025, contact 3 of relay 900, contact 1 of relay 1022, contact 1 of relay 923 to ground on contact 10 of relay 901. Relay 1022 again operates when the fifth pulse is dialed which operates the pulse 5 relay 1011 and releases the pulse 4 relay 1018. The circuit for relay 1011 may be traced from battery through its winding, contact 4 of pulse 4 relay 1018, contact 2 of relay 1022, contact 1 of relay 923 to ground on contact 10 of relay 901. The sixth pulse releases relay 1022 which operates relay 1010 but does not release the pulse 5 relay 1011. The circuit for the pulse 6 relay 1010 is traced from battery through its upper winding, contact 3 of relay 1011, contact 3 of relay 900, contact 1 of relay 1022 to ground through contact 1 of relay 923 and contact 10 of relay 901. Relay 1010 locks through its lower winding and contact 4 of digit control relay 900. The seventh pulse operates relay 1022 which again operates the pulse 1 relay 1017. The pulse 6 relay 1010 remains operated and therefore if the pulses are terminated at this point relays 1017 and 1010 would remain operated to form pulse number 7 and register this pulse 7 upon the switches as described later. The circuit for operating relay 1017 the second time extends through contact 2 of the pulse 6 relay 1010 instead of through contact 2 of the pulse 5 relay 1011 which is operated when the circuit for relay 1017 is established. From the armature of contact 2 on relay 1010 the circuit may be traced through the paths originally traced for operating relay 1017. The operation of relay 1017 releases the pulse 5 relay 1011 since the circuit for relay 1011 extended through contact 2 of relay 1017. The eighth, ninth and tenth pulses cause the release, operation and release of relay 1022 which successively operates the pulse 2 relay 1026, the pulse 3 relay 1025 which releases relay 1026 and the pulse 4 relay which releases relay 1025.

The following table shows the operation of the switch control relays which remain operated after any number of pulses from 1 to 10:

Pulses	Relays operated
1	1017
2	1026
3	1025
4	1018
5	1011
6	1011, 1010
7	1017, 1010
8	1026, 1010
9	1025, 1010
10	1018, 1010

The pulsing relays lock to ground through a break contact on relay 1300 in parallel with a break contact on relay 900. Relay 900 is unoperated during the dialing of a digit and relay 1300 may be operated for registering a previous digit but will release before relay 900 operates. This relationship will be explained more in detail in conjunction with the registration of digits.

The locking circuit for the pulse 1 relay 1017 is wired through three contacts in parallel, a make contact 1 on relay 1010, a break contact 2 of relay 900 and a make contact 1 on the A hold magnet 1400. If none of these circuits are established, relay 1017 is not locked and the digit 1 is not registered. This circuit may be traced from battery through the lower winding of relay 1017, contact 4 of relay 1017, contact 1 of relay 1010 if it is operated, contact 2 of relay 900, contact 1 of hold magnet 1400 if operated, contact 1 of pulse 2 relay 1026, contact 2 of pulse 3 relay 1025, contact 2 of pulse 4 relay 1018, contact 1 of pulse 5 relay 1011, contact 4 of relay 900 to ground of contact 10 of relay 901. These contacts in the locking circuit of the pulse 1 relay 1017 are used when absorbing preliminary pulses. If one pulse is received for the first digit, such as received by switchhook fumbling, relay 1017 will remain operated until relay 900 operates at the end of the one pulse digit. Relay 1017 will then release without registering a digit on the cross bar switch because its locking path is opened. However, if a seven is dialed both the pulse 1 relay 1017 and the pulse 6 relay 1010 will be operated and a locking circuit is established for the pulse 1 relay 1017 through the contact of the pulse 6 relay 1010. A seven will be registered upon the A digit vertical of the cross bar switch by the operation of the No. 6 select magnet and the hold magnet. After the A digit has been registered the make contact on the A hold magnet 1400 establishes the locking circuit for the pulse 1 relay 1017 so that the digit 1 may be registered on any register following the A digit.

Cross bar register switch and digit control relays

At the end of a train of pulses for any digit, relay 923 releases and relay 900 operates as described above. Contacts of relay 923 close a circuit through contacts of the pulse 1 relay 1017 either operated or released and the pulse 6 relay 1010 either operated or released through the winding of one of the select magnets of the cross bar switch. Select magnets 4, 9 and 10 have been shown. The remaining leads to the select magnets 1, 2, 3, 5, 6, 7 and 8 are shown in Fig. 10 as marked. These represent the leads which are selected for operating corresponding select magnets of the cross bar switch, Fig. 14. The number of the select magnet energized will correspond to the number of the digit dialed. The select magnet operates and extends its operating circuit through its one contact operating relay 1300. Relay 1300 and the select magnet lock to ground on relay 901 through contact 6 of relay 1300 under control of the back contact 3 on relay 1304. After relay 1300 has locked it opens the operating and locking circuits for the pulse 1 to pulse 6 relays restoring these relays to normal so that they may be used to count the pulses of the next digit while the digit just received is being registered on the cross bar switch. Relay 1303 operates through contact 1 of relay 1300 providing an additional locking circuit for relay 1300 and the select magnet and providing an operating circuit for relay 1304. Relay 1304 closes a circuit through its contact 1 from ground on relay 901 over lead 933 through the lower winding of relay 1303 and contacts of relays 1308, 1312 and 1315 through the winding of the hold magnet 1400 energizing the hold magnet and closing the cross-point of the vertical corresponding to the select magnet which was operated. The operation of relay 1304 releases relay 1300 which opens the circuit for the upper winding of relay 1303. Relay 1303, however, remains operated by current flowing through its lower winding which holds the select magnet until the hold magnet has fully operated. The secondary or lower winding of relay 1303 is then short-circuited by ground connected to contact 3 of the hold magnet from contact 2 of relay 901 causing the release of relays 1303 and 1304 and causing the release of the select magnet. The hold magnet 1400 is locked to ground on lead 932.

For example, let it be assumed that the first digit dialed comprises four pulses which operate the pulse 4 relay 1018 as previously described. This relay locks through its contact 2, contact 1 of relay 1011, contact 3 of relay 1300 to ground on contact 10 of relay 901. A circuit for select magnet 4 may be traced from battery through resistance 1411, winding of select magnet 4, contact 1 of pulse 4 relay 1018, contact 5 of pulse 6 relay 1010 released, contact 4 of relay 1300, contact 2 of relay 923 to ground on contact 11 of relay 901. Relay 1300 now operates from battery through its winding, contact 3 of relay 1304, contact of select magnet 4 to the ground which energized select magnet No. 4. Relay 1300 in energizing closes a locking circuit for itself and a locking circuit for select magnet No. 4 traced through contact 3 of relay 1304, contacts 2, 5 and 6 of relay 1300, to ground on contact 11 of relay 901. Relay 1300 establishes this locking circuit before the operating circuit for the select magnet 4 is opened through its contact 4. After relay 1300 has locked it opens the operating and locking circuits for the pulse 4 relay 1018 so that it may be used to count the pulses for the next digit if required while the digit 4 is being registered on the cross bar switch A, Fig. 14. A circuit for relay 1303 is established by relay 1300 which provides an operating circuit for relay 1304 as previously described. Relay 1304 establishes a circuit for the 0 hold magnet 1400 which closes the cross-points corresponding to the No. 4 select magnet and causes the release of relays 1303 and 1304 and causes the release of select magnet 4 in the manner previously explained.

Cross bar register switch

The pulses for each succeeding digit are counted by the register switch control relays 1010, 1011, 1017, 1018, 1023, 1025 and 1026 which operate particular select magnets. The operation of the cross bar switches is effected by the relays of Figs. 9 and 10, as outlined above, for registering the digits on the cross bar switches, Fig. 14, a seperate vertical of the cross bar switch being used for each digit except the B or second digit which requires three verticals B, BA and BB.

For two-digit office codes, the call is registered on the A and B verticals, the B, BA and BB verticals herein being designated the B verticals. The thousands, hundreds, tens, units and stations, if any, are registered on the C, D, E, F and G verticals, respectively. If the called subscriber's number is over 9999, the ten thousands, thousands, hundreds, tens and units are registered on the C, D, E, F and G verticals, respectively.

Three-digit office codes are registered on the A, B and C verticals and the thousands, hundreds, tens and units and stations, if any, are registered on the D, E, F, G and H verticals, respectively. If the called subscriber's number is over 9999, the ten thousands, thousands, hundreds, tens and units are registered on the D, E, F, G and H verticals, respectively.

When the relay 1304 is operated for registering the A digit, as previously described, a circuit is established for relay 1306 which operates relay 1306 but holds relay 1308 unoperated by a short-circuit. The circuit for relay 1306 may be traced from battery through resistance 1307, winding of relay 1306, contact 2 of relay 1304, lead 932, to ground on contact 2 of relay 901. It will be seen that this same ground short-circuits the winding of relay 1308. When relay 1304 is released after the A or first digit has been registered, the short-circuit is removed and relay 1308 operates from battery through resistance 1309, winding of relay 1308, contact of relay 1306, lead 932, to ground on contact 2 of relay 901. Relay 1306 is held operated through its contact to the same ground. The operation of relay 1308 establishes an operating circuit for relay 1311 from battery through resistance 1310, winding and contact of relay 1311, contact 1 of relay 1308, lead 932, to ground on contact 2 of relay 901. At this time the winding of relay 1312 is short-circuited so that the latter relay does not operate. The above procedure takes place during the time that a digit is being recorded on the cross bar switches and is maintained, as stated, until the following digit has been dialed.

When the B or second digit has been dialed and counted by the pulse responsive relays, relays 1300, 1303 and 1304 again operate as described after the first digit was dialed. It may be assumed, for example, that the second digit is 9 and consequently pulse relays 1025 and 1010 are operated and locked in position after the calling subscriber has completed dialing the pulses for the digit 9. A circuit for select magnet 9 is com-

pleted from battery, through resistance 1411, winding of select magnet 9, contact 1 of the pulse 3 relay 1025, contact 6 of the pulse 6 relay 1010 which, as stated, is operated, contact 4 of relay 1300, contact 2 of relay 923 to ground on contact 11 of relay 901. As previously explained, the select magnet in operating establishes a circuit for relay 1300, traced from battery through its winding, contact 3 of relay 1304, contact of the select magnet 9 to the ground which was established for operating the select magnet 9. Relay 1300 and the select magnet lock to ground on relay 901 through contact 6 of relay 1300 under the control of contacts of relay 1304. After relay 1300 has been locked, it then opens the operating and locking circuits for the pulse 3 relay 1025 and pulse 6 relay 1010 which release, or under other circumstances any pulse relays which were operated from dial pulses. The pulses for the succeeding digit may, therefore, be transmitted by the calling subscribers for operating the pulse responsive relays during the time that the second or B digit is being registered on the cross bar switches.

Relay 1303 is operated through its upper winding to ground on contact 1 of relay 1300 and the operation of relay 1303 provides an operating circuit for relay 1304 to ground on contact 2 of relay 901. The operation of relay 1304 releases relay 1300 and establishes a circuit for holding relay 1303 operated through its lower winding. The latter circuit may be traced from ground on contact 3 of relay 901, over lead 933, through contact 1 of relay 1304, lower winding of relay 1303, contact 3 of relay 1308, which it will be recalled is operated, contact 2 of relay 1312, which it will be recalled remains unoperated because of a short-circuit placed thereon through contact 1 of relay 1308, contact 3 of relay 1315 normal, winding of the BA hold magnet 1402 to battery operating the latter hold magnet. A circuit is also established for the B and BB hold magnets 1401 and 1403 from battery through their windings, contact 1 of the C hold magnet 1404, contact 4 of relay 1308, contact 1 of relay 1304, to ground on contact 3 of relay 901. When the three hold magnets 1401, 1402 and 1403 are operated, a short-circuit is placed on the lower winding of relay 1303 from ground through the contact of hold magnet 1403, contact 2 of hold magnet 1401, contact 3 of hold magnet 1402, contact 3 of relay 1315, contact 2 of relay 1312, contact 3 of relay 1308, to the terminal of the lower winding of relay 1303. The opposite terminal of this winding is connected to ground through contact 1 of relay 1304. This causes the release of relay 1303 and the release of relay 1303 causes the release of relay 1304. The hold magnets are locked in position as follows: 1400 from ground on lead 932; 1401 and 1403 from ground on contact 2 of magnet 1400; and 1402 from ground on contact of magnet 1403. The operation of hold magnets 1401, 1402 and 1403 closes three cross-points corresponding to the No. 9 select magnet operated for the B or second digit. It will be apparent from the description in later paragraphs that the B digit requires a large plurality of contacts which are more numerous in number than required for other digits. It will be noted that the contacts of the A vertical are wired to the common contacts of the B, BA and BB verticals for purposes as herein later described.

The operation of relay 1304 for the B or second digit short-circuits and releases relay 1306 by applying ground to contact 2 of relay 1308, but relay 1308 remains operated over a circuit through the continuity contact of relay 1306 released, which extends through contact 2 of relay 1304 to ground on lead 932. When relays 1300 and 1303 have released, as previously described, relay 1304 releases and relay 1308 releases, removing the short-circuit from relay 1312 which now operates. This prepares the circuit for registering the next digit C as soon as the pulse relays have been operated by the calling subscriber's manipulation of the dial. This, as previously described, reoperates relays 1300, 1303 and 1304 for registering the third or C digit again establishing a circuit through the lower winding of relay 1303. The operation of relay 1312 steers this circuit to the winding of the C hold magnet 1404 which may be traced from battery through the winding of magnet 1404, contact 2 of relay 1315, contact 3 of relay 1312, contact 3 of relay 1308 released, lower winding of relay 1303, contact 1 of relay 1304 to ground over lead 933 as previously traced. Also when relay 1304 operates for registering the C digit, a circuit is established for relay 1306. Since relay 1308 has been released, the circuit for relay 1306 is the same as previously traced. When the C hold magnet 1404 is operated, a short-circuit was established around the lower winding of relay 1303 and consequently the release of relay 1300 which is effected after the digit is registered and this short-circuit, as previously explained, brings about the release of relays 1303 and 1304. This release of relay 1304 removes the short-circuit from relay 1308 permitting it to operate over the circuit previously traced. The operation of relay 1308 establishes a short-circuit for relay 1311 from ground on lead 932, contact 1 of relay 1308, contact 1 of relay 1312 to a mid-point between resistance 1310 and the winding of relay 1311, releasing relay 1311. The hold magnet operating circuit for the D hold magnet 1405, as soon as the D digit is set up on the pulse relays, extends through the contacts of relays 1314, 1312 and 1308, lower winding of relay 1303, contact 1 of relay 1304 to ground on lead 933. Relay 1315 is operated from ground on contact 2 of the D magnet 1405 for connecting the E, F and G hold magnets 1406, 1407 and 1408 to the hold magnet steering circuit comprising relays 1306, 1308, 1311 and 1312. Relay 1314 is operated from ground on contact 2 of the F hold magnet 1407 or from ground connected to contact 5 of relay 1305.

The following table shows the relays operated for each digit before relay 1304 operates. The operation of relay 1304 will not change the path of the hold magnets. This path is changed by the operation of relays 1308, 1312, 1315 and 1314 when relay 1304 releases:

Digit about to be registered	Relays operated before 1304 operates
A	None
B	1306, 1308, 1311
C	1311, 1312
D	1306, 1308, 1312
E	1315
F	1306, 1308, 1311, 1315
G	1311, 1312, 1315, 1314
H	1306, 1308, 1312, 1315, 1314

Same code in different areas

This code is arranged so that subscribers in one area are permitted to dial two offices which have the same code. For example, a subscriber

may be located in an area which is an outlying area from a large town in which another telephone office is located, both areas having an office with the same office code letters. The office area in which the subscriber is located may be known as the "Walker" office having the code "WA" and another area may have an office known as "Watkins" also having the code "WA." In order to distinguish between these two conflicting codes, the subscriber will be required to dial 1—1 before the office code digits when dialing one of these office codes as designated in a directory. For example, the 1—1 before WA would obtain a trunk extending to the office in an area different from the area in which the same code is dialed not preceded by this 1—1. The 1—1 will, therefore, herein be known as the toll directing code. In order to provide this feature, relays **1014**, **1019**, **1029** and **1030** are used in the sender circuit and operated in the following manner.

When a 1 is dialed before the A or first digit is registered, the pulse 1 relay **1017** is operated, but it cannot be locked since, as herein previously explained, its locking circuit extends through the contact of relays which, under this condition, would not be operated. When relay **923** releases after one pulse has been sent by the calling subscriber, its contact **2** closes a circuit from ground on contact **11** of relay **901** through contact **7** of the pulse 1 relay **1017**, contact **6** of relay **817**, contact 1 of relay **1019**, winding of relay **1014** to battery which operates relay **1014**. As previously set forth, relay **900** operates between digits. When this relay operates, the circuit for relay **1017** is opened causing the release of the latter relay which opens the operating path for relay **1014**. However, relay **1014** is a fast operating relay and is fast enough to operate during the time its operating circuit was closed preceding the release of relay **1017**. Relay **1014** in operating establishes a locking circuit for itself through its upper winding to ground on contact **8** of relay **901** and also establishes an operating circuit for relay **1019** which is effective when the pulse 1 relay **1017** releases. This circuit may be traced from battery through the winding of relay **1019**, contact **2** of relay **1014**, contact **3** of relay **1017** released, contact **5** of relay **1010**, contact **4** of relay **1300**, contact **2** of relay **923** which is released between digits, thence to ground on contact **11** of relay **901**. Relay **1019** is locked to ground on contact **8** of relay **901**. If a second digit 1 is dialed, relay **1017** is again operated which establishes a circuit for relay **1029** which may be traced from battery through its lower winding, contact 1 of relay **1019**, contact **6** of relay **817**, contact **7** of relay **1017**, contact **5** of relay **1010**, contact **4** of relay **1300**, contact **2** of relay **923** to ground on contact **11** of relay **901**. Relay **1029** is also fast in operating and establishes a locking circuit for itself when relay **1017** is released after the digit is dialed. This locking circuit may be traced from battery through the upper winding and contact 1 of relay **1029**, to ground on contact **8** of relay **901**. A circuit for relay **1030** is established by the operation of relay **1029** from battery through the winding of relay **1030** to ground on contact **2** of relay **1029**. Relay **1030** controls the 1—1 index, the translator and the outward pulse transmission of the 1—1 by the sender pulse transmitting mechanism, Fig. 15, before the office code in the manner described in subsequent paragraphs under the above headings.

Absorbing preliminary pulse

If only a single 1 is dialed by the calling subscriber, relays **1029** and **1030** will not be operated, but relays **1014** and **1019** will be operated. One preliminary pulse may be caused by switchhook fumbling and this switchhook fumbling pulse will be absorbed as hereinafter described. If 1—1 is dialed after a 1 caused by switchhook fumbling, relays **1014**, **1019**, **1029** and **1030** are operated and the third 1 is absorbed. This will merely result in an additional circuit closure for relays **1029** and **1030** which is not effective since they were operated by the second pulse. In the latter case, three 1's would have been dialed, but only two of these digits would be registered and the third would not operate the sender in any manner since after relay **1030** is operated it would eliminate the succeeding digit.

Digit 1 used for second and subsequent digits

Relay **817** is operated by a contact of the A or first digit hold magnet **1400** so that after the A digit has been registered, the contact **7** of the pulse 1 relay **1017** is transferred from the winding of prefix pulse relay **1014** to the winding of the No. 1 select magnet in order that the No. 1 select magnet may be operated for all digits after the A digit is registered. The circuit for relay **817** may be traced from battery through its winding, contact **2** of hold magnet **1400** to ground. The circuit for the No. 1 select magnet which is effective after the operation of relay **817** may be traced from battery through the winding of select magnet No. 1 shown diagrammatically in Fig. 10, contact **5** of relay **817**, contact **7** of relay **1017**, thence to ground on contact **10** of relay **901** over a circuit as previously traced, through contact **5** of relay **1010**.

3, 2 and 3—2 digit areas

In areas where some office codes are three digits and some office codes are two digits, all codes beginning with certain A digits will be three digits and the codes beginning with all the remaining A digits will be two digits. The A digits of the two-digit codes will be known herein as two-digit indices where two dialing areas are involved, separate two digit indices may be used for the two different areas. In order to furnish this 3—2 digit feature, the relay **1305** is furnished as shown in Fig. 13. The winding of this relay is connected to the A digit vertical and may be cross-connected to any of the terminals marked L or T; one of the sixteen terminals will be grounded depending upon the A digit register and whether or not the office code is preceded by 1—1. If the 1—1 prefix has not been dialed, relay **1030** will not be operated and one of the L terminals will be grounded. If the 1—1 prefix has been dialed, relay **1030** is operated and one of the T terminals will be grounded. In either case, the contact will be grounded which numerical designation corresponds to the A digit register. All of the L and T contacts corresponding to two-digit indices shall be cross-connected to the winding of relay **1305**. This will cause the operation of this relay for two-digit office codes. With relay **1305** operated, circuits are closed to provide certain functions as described later, one digit earlier than with relay **1305** not operated. Where all codes are three digits or all codes are two digits, relay **1305** is omitted from the operating circuit or omitted entirely and circuits are

provided equivalent to those shown provided through the relay contacts.

1—1 code prefix

Considering the call which requires the 1—1 prefix, let it be assumed that a two-digit code 9—4 represents the office code in two different dial areas which a subscriber is permitted to dial, one office being named Whitman and the other Whittier, both of which will be registered as **94**. The calling subscriber would therefore be required to dial the code 9—4 to reach a subscriber in one area and 1—1—9—4 to reach a subscriber in the other area. In the preceding description the circuits were traced for operating relays **1014**, **1019**, **1029** and **1030** responsive to the 1—1 code pulses. After the 1—1 code pulses a 9 is dialed by the calling subscriber as the A digit which operates digit recording relays **1010** and **1025**. They are momentarily locked to record this number on the A digit cross bar vertical by operating select magnet **9** and the A hold magnet **1400**. The calling subscriber would next dial digit 4. In response to the pulses for the digit 4 relay **1018** is operated causing the operation of the No. 4 select magnet. The hold magnets **1401**, **1402** and **1403** are now operated and ground is connected to the **94'** contact connected to code point terminal **1423**. This circuit extends from contact **7** of relay **901**, contact **1** of relay **1030**, contact **9'** of the A vertical, contact **94'** of the BB vertical to terminal **1423**. This terminal is cross-connected through a route relay winding terminal such as terminal **1915** for operating route relay **1905** to route the call to one of the offices which has the same code as another office.

Assuming that this routing extends the call to a step-by-step office the route relay contacts will be cross-connected to relay **1619** and relay **1526**. The out-dialing pulses will therefore start with progress relay **1708** and thus relay **1710** is operated following the operation of relay **1709** under the control of relay **1526** for dialing the first digit 1. It is of course understood that a digit is dialed for each of relays **1708** and **1709** for selecting the outgoing trunk and that the one controlled by relay **1710** is dialed out following the preceding two digits. Relay **1711** is operated for the second digit 1 which controls the operation of the selector for selecting a trunk to a second office having the same code as another office in a different area, such, for example, as office **545**. The circuit for relay **1710** is established through an inner contact of relay **1526** and may be traced as follows: Battery through the winding of relay **1710**, contact **2** of relay **1711**, contact **2** of relay **1526**, operated contact of relay **1529**, released contact **1** of relay **1530**, contact **1** of relay **1613**, contact **1** of relay **1612**, contact **2** of relay **1709**, contact **2** of relay **1619**, contact **1** of relay **1621** to ground on contact **4** of relay **1607**. When a call giving the 1—1 prefix is extended to a cross bar or panel office having incoming senders therein, relay **1529** is connected to the route relay contact instead of relay **1526**. The difference in the two routings is for controlling the speed of pulsing. As previously related, the pulsing to a step-by-step office is slower than the pulsing to a cross bar or panel office sender which is arranged to receive the pulses at a higher speed.

Class of service signals

Returning to the point when the path between the calling line and the sender is first established, class signals are sent to the sender as the first digit is dialed. These signals are sent over leads **647**, **645** and **644** to indicate the class of the calling line to the sender. The first signal received is over lead **647**. This signal is transmitted from the calling line through the line finder, trunk, and trunk selector to the sender and the signal sent from the line depends upon the class of service to which that line is entitled. When the line finder is associated with the calling line, brush **112** is connected with terminal **108**, and terminal **108** may be connected over lead **102** to equipment as shown or it may be open. Lead **102** is open for restricted service lines, connected directly to ground or through a low resistance message register **104** to ground on extended scope and message rate lines or this lead may be connected to ground through a high resistance **103**, the latter condition is ordinarily used for coin lines. In some cases where all lines of a line finder level are coin lines the high resistance ground may be furnished through line finder normal post spring which is closed on the coin levels and connected through a make contact of the line finder cut through relay **114** so that a responsive relay in the sender can not operate until the line is found.

The sender class relays are shown in Fig. 7 and these relays are operated in combinations depending upon the signal received over leads **647**, **644** and **645**. Relays **702** and **706** are operated by the signal received over lead **647**, relays **701** and **705** are operated by the signals received over lead **644** and relays **700** and **704** are operated by the signal received over lead **645**. The circuit for relays **702** and **706** may be traced from battery through the windings of these relays in series, contact **3** of relay **707**, lead **647**, contact **3** of relay **600**, brush **605**, terminal **609**, contact **2** of relay **211**, contact **2** of relay **202**, lead **143**, contact **2** of relay **114**, contact **2** of relay **113**, brush **112**, terminal **108**, lead **102** which may be opened, connected directly to ground, connected through high resistance **103** or through low resistance message register **104**. If lead **102** is open neither of relays **702** or **706** operates and a circuit is established to cross-connecting terminal **750**. Terminals **750**, **755** to **757** and **740** to **747** as shown on the drawings are cross-connected to a plurality of class signal relays, such as **708** and **709** which are operated as later described. The circuit for terminal **750** extends through contact **2** of relay **706**, contact **1** of relay **702**, thence over lead **730**, contact **1** of relay **1200**, lead **731**, contact **1** of relay **707**, contact **1** of relay **703** and thence through resistance **1207** to battery **1209**. This battery condition, as will be noted, is later changed by the operation of relay **703** which connects ground through contact **1** of relay **707** and thus connects ground to terminal **750** which operates a class signal relay cross-connected to this terminal. When lead **102** is connected through high resistance **103** to ground relay **706** operates but since relay **702** is marginal it does not operate. The operation of relay **706** alone establishes a circuit to terminals **755**, **756** or **757** depending upon the combination of other relays **700**, **701**, **704** and **705** which are operated as later described over leads **644** and **645**. When lead **102** is connected through the low resistance message register **104** to ground or directly to ground both relays **706** and **702** are operated. With both relays operated a circuit is closed to one of the terminals **740** to **747**, inclusive, depending upon the combination of the other relays **700**, **701**, **704** and **705** which are operated.

When relay **706** operates it connects the funda-

mental tip lead 645 to the windings of marginal relay 700 and non-marginal relay 704 to battery traced as follows: The circuit for relays 700 and 704 extends from the line finder variably wired normal post springs 121 through the line finder selector trunk circuit, lead 245, terminal 614, brush 610, contact 5 of relay 600, lead 645, thence through contact 5 of relay 707, contact 4 of relay 706, lead 732, contact 4 of relay 1205, contact 2 of relay 1200, lead 733, winding of marginal relay 700, winding of non-marginal relay 704 to battery. The circuit for relays 701 and 705 extends from the line finder and line finder selector trunk circuit over lead 244 to terminal 615, brush 611, contact 6 of relay 600, lead 644, contact 2 of relay 707, contact 1 of relay 706, lead 734, contact 2 of relay 1205, lead 735, winding of marginal relay 701, winding of relay 705 to battery. Each of these leads, the fundamental tip lead 645 and the fundamental ring lead 644 are connected in the line finder selector trunk over the line finder either directly to ground, through a high resistance or left open. If lead 644 or lead 645 is open neither the marginal relay nor the non-marginal relay operates. This applies to either the 700, 704 combination or the 701, 705 combination. If either of these leads is connected directly to ground both relays connected to the lead operate and if the lead is connected through a high resistance to ground the relays 704 or 705 operate depending upon which lead is associated with the high resistance and the marginal relays 700 and 701 do not operate. When different levels of a line finder group require different signals over the fundamental tip lead 645 and the fundamental ring lead 644, these signals are controlled by contacts on the line finder normal post springs such as 121 shown in Fig. 1. The fundamental tip and fundamental ring leads are wired through contacts of relay 706 so that closure and opening of the line finder normal post springs will not falsely operate relays 700 or 701 which might subsequently be required to release in series with a high resistance to ground which may be associated with the lead when the circuit is established.

Terminals 740 to 747, 750, and 755 to 757 are connected to ground as a result of signals on leads 647, 644 and 645 according to the following table:

Leads		647	644	645
Restricted service	750	Open	Open	Open.
	755	H. R. G.	H. R. G. or open.	Do.
Coin	756	H. R. G.	Open	H. R. G. or open.
	757	H. R. G.	G	Open.
Message rate or extended scope	740	G	Open	Do.
	741	G	H. R. G.	Do.
	742	G	G	Do.
	743	G	Open	H. R. G.
	744	G	H. R. G.	Do.
	745	G	G	Do.
	746	G	Open	G.
	747	G	H. R. G.	Do.

G=direct ground; H. R. G.=high resistance ground.

Terminals 750, 755 to 757 and 740 to 747 may be cross-connected directly to class signal terminals such as 760 and 761 which causes the operation of a class signal relay such as relays 708 or 709. One such class signal relay is provided for each class of line in the office. When the above relays 702, 706, 700, 701, 704 and 705 have been given an opportunity to operate and select the path to the proper class signal relay circuit is closed for relay 703 which operates the connected class signal relay such as 708 and 709. Relay 703 operates in parallel with the pulse 2 relay 1026 when the second pulse of the A digit is received from the calling subscriber. The circuit for relay 703 may be traced from battery through its winding and continuity contact 2 to the winding of the pulse 2 relay 1026. It will be remembered that the pulse 2 relay 1026 is operated through contact 5 of the pulse 1 relay 1017 to ground as previously traced which establishes a circuit for relay 703 at the same time the circuit is established for relay 1026 when the pulse for the A digit is transmitted by the calling subscriber. It will also be recalled that the digit 1 is not used for the A digit and consequently the pulse 2 relay 1026 always operates when the A digit is dialed by the calling subscriber. Relay 703 locks to off-normal ground on contact 10 of relay 901 and disconnects its winding from the winding of the pulse 2 relay 1026. Relay 703 in operating also establishes a circuit for the class signal relay such as 708 or 709. The closure of the circuit for the class signal relay is thus delayed until the possibility has passed for falsely operating a class signal relay while the marginal and class signal relays 700, 701, 704 and 705 are operating. The circuit for operating the class signal relay may be traced from ground to contact 1 of relay 703, contact 1 of relay 707, lead 731, contact 1 of relay 1200, lead 730 thence through a contact 1 or 2 of relay 702 depending upon whether this relay is normal or operated, through a contact of relay 706 depending upon whether this relay is normal or operated, to a class relay connected to terminals 750, 755 to 757 or terminals 740 to 747. If relay 702 is operated, lead 730 is connected to contact 1 or 2 of relay 704 and thence through contacts of relays 705, 701 and 700 to terminals 740 to 747, depending upon which of these relays are normal and which are operated over the class signal circuits described in the foregoing paragraphs. For example, if both relays 702 and 706 are normal, lead 730 will extend through contact 1 of relay 702, contact 2 of relay 706 to terminal 750 for operating a class signal relay connected to terminal 750. If relay 702 is normal and relay 706 is energized and relays 700, 701, 704 and 705 are normal, ground over lead 730 extends over contact 1 of relay 702, contact 3 of relay 706, contact 3 of relay 701, contact 3 of relay 704 to terminal 755. From the above the manner of effecting the operation of the class signal relays is apparent. The class signal relay which is operated locks from battery through its winding and contact 4 to ground on contact 1 of relay 703 and thus disconnects its winding from the contacts of the marginal and sensitive relays so that the holding circuit of the class signal relay will not be extended through the contacts of relays 700, 701, 704 and 705 which might, under certain circumstances, cause the false operation of another class signal relay when those relays are released.

As explained more in detail in later paragraphs, contacts of the class signal relays, such as 708 and 709, are used for the following purposes:

(1) To indicate which routes the calling subscriber is permitted to call and which are denied this subscriber;

(2) To indicate what charge should be made where different classes of subscribers are charged different rates for calls to the same point;

(3) To select the proper routing where there is more than one routing for the same office code;

(4) To indicate whether to make a two-party identification test.

For classes other than two-party message rate calls the terminal **726** is cross-connected to the terminal **728**. As hereinafter described this operates relay **707** as soon as the class relay is operated. The terminal **726** is, however, cross-connected to terminal **727** as shown for two-party message rate classes. This causes a two-party identification test to be made and at the conclusion of the test relay **707** is operated over lead **729** by relay **1205** as later described. Relay **707** locks through its contact **4** to ground on contact **4** of relay **901** when it is operated as later described. This relay then transfers the fundamental tip and fundamental ring leads **644** and **645** to the outgoing dialing circuit of the sender, transfers lead **647** to the zone charge control circuit of the sender, supplies ground through a resistance **819** to lead **643** causing the line finder trunk to connect the fundamental tip and fundamental ring leads to the dual selector for response to outgoing pulses and opens the ground supply for operating the class signal relays. At this time relays **702**, **706**, **700**, **701**, **704** and **705** are released.

Call routing control by route relays

A route relay is provided in the sender for each office reached by direct trunks to step-by-step panel or cross bar offices. Other route relays are provided for groups of trunks extending to outlying offices and other route relays are provided for special purposes as outlined below. The route relay winding terminal, such for example as terminal **1915**, of each of these route relays is cross-connected to code points corresponding to the called office. In certain cases, incoming calls may be routed through a panel office or a cross bar office to a manual office or another panel or cross bar office. In this case, the route relay may be the same for these additional offices if the zone charge and stations delay conditions are the same as for the office connected by a direct trunk.

One or more route relays may be provided for each tandem office; one relay will be provided for each group of offices reached through the same tandem office, which have the same zone charge and stations delay conditions. The route relay terminal connected to the winding, such as terminal **1915**, of each route relay may be cross-connected to the code points corresponding to all of the offices of the group of offices served by this tandem office. The operator in the tandem office then routes the calls to the desired office.

One or two route relays will be provided for each route to a telephone operator. Two route relays are provided for those codes which require separate groups of trunks for coin and non-coin subscribers or operators. Where only one route relay is required, the route relay winding terminal, such as **1915**, is cross-connected to the code point for that code. Where two relays are required, the code point is connected to the terminal, such as terminal **763**, of a class relay, such as relay **709**. The connecting or associated terminal, such as terminal **724**, for certain classes is cross-connected to the winding terminal of a route relay, such as terminal **1915**, and the winding of the other route relay connected to a class terminal **722** connected to contact **6** of class relay **708**. This combination and arrangement of route relays for different classes will be later described more in detail. Several code points are provided for connections with operators and may be cross-connected to the winding of a single route relay or under special conditions to the terminals of class relays where these operators may be reached over a single routing. For example, a single routing may be used for connection to a repair operator, information operator or an operator who is connected in response to the dialing of a vacant code point by a calling subscriber. Such cross-connections may be the same as a cross-connection to a code point for reaching what is known as the zero operator. It is, of course, apparent that the zero operator is reached by the calling subscriber by dialing zero which elevates the first selector to a trunk connected to the zero operator. When a subscriber dials the vacant code in error, the incoming call is automatically routed to an operator who advises the calling subscriber that a mistake has been made and for the subscriber to redial the wanted number.

One route relay is also provided for two-party message rate service when the retest of a line indicates that a false ground is connected to the line. This route relay automatically routes the line conductors to a false ground holding trunk so that the line may be properly tested to find whether a false ground exists on this two-party message rate line or whether a mistake has been made in the line connection. The winding of this route relay is cross-connected to terminal **1223** which is connected to the contact of relay **1200**. The operation of the sender circuit responsive to a false ground indication will be later described.

There are certain routes in the office in a zoning area in which all subscribers are permitted to call. The route relays for such areas have their winding connected directly to battery instead of extending through class relays shown in Fig. 7. This allows the route relay to operate regardless of the class of the calling subscriber.

For routes which are denied to some classes of subscriber, the winding terminal, such as **1914**, is cross-connected to the class relay contacts such as **762**, **763** or **764** so that the class of the subscriber is indicated to the sender and the route relay operated accordingly. The opposite contact terminals of those classes not restricted will be cross-connected to battery permitting the route relay to operate under all conditions. However, the opposite terminal of those classes of calling subscribers which are restricted, such as terminal **725**, will be cross-connected to terminals such as terminal **1048**. Thus when the restricted subscriber attempts to call a route which is denied this subscriber, without his own charge, the regular route relay will not operate but relay **1032** will instead be operated. The operation of relay **1032** associates ground with terminal **1049** which is cross-connected to the winding terminal of the zero operator's route relay **1020**. The operation of the zero operator's route relay **1020** connects the calling subscriber with the zero operator who advises the calling subscriber how to dial the party wanted or the zero operator may set up the connection for the calling subscriber in order to make the proper charge for the call desired by the subscriber.

Party line identification test

The party identification test is made as soon as the first digit has been received by the sender and is used by the sender to determine whether the calling subscriber of a two-party message rate line is the tip party or the ring party. This test

is made only when the operated class signal relay indicates that the calling line is a two-party message rate line. This character of class signal relay establishes a circuit for operating relay 1200. Relay 1200 is operated while the first or A digit is being received and remains operated for the duration of the call. The circuit for relay 1200 may be traced from battery through its winding, lead 1240, terminal 727 which is cross-connected to terminal 726, contact 1 of relay 709 to ground on contact 9 of relay 901.

Since as stated, the party line identification test is made as soon as the first digit is recorded certain of the control relays involved are pre-operated before or during the dialing of the first digit and the party line test relay 1112 is connected to the tip and ring of the calling subscriber's line for a given time interval between the dialing of the first and second digit. If relay 1112 is operated at the end of this timing interval it indicates that the calling subscriber is a tip party subscriber since the relay 1112 will operate to a high resistance ground in the tip party's subscriber's set. The timing is controlled by the condenser 1108 which times the operation and release of relay 1105. If relay 1112 is not operated at the end of the timing interval it indicates that the calling party is a ring party on a two-party message rate line.

Control and timing of two-party message rate line test

It will be remembered that relays 901 and 917 were operated when the sender is first seized in order to establish battery and ground supplies to the relays of the sender. This establishes a current flow in the biasing winding of the aforementioned relay 1105 and operates relay 1214 through the contact 2 of relay 1213. Relay 1105 is placed in the circuit as follows: Ground from contact 9 of relay 901 extends over lead 941, resistance 1103 and resistance 1104, lead 1120, the upper winding of relay 1105, lead 940, contact 5 of relay 917 to battery. Ground from contact 4 of relay 901 extends over lead 942 thence through contact 2 of relay 1213, winding of relay 1214 to battery, operating relay 1214. Relay 1214 in operating establishes a circuit for relay 1215 which is obvious and need not be traced. Relay 1215 establishes a circuit through the lower winding of relay 1105 traced from ground on lead 941, contact 3 of relay 1215, contact of jack 1113, lower winding of relay 1105 to battery on lead 940. Relay 1105 now operates as timed and in so doing establishes an operating circuit for relay 1110. This may be traced from battery through the winding of relay 1110, contact 2 of relay 1106, contact of relay 1105, thence over lead 943 to ground on contact 2 of relay 917. Relay 1110 in operating locks through its contact 5, contact 1 of relay 1106 to ground on contact 2 of relay 917 as traced over lead 943.

It will be remembered that relay 923 is operated during the pulses of a digit and released after the pulses of a digit have been transmitted by the calling subscriber. When relay 923 releases at the end of the pulses for the first digit to be recorded in the sender, a circuit is established to operate relay 1213. This may be traced from battery through the winding of relay 1213, contact 4 of relay 1200, contacts 3 and 2 of relay 923 to ground on contact 11 of relay 901. Relay 1213 in operating locks through its continuity contact 1 to ground as traced over lead 942 and also releases relay 1214 since the operating circuit for the latter relay was established through the contact of relay 1213. The release of relay 1214 releases relay 1215 which opens the circuit to the condenser timed relay 1105. With relays 1214 and 1215 released and relay 1110 operated a circuit is established from 110-volt battery 1162 through the upper winding of relay 1112 to the tip and ring conductors of the subscriber's line. This circuit may be traced from the 110-volt battery 1162 through the upper contact of jack 1113, resistance 1118, upper winding of relay 1112, contact 3 of relay 1102, lead 1161, varistor 1217 and resistance 1216, contact 1 of relay 1215 to a junction point 1241 connected with tip and ring conductors of the subscriber's line. The connection to the tip conductor extends through contact 3 of relay 1214, contact 3 of relay 1110 operated, lead 1249, contact 6 of relay 1203, tip conductor 649 which extends through contact 1 of relay 600, brush 602, terminal 601, contact 3 of relay 202, upper winding of relay 200, contact 1 of relay 114, contact 1 of relay 113, brush 109, terminal 105 to the tip conductor of the subscriber's line. From the junction point 1241 the connection is made to the ring conductor of the subscriber's line through contact 4 of relay 1110, contact 2 of relay 1203, ring conductor 648 which extends through contact 2 of relay 600, brush 603, terminal 607 and thence to the subscriber's line over a path similar to that traced for the tip conductor. During the time that relay 1112 is presented to the calling subscriber's line the L relay 905 is held operated in a local circuit under control of relay 1214 and relay 1110. This circuit may be traced from battery through the upper contact of jack 912, lower winding of the L relay 905, contact 2 of jack 912, induction coil 915, lead 945, coil winding 920, contact 1 of relay 904, lead 946, contact 3 of relay 1203, contact 2 of relay 1214, contacts 1 and 6 of relay 1110, resistance 1109 to ground.

Relay 1105 releases in approximately .050 second and when released, connects ground through contact 3 of relay 1106 released and contact 2 of relay 1110 operated to the armature of relay 1112. If the calling subscriber is a tip party of a two-party message rate line, relay 1112 will have been operated when associated with the high resistance ground at the tip party subscriber's station. With relay 1112 operated ground will be continued through the contact of relay 1112, winding of relay 1114 to battery through resistance lamp 1116. If relay 1114 is thus operated it locks to ground on lead 943 and establishes a circuit to operate relay 1102 which reoperates relay 1105. The circuit for relay 1102 may be traced from battery through its winding, contact 3 of relay 1114, contact 4 of relay 1203 to ground on lead 943 as previously traced. Relay 1114 connects 48-volt battery through lamp 1116 to the tip lead 1161 to replace the 110-volt battery supply which is cut off by the operation of relay 1102. Relay 1102 extends its operating ground through its contact 5 to operate relay 1111 which may be traced from the operating ground on lead 943 through contact 5 of relay 1102, upper winding of relay 1111 to battery. The operation of relay 1102 also shunts resistance 1103 in series with the biasing winding of relay 1105. Relay 1106 is operated over an obvious circuit to ground on contact 2 of relay 1102. The 110-volt battery supply 1162 normally extending through contact 3 of relay 1102 is disconnected from the subscriber's line as soon as the latter relay operates.

Relay 1105 due to the reduction of resistance in

series with its upper or biasing winding releases in approximately .015 second. During this interval 48-volt battery connected to the subscriber's line in conjunction with the varistor 1217 and shunting resistance 1216 causes the discharge of the line in such a way as to prevent bell tapping at the subscriber's station.

The release of relay 1105 and the operation of relay 1106 opens the locking circuit previously traced for relay 1110 which now releases. This removes the holding circuit for the L relay 905 and opens the line leads taken through relay 1110. The party identification is now complete and the pulsing circuit is ready to receive the next digit dialed by the subscriber. The complete party identification test cycle, that is, testing the line, discharging the line after the test and the functioning of the test control relays is such that the open test period introduced to the subscriber's line between the dialing of the first and second digits does not exceed .105 second which does not interfere with dialing by the calling subscriber.

If the calling subscriber is not a tip party on a two-party message rate line, relay 1112 will not be operated when relay 1105 releases for the first time. This will result in the operation of relays 1115 and 1100 instead of relays 1114 and 1111 as described for the tip party; otherwise the operation is the same as for the tip party.

The following relays remain operated at the end of the party identification test if the calling party is a tip party of a two-party message rate line: relays 1114 and 1106 under the control of relay 1203 which is normal. Relays 1111 and 1211 remain operated under the control of relay 901. The circuits for the above relays with the exception of relay 1211, have previously been traced. Relay 1211 is energized from battery through its winding, contact 1 of relay 1111, contact 1 of relay 1100 to ground over lead 941 on contact 9 of relay 901. If the calling party is not a tip party of a two-party message rate line the following relays remain operated: 1115, 1102 and 1106 under the control of relay 1203; relay 1100 under the control of relay 901.

Line finder lock for tip party call

If relay 1211 is operated showing that the tip party is calling, a circuit is closed for operating the tip party relay 204 in the line finder selector trunk circuit, Fig. 2, to lock the line finder and trunk to the line when the calling party disconnects. A circuit for relay 204 may be traced from ground on contact 1 of relay 1211, contact 3 of relay 1200 which is operated, upper and lower windings of relay 1204, contact 2 of relay 1200, contact 4 of relay 1205, thence over lead 732, contact 4 of relay 706, contact 5 of relay 707, lead 645, contact 5 of relay 600, brush 610, terminal 614, lead 245, contact 4 of relay 211, terminal 208, contact 1 of normal post springs 121, winding of tip party relay 204 to battery. Relay 1204 operates in the circuit traced but relay 204 does not operate in this circuit. The operation of relay 1204 establishes an operating circuit for relay 1201 from battery through its winding, contact of relay 1204 to ground on lead 941 as previously traced. The operation of relay 1201 short-circuits the high resistance upper winding of relay 1204 which holds relay 1204 operated and now causes the operation of the trunk tip party relay 204. The operation of relay 204 connects ground to the fundamental tip leads 245 and 645 and establishes a locking circuit for itself. This ground extends from contact 6 of relay 202, contact 3 and winding of relay 204 and to lead 245 which extends to lead 645 through the trunk finder and sender. The operation of relay 204 thus causes the release of relay 1204. The release of relay 1204 operates relay 707 which performs the functions described under the subheading class of service. A circuit for relay 707 may be traced from battery through its winding, lead 729, contact 3 of relay 1201, contact of relay 1204 released to ground on lead 941. It will be noted that relay 1201 remains locked through its contact 1 to ground on lead 941 after the release of relay 1204. Relay 707 in operating locks to ground on contact 9 of relay 901. It will be remembered as described under class signals that the operation of relay 707 transfers the fundamental tip and fundamental ring leads 644 and 645 to the out-pulsing circuit of the sender, transfers leads to the zone charge control circuit of the sender, connects ground through resistance 819 to lead 643 causing the line finder selector trunk to connect the fundamental tip and fundamental ring leads to the dual selector, and opens the circuits for relays 702, 706, 700, 704, 701 and 705. The ground supplied to lead 643 may be traced from ground on contact 3 of relay 808, contact 7 of relay 707, resistance 819, lead 643 which extends through contact 7 of relay 600, brush 612, terminal 616, winding of relays 210 and 211 to battery. The operation of relay 211 transfers the fundamental tip and fundamental ring leads 244 and 245 to the selector for outgoing pulses from the sender for use after the office code has been completely registered.

If relay 1100 operates instead of relay 1111 and relay 1211, the operation of relay 707 takes place immediately and relay 204 of the trunk circuit is not operated since a circuit is not established for the later relay.

Check for ability of line test to function

Relay 1112 as set forth in the foregoing should operate over the tip line conductor to ground through a high resistance in the subscriber's station set which is known as the tip station set of a two-party message rate line and this relay 1112 non-operates under all other line conditions with the exception of a false ground connected to the line. In order to insure against faulty operation of relay 1112 and thus insure against false charges to a subscriber for telephone calls which were not made by the subscriber, a check test is made at the end of each call before the sender is released. If relay 1112 operated on the party identification test, this relay is checked by the sender mechanism for its ability to meet its non-operate condition, thus insuring that it did not operate falsely when associated with current which would be the equivalent of its non-operate circuit. If relay 1112 is non-operated on the party identification test, the relay is checked for its ability to meet its operating condition so that if a call was made by the tip party and this relay did not operate, it would be apparent that the ring party of the two-party line should not be charged for the call. This test is accomplished in the following manner.

When relay 1112 originally operates on the party identification test, relays 1111 and 1211 operate and lock as stated in the foregoing description and in response to the operation of the route relay for routing the call to the proper destination, one of relays 1618, 1619, or 1620 operates as later described, a circuit is established for operating relay 1203. Relays 1114, 1102 and 1106 are released. Relay 1203 transfers the tip

and ring leads 648 and 649 directly to the L relay 905 and tone call 918 through continuity contacts without disturbing the L relay 905 and prepares for testing relay 1112. When one digit has been dialed in the out-dialing circuit for obtaining connection with the wanted party, relay 1622 operates which operates relay 1214 and the latter relay operates relays 1215, 1213 and 1110. Relay 1110 connects a ground through resistance 1109 over a circuit through contact 1 of relay 1110, contact 2 of relay 1214, contact 4 of relay 1111, the winding of relay 1202 to battery thus operating relay 1202. The latter relay in operating releases relays 1214 and 1215. This test cycle is the same as previously described for testing the line, excepting that instead of having relay 1112 connected to the tip and ring of the line, it is connected to resistance 1121 to ground through contact 6 of relay 1111. This circuit may be traced from battery through the contact of jack 1113, resistance 1118, upper winding of relay 1112, contact 3 of relay 1102 thence through varistor in parallel with resistance 1216, contact 1 of relay 1215, contact 3 of relay 1214, contact 3 of relay 1110, contact 6 of relay 1203 to ground through resistance 1121. This is a non-operate condition for relay 1112 and as a result of the relay non-operating, relays 1115, 1102, 1106 and 1100 are operated. If relay 1112 is operated when associated with the foregoing resistance on its non-operate condition, then relay 1100 will not operate and the sender will be prevented from dialing the tens digit.

When relay 1112 non-operates on the party identification test, relay 1100 is operated as a result of the non-operation of relay 1112 and relay 1100 locks to ground when relay 1203 is operated. As described in the foregoing, relays 1115, 1102 and 1106 are released. The party identification relay 1112 functions as described in the foregoing party identification test with the exception that with relay 1100 operated, the party identification relay 1112 is connected to an operating network, designated 1101, through contact 4 of relay 1100. If relay 1112 is in correct adjustment, it will operate when associated with this network and relay 1111 will be operated. However, if relay 1112 fails to operate, relay 1111 will not be operated and the sender will be prevented from dialing the tens digit.

Cross-connection of route relay contacts

The route relay operated in accordance with the code digits registered is used to direct the sender in setting up its mechanism to transmit pulses known as out-dialing pulses for connecting the calling subscriber with a subscriber in a step-by-step office, a cross bar office, a panel office, a tandem office or local offices connected with the foregoing offices. Connections are also made from this office by the sender through one step-by-step office or similar office to other step-by-step offices through which the called subscriber may be reached. The route relay and other mechanism of the sender exercises the following control for completing the above-mentioned telephone connections:

(1) It controls the number of digits and the number of pulses per digit required to select the trunk to the distant office or operator.

(2) It selects which of the digits registered on the cross bar switches, Fig. 14, should be transmitted to a distant office.

(3) It selects the speed of transmitting the out-dialing pulses for the code and numerical pulses transmitted to different characters of distant offices.

(4) Mechanisms are provided in the sender to guide the sender when it should wait for numerical digits and for stations digits to be dialed.

(5) The registers are arranged for dialing a 1—1 before the office code when the same office code is included in adjacent telephone exchange areas. Mechanism is provided to indicate the zone of the called station.

These and other functions are provided by means associated and connected with the contacts of the route relays which, as will be seen, may be different for each route relay.

Number of digits for selecting outgoing trunk

An example of the route relay control of the number of digits transmitted by the sender for the selection of an outgoing trunk to a particular destination and the number of pulses per digit for selecting this outgoing trunk is demonstrated in the wiring of route relay 1905.

The number of digits to be transmitted by the sender in selecting the outgoing trunk is controlled by cross-connecting a terminal of the route relay, such as terminal 1910 of route relay 1905 to one of the terminals 1630, 1631 or 1632 which are connected through the windings of relays 1618, 1619 and 1620 respectively to battery. The associated contact terminal 1911 is either connected to ground or through a relay winding to ground, the utility of which will be later described. The terminal 1910 is cross-connected to the winding of relay 1618 if one digit is required to select the outgoing trunk. Terminal 1910 is cross-connected to the winding of relay 1619 if two digits are required to select the outgoing trunk for a particular routing. Terminal 1910 is cross-connected to the winding of relay 1620 if three digits are required for selecting the outgoing trunk for a particular routing. The operation of one of relays 1618, 1619 or 1620 causes pulsing for outgoing digits to start at the proper point in the progress relays. The opposite contact 1911 of the various route relays depending upon the routing controlled by the route relay is cross-connected to ground or to terminals 1642, 1643, 1531, 1532, 1533 or 1534 each of which is connected through the winding of a different relay to ground and each of which serves for controlling the pulsing mechanism of the sender in a different capacity.

The progress relays of Fig. 17 are variably used. The relays used depend on the number of digits for selecting an outgoing trunk according to the office code registered, whether the 1—1 prefix is to be transmitted by the sender, whether an office code is to be transmitted by the sender, plus numerical and station digits. Relays 1707, 1708 and 1709 are variably operated to control the number of digits for selecting an outgoing trunk. Relays 1710 and 1711 are used for the 1—1 prefix and are skipped if this prefix is not to be transmitted by the sender. Relays 1712, 1706 and 1705 are connected to the registers for transmitting office codes to a panel or cross bar sender but are skipped when connection is made to a step-y-step office since the step-by-step switches are set directly by the fringe office sender pulsing mechanism. The remaining progress relays 1704, 1703, 1702 and 1701 are used for numerical and station digits. The route relay contact 1911 associated with the contact 1910 is connected to the winding of a relay for con-

trolling the progressive operation of the sender pulsing mechanism as follows:

Route relay service contacts

Terminal **1911** is cross-connected to terminal **1642** or **1643** for routes directed to two or three digit step-by-step offices respectively. Terminal **1642** is connected through the winding of relay **1612** to ground and terminal **1643** is connected through the winding of relay **1613** to ground. The operation of relay **1612** causes the sender to delete the A and B office code digits when transmitting the digits to the distant office. Consequently, if one digit is required to select the outgoing trunk and the A and B digits are deleted when transmitting the digits, the winding relay **1612** will be cross-connected to the winding relay **1618** through contacts such as **1910** and **1911** of the route relay and thus both of these relays will operate since the winding of relay **1618** is connected to battery and the winding of relay **1612** connected to ground. When terminal **1911** is connected to terminal **1643**, relay **1613** is operated causing the sender to delete the A, B and C digits of the office code. It will be recognized that these relays are not used for connections to panel or cross bar offices since the office code digits are transmitted to the senders of these offices.

Terminal **1911** may be cross-connected to terminal **1531** which operates relay **1530** for routing an incoming call directly to an operator. This prevents transmitting any pulses from the sender to the distant office.

Terminal **1911** is cross-connected to terminals **1532** operating relay **1524** to facilitate calls to cross bar or panel offices if the pulses to the distant office are to be sent at a higher rate than to a step-by-step office as would be the case for operating sender registers in these distant offices. The 1—1 prefix is not transmitted when relay **1524** is operated but when relay **1526** is operated the pulses are transmitted at the high rate of speed including the 1—1 prefix. The difference between these two relays is therefore to designate whether the digits 1—1 are to be transmitted or not transmitted before the office code. These relays are operated so that the pulses are dialed at a fast rate of speed for cross bar or panel offices in order to reduce the holding time of the sender. This is only done where the sender at the distant office is capable of registering pulses at this speed over the trunk as regulated by the route relay used. Pulses to step-by-step offices are dialed at a slower speed and consequently relays **1524** and **1526** are not connected to any route relays which route calls to step-by-step offices.

Terminal **1911** is cross-connected directly to ground or to terminal **1534** through the winding of relay **1529** to ground for calls to distant offices when pulses should be transmitted at the rate of nine to eleven pulses per second. The direct ground is connected to terminal **1911** if the 1—1 does not precede the office code and to relay **1529** when the 1—1 is to be dialed before the office code.

For other routes to an operator, whether direct or through another office, route relay terminal **1912** is cross-connected to terminal **1420**. The opposite route relay contact **1913** in this case is cross-connected to terminal **830** which is connected through contact **3** of relay **817**, winding of relay **800** to battery under different conditions. When zero is registered for the A digit or when the C digit of a three digit operator's code is registered, a circuit is established for operating relay **800** to indicate that dialing is finished. This same cross-connection may be used for vacant codes so that an operator may properly advise the calling subscriber who has made an error in dialing.

For routes other than operators' routes, terminal **1912** may be cross-connected to terminal **1320** and the opposite terminal **1913** of the route relay is cross-connected to either terminal **830** if no station or fifth numerical digit is to be dialed or to terminal **831** to control the sender so that it will wait for the stations or fifth numerical digit. The sender is required to wait if the called office is a manual office having some lines with station letters or some lines with numbers above **9999**. This is effective when the F digit has been registered for two digit calls or when the G digit has been registered for three digit calls. In both cases, relay **800** is operated. Relay **800** is also operated when the G digit has been registered for two-digit calls or when the H digit has been registered for three-digit calls. If this last digit is not dialed, relay **800** operates when relay **802** operates from a timing device controlled by relay **803**, as described later. In any event, relay **800** operates when the subscriber is finished dialing.

Referring again to the route relay connections, reference is here made to multiregistration where a different number of subscriber lines register operations are required depending upon designation of the call. Route relay contact terminal **1925** may be cross-connected to indicate the zone in which the called office is located. This terminal is cross-connected to zone sector terminal **1835** in the lower portion of Fig. 18, or a similar circuit depending upon the zone in which the called office or office represented by the route relay is located. This causes a zone charge circuit, not shown, to be used with the sender to indicate to the sender the zone of the called office. Terminal **1925** of the route relays used for codes not requiring such multiregistration is cross-connected to terminal **1836**. This will cause the call to be established without the use of a zone charge circuit.

Number of pulses for each digit

The lower three contacts shown on route relay **1905** control the number of pulses for each digit transmitted for the selection of the outgoing trunk. Contact **6** is used for a one-digit selection, contacts **5** and **6** for a two-digit selection and contacts **4**, **5** and **6** for a three-digit selection. Relay **1707**, **1708** and **1709** control these selections. These relays are operated successively starting with relay **1707** for a three-digit selection, starting with relay **1708** for a two-digit selection and **1709** for a one-digit selection. A circuit for the starting relay is established through the contacts of one of relays **1618**, **1619** or **1620**. For example, if three digits are required for the selection the winding of relay **1620** is cross-connected to terminal **1910** which operates relay **1620**. A circuit is thus established for the three-digit relay **1707** from battery through its winding, contact **1** of relay **1708**, contact **1** of relay **1620**, contact **1** of relay **1621** to ground over contact **4** of relay **1607**. If only one digit is required for the selection of the outgoing trunk, relay **1618** is connected to terminal **1910** which operates relay **1618**. A circuit is thus established for relay **1709** from battery through its winding, contact **1** of relay

1710, contact 1 of relay 1712, contact 2 of relay 1613, contact 1 of relay 1705, contact 2 of relay 1618, contact 1 of relay 1621 to ground on contact 4 of relay 1607. Relay 1619 is operated for a two-digit selection which accordingly establishes a circuit for relay 1708.

For controlling the number of pulses for each digit, terminals 1919, 1920 and 1921 are cross-connected through the contacts of outgoing pulse counting relays 1800 to 1805 to a stop pulsing relay 1607. If four pulses are to be transmitted for a digit whether it is the first, second or third digit, the route relay terminal such as 1919, 1920 or 1921 is connected to contact 4 of relay 1803 which is operated when the fourth outgoing pulse is transmitted for establishing a circuit over lead 1843 for operating relay 1607. Terminals 1916, 1917 and 1918 of the route relay are cross-connected to complete the circuit for relay 1607.

From the foregoing it is apparent that if three digits are required for selecting an outgoing trunk connection, relay 1620 is operated and relay 1707 is the first progress relay to be operated. Terminal 1916 of this route relay would be cross-connected to terminal 1723, contact 3 of relay 1707 which extends over the lower contacts of all of the progress relays in a chain and from contact 4 of relay 1700 through contact 3 of relay 1609 to ground on contact 1 of relay 917. Summing up this action at this point, the wiring through the contacts of this route relay would operate relay 1620 for three-digit control which operates relay 1707 for controlling the first one of the three digits and assuming that contact 1919 is connected to contact 4 of relay 1803 would limit the number of pulses for this digit to four pulses. After the first digit is transmitted relay 1708 is operated by action of the pulsing mechanism during the interdigital period when relay 1621 is operated and relay 1607 has been released. Route relay terminal 1917 would be cross-connected to terminal 1722, contact 4 of relay 1708 to ground as previously traced and terminal 1920 would be connected to the proper relay contact Fig. 18 for determining the number of pulses for this digit. If nine pulses constitute the second digit terminal 1920 is connected to contact 4 of relay 1802 since relay 1805 is operated and locked by the sixth pulse and relay 1802 by the ninth pulse and a circuit is thus established through contact 5 of the route relay, contact 4 of relay 1802, contact 4 of relay 1805, lead 1843 through the winding of relay 1607 for terminating the digit pulses with the ninth pulse. Relay 1709 is operated during the interdigital period between the second and third pulse. Terminal 1918 of the route relay is connected to terminal 1721 and contact 6 of relay 1709 and terminal 1921 is connected to one of the contacts on a relay 1800 to 1805 to determine the number of pulses which constitute the third digit in the manner described for the first and second digit.

It is apparent that if only one digit is sent for selecting the outgoing trunk relay 1618 operates relay 1709 and relays 1707 and 1708 are not used. Thus only one of the three lower contacts on route relay 1905 or any route relay is used. Under this condition terminal 1918 is connected to terminal 1721 and route relay terminal 1921 is connected to a contact on one of relays 1800 to 1805 for terminating pulsing according to the number of pulses to be transmitted for selecting a trunk for this particular one-digit routing.

Three-digit translator

For calls requiring a three-digit code, a translator is required. In order to obviate the use of the usual complicated translator a simplified translator has been devised using the C cross bar switch vertical common to all three-digit codes and a relay for each ten three-digit codes which have the same first and second digits or have a plurality of three-digit codes each of which extends the calling line to the same group of trunks for connection with a tandem operator or another common trunking destination.

In the arrangement of this translator the first two digits of the three-digit code operate a translator relay having ten contacts. For example, if the first two digits of a three-digit code are 4—4, the code point 4—4 on the BA vertical is connected to translator relay 1901 and the registration of the first two digits 4—4 establishes a circuit for this relay. The circuit for relay 1901 may be traced from battery through its winding, contact 44 of the BA vertical, contact 4 of the A vertical, contact 1 of relay 1130 to ground on contact 7 of relay 901. Relay 1901 has ten contacts connected to the 0–9 contacts on the C vertical Let it be assumed that the third digit is 9 and therefore that the No. 9 select magnet was operated in response to the dialing of the third digit and the C hold magnet 1404 operated to hold the No. 9 contact against the vertical bar. The alternate contacts of relay 1901 are code points 440 to 449. Since ground on contact 7 of relay 901 is connected to the C vertical bar a circuit is now established to code point 449 for operating route relay 1902. If the third digit had been zero a circuit would have been established through the zero contact of the C vertical to code point 440 for operating route relay 1904. The contacts of these route relays are connected to the sender mechanism in the same manner as described for route relay 1905 with the connections for contact terminals 1910, 1911, 1912 and 1913 varied according to conditions of routing as described in the foregoing.

The contacts of the C vertical are connected to the contacts of all of the three-digit translator relays and therefore any three-digit translator relay operated by a circuit established through the contacts of the A and B verticals responsive to the dialing of the first and second digits has its contacts connected to contacts 0 to 9 of the C vertical, one of which establishes a circuit to the desired code point in response to the dialing of the third digit. For example, the windings of three-digit translator relays may be connected to any of the contacts on the B, BA, or BB verticals. The first two digits 2—2, 6—4, 7—8, etc. will establish a circuit for a translator relay connected to the 22, 64, 78, etc. contact of the B verticals. In each case the code point reached through the C digit vertical may be 220 to 229, 640 to 649, 780 to 789 or other three-digit codes as will be apparent from the foregoing description.

In certain instances groups of trunks to a tandem office may be assigned serial office code numbers such as 990 to 994, comprising five trunks or five small groups of trunks which reach the same destination by the selection of any of the five trunks by a trunk selecting switch. For this character of routing only one route relay is required for the five trunks or five small groups of trunks. The operation of this one route relay such as route relay 1903 is responsive to the dial-

ing of any of the codes 990 to 994. Other route relays for different routings may be connected to the code points 996 to 999. The first two digits 99 operate the three-digit translator relay 1900 for establishing circuits through the C vertical contacts to any of these code points. The three-digit translator relay 1900 is therefore operated in response to any three-digit code, starting with 99 for the first two digits. After the operation of relay 1900 the third digit of the circuit is established for the single route relay 1903 for obtaining access to a plurality of trunks or should the third digit be one of the numerals 6 to 9 a route relay is operated which is connected to the other code points shown, for example, as route relays connected to any of the terminals 995 to 999.

Coin and non-coin subscribers

Two route relays are provided for either two or three-digit codes which require separate groups of trunks for coin and non-coin subscribers. The code part may be connected to a three-digit relay or may be connected directly to the cross-bar switch contacts. An arrangement is shown for a two-digit number for code point 79 which is connected to contact 5 of class relay 708 and contact 5 of class relay 709. It will be remembered that these class relays determine the class of call and consequently when one of these relays is operated the routing will be made from a coin line and when the other relay is operated a routing will be made from the non-coin subscriber. These and similar class relays have their windings cross-connected to the contacts of class designating relays in the upper portion of Fig. 7 which are operated as previously described under class designations. Route relays 770 and 771 are shown connected to the contacts of the class relays and the operation of the route relay 770 or 771 depends upon which of the class relays 708 or 709 is operated responsive to the class of service circuit established by either a coin line or a non-coin line for routing the call over a particular trunk connection. If the code is a three-digit code the terminal 763 is connected to a code point on a translator relay contact instead of a two-digit code point such as a 779 as shown in this illustration.

Selector operation

The line-finder selector trunk circuit, Figs. 2 and 3, responds differently under sender control to differently routed calls. The action in the line-finder selector trunk responsive to a local call office code having been dialed by the calling subscriber into the sender as controlled by the sender causes the line-finder selector trunk to connect the dual selector, Fig. 4, directly to the calling subscriber's line and releases the trunk finder and sender. If the code is such as to route the call over an outgoing trunk, the calling subscriber's line remains connected to the sender and the dual selector is connected to the sender pulsing mechanism by the action of the line-finder selector trunk.

Incoming calls for local subscriber

The term "local call" as used herein for obtaining connection between a calling subscriber and a local subscriber is used where a connection is established between a calling subscriber and a subscriber which may be reached directly by the connection of the dual selector with a second selector 420 or 421. The second selector 420 represents one local office and the second selector 421 represents a second selector in another local office. The called subscriber may be reached through the second selector 420 and connector 500 or second selector 421 and connector 501 in a different office in the usual manner of operating switch selectors and connectors in step-by-step offices. The subscriber C may be assumed as in local office No. 1 and subscriber D may be assumed as in local office No. 2. The sender is connected through a trunk finder circuit to the finder selector circuit and line finder for local calls in the manner hereinbefore outlined in response to the office code digits dialed by the calling subscriber.

It will be remembered that in response to initiation of a call by a calling subscriber the line finder, the finder selector, trunk circuit and the dual selector circuit are energized in addition to the operation of the sender and a trunk finder circuit. Relays are energized in the line-finder selector trunk circuit, Fig. 2, which cause the operation of the A relay 402 and the B relay 403. The operation of the B relay 403 connects ground with sleeve lead 455 extending back to the line-finder selector trunk circuit through contact 3 of relay 210, contact 9 of relay 209, contact 6 of relay 210 to lock relay 215 after its operation by relay 217 as herein described. The sleeve ground also extends through contact 3 of relay 215, contact 3 of relay 217 which is released upon the operation of relay 215 thence over conductor 242, terminal 608, brush 604, contact 4 and winding of relay 600 for holding the trunk finder circuit after it has selected the line-finder selector trunk circuit and for extending ground through the sender. This same ground extends from the dual selector circuit through contact 8 of relay 211 to the line-finder conductor 140 for holding the line finder. It will also be remembered that the operation of relay 403, the dual selector connects ground to lead 452 which extends through the winding of relay 202, the upper winding of relay 209, lead 256, brush 617, terminal 613, contact 8 of relay 600 thence over lead 642 and when an idle sender is attached this lead is extended through the winding of relay 902 to battery. Relay 202 is operated but relay 209 is not operated since the resistance 903 and the relay winding 902 do not permit sufficient current flow for the operation of relay 209. The operation of relay 202 supplies a holding bridge for the A relay 402 of the dual selector, Fig. 4 and transfers the calling line tip and ring leads 260 and 261 to the tip and ring leads 258 and 257 through its contacts 3 and 7, respectively. Relay 202 also connects lead 143 from the subscriber's line lead 102 to lead 246 extending to the class signaling equipment in the sender. A holding ground for relay 202 is supplied through its contact 5. When the calling subscriber receives the dial tone from the sender the office code is first dialed which for example may be assumed as a local call having digits 4, 9 which it will be assumed may be for extending a call through a subscriber's line available through one of the second selectors 420 or 421 and does not involve the use of a trunk to another office. The sender responds to the four pulses for the digit 4 by operating the pulse 4, relay 1018, which is automatically locked after the digit is dialed for registering the first digit. As previously described this energizes the No. 4 select magnet and causes the operation of hold magnet 1400. The pulses for the digit 9

cause the energization of the pulse 6, relay 1010 and the pulse 3, relay 1025 which are both automatically locked to cause the registration of nine on the B cross bar register verticals and as herein described the hold magnets 1401, 1402 and 1403 are energized. In this instance hold magnet 1402 is the one which is effective since the code point 49 is on the left upper contact of the BA verticals.

Since the sender does not transmit outgoing pulses for local calls it is arranged to be immediately disconnected when a local call is dialed by a calling subscriber. It is also arranged to readjust the line-finder selector trunk circuit, Figs. 2 and 3, for causing the connection of the calling subscriber's line and the line finder directly with the dual selector which will act as a first selector in response to subsequent digits dialed by the calling subscriber.

As shown in Fig. 14 the contact 4 of the A vertical is permanently connected to the vertical 4 of the BA verticals. The code point 49 is cross-connected to terminal 832 which extends through the winding 808 to battery. The circuit for relay 808 may thus be traced from battery through its winding, "BA" vertical code point 49, contact 4 of the first A vertical, contact 1 of relay 1030 which under this condition is normal, to ground on contact 7 of off-normal relay 901. The operation of relay 808 causes the release of the sender and readjustment of the line-finder trunk circuit as follows.

Sender release

Relay 808 connects battery through low resistance 809 to lead 642 to increase the current flow over lead 642. Previously this lead extended through the winding of relay 902 and the high resistance 903 to battery as previously traced for initiating the operation of the sender. Increasing the current flow over lead 642 causes the operation of relay 209 in the line-finder selector trunk circuit. The operation of relay 209 opens the sleeve ground through its contact 9 which as previously traced extended from contact 3 of relay 403 to the winding of relay 215 and over sleeve lead 242 to contact 4 of relay 600 in the trunk finder circuit 6, sleeve lead 646, contact of relay 619, and over sleeve lead 641 to the sender. Relay 209 in operating locks through its lower winding and its contact 9, contact 8 of relay 210 over the sleeve to ground on contact 3 of relay 403. The operation of relay 209 therefore causes the release of relay 215 in the line-finder selector circuit and also causes the release of relay 600 in the trunk selector since the locking circuit for relay 600 extends through contacts 3 and 1 of relay 619 to this sleeve ground. The latter relay releasing causes the disconnection of all leads between the sender and the line-finder selector trunk. Relay 202 of line-finder selector trunk circuit is thus released but relay 209 remains locked through its lower winding to ground on contact 3 of relay 403 of the dual selector. The release of relay 202 connects the windings of the A relay 402 over the line loop through the mechanism of the subscriber's station and also removes the holding bridge for this dual selector A relay. The pulses dialed by the calling subscriber for the next digit are thus received by the dual selector causing the intermittent release and operation of the A relay 402 to position this selector. Subsequent pulses are received by the second selector and connector for associating the calling subscriber with subscriber 560 if the second selector 420 is dialed or subscriber 561 in another office if second selector 421 is dialed.

The trunk selector, Fig. 6, is restored to normal since the release of relay 600 establishes a circuit through its contact 10 and contacts 1 and 2 of the vertical off-normal springs for energizing the release magnet 630. The opening of the sleeve ground also disconnects ground from lead 641 in the sender which causes the release of off-normal relays 901 and 917. The release of these relays causes the release of relays and hold magnets of the sender, restoring the sender to normal so that it is available for another call.

Incoming call for other offices

A general statement regarding the action of the line-finder selector trunk under the control of the sender, for outgoing calls to other offices may be here of assistance in the understanding of the optional arrangements of the sender in determining the pulsing device to be connected to the dual selector circuit. As above stated the operation of relay 202 places a bridge across the windings of the dual selector A, relay 402, which holds this relay operated. During the dialing of the digits by the calling subscriber and as the sender progresses in its responsive and automatic operations a circuit is established for relay 707. This relay establishes a circuit through other relay contacts for operating the selector trunk relay 211. Relay 211 by the operation of two continuity contacts disconnects the windings of the dual selector A, relay 402, from the bridge circuit established by the operation of relay 202, and disconnects the windings of relay 402 over leads 244 and 245 in the selector trunk and sender leads 644 and 645 which extend to the outgoing pulsing mechanism of the sender which forms a closed fundamental circuit at this time and therefore also forms a bridge for holding relay 402 operated. The windings of relay 402 are thus transferred from one bridge to another without operating the selector. After the office code has been registered and the sender is in readiness to transmit outgoing pulses as later described, this fundamental is opened for the first outgoing pulse to position the first or dual selector for selecting an outgoing trunk. Relay 202 remains operated and thus continues to hold the calling subscriber's line connected to the dial pulse responsive mechanism in the sender until all pulses including numerical pulses and station pulses if any are registered and transmitted by the outpulsing mechanism of the sender. Relay 202 is then released for connecting the calling subscriber to the distant office over the selected outgoing trunk, the distant office mechanism having already been operated by the fringe office sender for connecting the calling subscriber to the called subscriber.

Sender pulsing mechanism

The out-dialing is accomplished by electrical devices and circuits shown in Figs. 13, 14, 15, 16, 17 and 18. The pulses for one, two or three digit trunk selections are transmitted as controlled by the route relay contact cross-connections as described in the foregoing to cause the operation of step-by-step selectors for connecting subscribers with step-by-step offices, panel offices, cross-bar offices, or tandem offices. This mechanism transmits digit pulses for the selection of a trunk to a distant office, transmits the 1—1 pulses as indicated by relay 1526 or relay 1529 if operated under control of class indicating means and the

route relay and thereafter transmits digit pulses for the office code, which may be one, two or three digits, the subscriber's number and stations digit as register on the cross bar switches. Relays 1707, 1708, 1709, 1710, 1711, 1712, 1706, 1705, 1704, 1703, 1702, 1701 and 1700 are progressively operated as the digits are transmitted. These relays operate in successive order unless certain of them are skipped when the digit is to be omitted. The last one operated indicates the next digit to be transmitted.

Relay 1500 generates the dial pulses at approximately ten or approximately twenty pulses per second depending upon the type of office to which the switching connection is extended as controlled by the route relay. The potentiometer associated with relay 1502 controls the speed of pulsing which is altered by the operation of this relay. Relay 1500 causes relays 1514 and 1518 to pulse responsively at the same speed as relay 1500 is operated. When ground is connected to the No. 5 winding terminal of polarized relay 1500 this relay is held unoperated and the polarized relays 1514 and 1518 are held operated. Under this condition the fundamental circuit over which outward pulses are transmitted is closed through the contact of relay 1514 and thus the dual selector A relay 402 is held operated until the first pulse is transmitted. The circuit for relays 1514 and 1518 may be traced from battery through the potentiometer resistances 1508 and 1509, winding of relay 1514, winding of relay 1518, contact 2 of jack 1501, No. 2 winding terminal of relay 1500, No. 5 winding terminal of relay 1500, contact 3 of jack 1501, thence over lead 1732, contact 1 of relay 1707, contact 2 of relay 1708, contact 1 of relay 1709, thence over lead 963 to ground on contact 5 of relay 901. It will be remembered that this circuit was established when off-normal ground relay 901 was operated as the sender was taken for use. This is done so that the windings of the selector relay 402 may be connected to the fundamental circuit as soon as the sender determines that a trunk connection is required. This ground also extends over lead 1543 to another point on the potentiometer. The current in the circuit traced is in the proper direction to operate relays 1514 and 1518 but with ground associated with winding terminal 5 of relay 1500 the latter relay is not operated. This ground is removed by the operation of relay 1707, 1708 or 1709 depending upon which of these three relays is operated for trunk selection through the contacts of the one-digit relay 1618, the two-digit relay 1619 or the three-digit relay 1620, one of which has its winding connected to a contact of the route relay. The operation and release of relay 1500 after the ground is removed by the operation of either relay 1707, 1708 or 1709 is under the control of condenser 1504, a circuit from battery through resistance 1513 and the potentiometer associated with relay 1502 as previously explained. Relay 1514 interrupts the circuit of the fundamental tip and the fundamental ring leads to cause the operation of selectors, connectors, or sender registers to be actuated. Pulses from the contact of relay 1518 are counted by relays 1615, 1616, 1617, and relays 1800 to 1805, inclusive. When the number of the pulses have been sent corresponding to route relay operated or the lead which is grounded by a cross bar switch register, Fig. 14, relay 1607 operates, again connecting ground to terminal 5 of relay 1500 to stop the pulse generator. The circuit for relay 1607 may be traced from battery through resistance 1601, winding of relay 1607, lead 1843 through a contact of one of the progress relays 1800 to 1805 to ground through a contact of a route relay as previously traced or to ground through the contact of an operated register switch as shown. Assuming, for example, that relays 1802 and 1805 are operated this circuit would extend from lead 1843 through contact 4 of relay 1805, contact 4 of relay 1802 thence over the No. 9 lead connected to terminal 1829, lead 1849, to the contact of a register switch to ground through a contact of the operated progress relay, Fig. 17, or through a route relay contact such as contact 5 of route relay 1905 which may be assumed to have been operated, to ground through one of the trunk selection progress relays 1707, 1708 or 1709 operated under the control of a route relay, thence through contact 6 of relay 1709, contact 4 of relay 1710, contact 4 of relay 1712, lower contacts of relays 1700 to 1706, contact 3 of relay 1609 over lead 960 which extends to ground on contact 1 of relay 917. As will be explained hereinafter relay 1608 and relay 1609 are operated and released under the control of the pulsing mechanism. The operation of relay 1607 at the end of pulses for a digit causes these relays to function which releases pulse counting relays 1615, 1616, 1617 and 1800 to 1805 and then caused three or six pulses to be counted during the between-the-digit interval releasing the pulse counting relays again at the end of this period and also causing relays 1621 and 1622 to advance relays 1707, 1708 and 1709 and other progress relays to the next step in order to prepare for transmitting the next digit. Relays 1512, 1501, 1527 and 1528 are used for calls to panel and cross bar offices and also cross bar tandem offices which are arranged to recognize by means of current reversal that the distant sender is ready to receive pulses. These relays prevent the transmission of pulses over the trunk until the signal is received. The above is a broad statement of the events in out-pulsing which is covered more in detail in the following description.

As previously outlined the operation of relays 1620, 1619 or 1618 is controlled from a contact of the route relay. A connection is made from a contact on the route relay to terminal 1630, 1631 or 1632 as previously outlined. The operation of one of the foregoing relays operates either relay 1707, 1708 or 1709 which closes a circuit from off-normal ground on lead 960 through contact 3 of relay 1609, contacts on the progress relay 1700 to 1706 to the contacts of the operated relay 1707, 1708 or 1709 to terminal 1721, 1722 or 1723, respectively. As previously traced this extends through a contact of an operated route relay such as traced through relay 1905 to one of the 0 to 9 terminals, 1820 to 1829 connected to the contacts of the out-pulsing relays 1800 to 1805. The operated relay 1707, 1708 or 1709 opens a circuit from off-normal ground to terminal 5 of pulsing relay 1500 which has been holding relay 1500 unoperated and relays 1514 and 1518 operated. Up to this time the contacts of relay 1514 has been holding the A relay 402 of first or dual selector energized and relay 1518 holds relay 1615 operated. The circuit for the A relay 402 may be traced over the pulsing circuit from battery through its lower winding, contact 3 of relay 400, contact 3 of relay 203, contact 1 of relay 211, lead 244, terminal 615, brush 611, contact 6 of relay 600, lead 644, contact 2 of relay 707, lead 790,

contact 3 of relay 1511, resistances 1523 and 1522, conductor 1592, contact 2 of jack 1515, contact of relay 1514 returning now over the tip fundamental conductor through contact 1 of jack 1515, thence over lead 1591, contact 5 of relay 823, contact 3 of relay 904 thence over lead 791, contact 5 of relay 707, lead 645, contact 5 of relay 600, brush 610, terminal 614, lead 245, contact 3 of relay 211, contact 2 of relay 203, lead 450, contact 2 of relay 400, upper winding of relay 402, contact of 11th rotary switch 417 to ground. The circuit for relay 1615 operated by relay 1518 may be traced from battery through the winding of relay 1615, contact 1 of relay 1617, contact of relay 1518 to ground over lead 1542 which connects with lead 960 previously traced to ground on the off-normal ground relay.

The removal of ground from winding terminal 5 of relay 1500 by the operation of one of relays 1707, 1708 or 1709 causing the immediate release of relays 1514 and 1518. Relay 1500 now starts to operate in the circuit from 48-volt battery through resistance 1513, lower primary winding of relay 1500, windings of relays 1518 and 1514 to the mid-point 1540 of the potentiometer. The current is now in the direction to operate relay 1500 and non-operate relays 1518 and 1514 as will be apparent by the markings on the windings of these polarized relays. The operation of relay 1500 is delayed due to current flowing through resistance 1513, secondary upper winding of relay 1500 and condenser 1504 which is in the direction to non-operate relay 1500. The operation of relay 1500 is therefore delayed until condenser 1504 is sufficiently charged to reduce the current in the secondary upper winding of relay 1500 to a point where the ampere turns of the primary lower winding of relay 1500 exceed the ampere turns of the upper secondary winding by an amount sufficient to operate the relay 1500. The operation of relay 1500 connects ground from lead 1545 to its No. 5 winding terminal which now operates relays 1514 and 1518 and starts the release of relay 1500. The release of relay 1500 is delayed due to current in the upper secondary winding which is in a direction to hold the relay operated momentarily. The source of this current is condenser 1504 which now discharges through the upper secondary winding when the contact of relay 1500 is closed. As previously outlined the operation of relay 1518 established a circuit to operate relay 1615.

The release of relay 1500 removes ground from its winding terminal 5 and the above cycle is repeated causing the transmission of pulses for each operation and release of relay 1500. Relay 1514 releases and reoperates responsive to the transmission of each pulse once per cycle and opens the circuit for the selector A relay 402 over the circuit as previously traced which causes the advance of the selector switch one level. Relay 1518 also releases and reoperates once per cycle. The release of relay 1518 removes the short-circuit from relay 1617 causing it to operate in series with relay 1615. This circuit may be traced from ground on lead 960, contact 3 of relay 1600, contact 2 of relay 1615, contact 1 of relay 1616, lower winding of relay 1617, winding of relay 1615 to battery. It will be apparent that the ground which held relay 1617 from previously operating extends from lead 1542 through the contact of relay 1518, contact 1 of relay 1617, to a terminal of its lower winding. This ground held relay 1615 operated and prevented relay 1617 from operating until relay 1518 released. The subsequent operation of relay 1518 causes the operation of relay 1616 and holds relay 1617 operated. This circuit may be traced from battery through the upper winding of relay 1616, upper winding and contact 2 of relay 1617, contact of relay 1518 to ground on conductor 1542. The operation of relay 1616 opens the circuit for relay 1615 causing the release of the latter relay. The next release of relay 1518 causes the release of both relays 1616 and 1617 and the reoperation of relay 1518 causes the operation of relay 1615. This cycle of operation and release of relays 1615, 1616 and 1617 occurs for each two pulses transmitted over the fundamental tip and fundamental ring conductors to the selector switches. The first operation of relay 1617 causes the operation of the pulse 1 counting relay 1800. This circuit may be traced from battery through the lower winding of relay 1800, contact 1 of relay 1804, contact 1 of relay 1802, contact 1 of relay 1801, contact 1 of relay 1803, conductor 1841, contact 4 of relay 1617, contact 2 of relay 1600 to ground on lead 960. The first release of relay 1617 causes the operation of relay 1801 which releases relay 1800. The operation of relay 1801 may be traced over a circuit similar to the one traced for relay 1800 extending through contact 2 of relay 1800 thence over lead 1840 through contact 3 of relay 1617 released, to ground on lead 960.

The dual or first selector operates in the manner herein described and its first response to pulses either from the calling subscriber's dial for a local call or from the sender pulsing mechanism as determined by the control circuits of the sender, releases relay 402 during the open periods of the pulses. This selector operates in the usual manner of step-by-step first selectors to move the brushes first in a vertical direction under the control of the A relay 402 and in a rotary direction under the control of the C and E relays 405 and 410 to hunt for an idle trunk or second selector. When the trunks or second selectors are all busy the brushes move to the 11th rotary step where a busy tone is connected to the calling line. The cut-in relay 400 operates when an idle trunk or second selector is found which extends the pulsing circuit to the selected trunk or second selector which responds to the pulses of the next digit. The A and B relays 402 and 403 are released and sleeve ground is extended from the selected trunk or second selector to conductor 455 through contact 5 of relay 400.

Interdigital interval

Pulses for the first digit operate the dual selector under the control of a route relay as herein described. When the correct number of pulses for this digit have been transmitted, a circuit is established through the contacts of one of relays 1800 to 1805, lead 1843, winding of relay 1607, resistance 1601 to battery to operate the latter relay. The winding of relay 1607 is short-circuited by ground on the contact of relay 1518 until the last pulse of the digit ends and relay 1518 is operated. Relay 1607 in operating short-circuits the contacts of relay 1514 to hold the fundamental pulsing circuit closed and operates relay 1608. Relay 1608 also short-circuits the contacts of relay 1514 and operates relay 1621. The reasons for closing the fundamental pulsing circuit through the contacts of relays 1607 and 1608 will be apparent in the following procedure. Relays 1500, 1514 and 1518 continue to pulse and the next closure of the contacts of relay 1518 operates relay 1600. Relay 1600 in operating

establishes a holding circuit for relay 1607 through its contact 1 and contact 1 of relay 1607. Relay 1600 in operating also releases relays 1615, and releases relays 1800 to 1805 by opening the locking circuit for the latter relay which extends over lead 1842 through contact 2 of relay 1600. When relay 1518 again operates as pulsing continues, relays 1607 and 1600 release and reestablish the locking circuit for relays 1615, 1616 and 1617 and the locking circuit for relays 1800 to 1805. The release of relay 1607 also establishes a circuit for the next in order progress relay 1708 or 1709 if a three-digit selection is being made and causes the operation of relay 1609 by removing the short-circuit from its winding. Relay 1609 operates through contact 4 of relay 1608 to ground on lead 1543. Relay 1609 disconnects ground from lead 1741 which extends through contact 3 of relay 1609 from lead 960 thus preventing ground from momentarily being extended to the pulse counting relays, Fig. 18. The operation of relay 1609 also connects ground from lead 960 through its contact 2, contact 4 of relay 1527 to the No. 4 lead 1824 arranged in this circuit to count four cycles of relay 1500. The contact of relay 1514 is short-circuited by contact 1 of relay 1608. This is part of an interval to permit a selector to recognize the end of a digit, release its C relay and find idle conductors to extend the connection or to find an idle trunk. At the end of the four-cycle period, relay 1607 operates as previously described as a result of the operation of relay 1803 and short-circuits relay 1608 through its contact 3 causing relay 1608 to release. The release of relay 1608 causes the operation of relay 1622 which has been short-circuited through contact 5 of relay 1608. Relay 1622 operates through contact 2 of relay 1621 to ground on lead 1543. Relays 1500, 1514 and 1518 continue to pulse with the contact of relay 1514 short-circuited by contact of relay 1607. Upon the next release of relay 1518, relay 1600 operates. This provides a holding circuit for relay 1607, releases the relays 1615 to 1617 and 1800 to 1805. When relay 1518 again operates, the circuit for relays 1607 and 1600 is open causing their release which recloses the locking circuits for relays 1615 to 1617, 1800 to 1805. This also removes the short-circuit on the contact of relay 1514 through the contact 2 of relay 1607 but the fundamental circuit is held closed by the contacts of relay 1514. Relay 1609 is released which removes the ground from lead 1824 and connects ground through the progress relays, Fig. 17.

The interdigital interval may consists of one or four pulse cycles plus one pulse cycle for operating relay 1600 before the one to four cycles are counted, and one pulse cycle to operate relay 1600 after the one or four cycles have been counted. The entire interdigital interval, therefore, may consist in three or six pulse cycles plus the make interval of one pulse cycle. Six pulse cycles at nine to eleven pulses per second are required for step-by-step selectors. Three pulse cycles at nine to eleven pulses per second or six pulse cycles at eighteen to twenty pulses per second are required for panel or cross bar senders. The number of pulses for the interdigital interval is determined by contacts of relays 1502 and 1527 as will be explained later in detail. When relay 1607 releases near the beginning of the interdigital interval, the next relay in the chain of out-dialing progress relays is operated. If relay 1707 is operated for the first digit, the next relay will be 1709 which will control the number of pulses to be dialed for the second digit. If relay 1708 is operated for the first digit, the next progress relay 1709 will be operated upon the release of relay 1607. Each operation or release of relay 1621 and a subsequent release of relay 1607 will operate the next out-dialing progress relay with the exception that some of the progress relays may be skipped if certain digits are not required.

Route relay connections using three digits for selection of outgoing trunk

For an example of sending out digit pulses using three digits for selecting the outgoing trunk, let it be assumed that route relay 1902 has been operated by the three-digit translator and, therefore, that the office code digits 4—4—9 were dialed by the calling subscriber.

By reference to Fig. 18 it will be noted that terminals 1820 to 1829 are connected to the contacts of relays 1800 to 1805 which are operated successively as the pulses of a digit are transmitted, in each case the preceding relay being released. The first five pulses operate relays 1800 to 1804, the sixth pulse operates relay 1805 which locks in position. The seventh, eighth, ninth, and tenth pulses reoperate relays 1800 to 1803. The pulses are counted by these relays according to cross-connection to contacts of the operated group relay and when a particular relay is operated for numbers 1 to 5 or two relays operated for numbers 6 to 0, a circuit is established through the contacts of operated relays to conductor 1843 for operating relay 1607 which terminates the sending of pulses as described in the foregoing and starts the interdigital period of pulses. As will be apparent by reference to Fig. 18, one relay is operated for pulses one to five, the preceding relay being released as the pulses are transmitted. The sixth pulse operates and locks relay 1805 and relay 1804 also remains locked unless relay 1800 is operated for pulse seven. Therefore, for pulse six, lead 1826 is connected through contact 4 of relay 1804, contact 4 of relay 1805 to lead 1843. Relay 1805 remains locked for numerals 7, 8, 9 and 10 and one of these relays remains operated depending upon the number of pulses transmitted if the number of pulses is above six.

Route relay 1902 has terminal 1919 connected to the No. 4 terminal 1824, terminal 1920 connected to the No. 9 terminal 1829, and terminal 1921 connected to the No. 3 terminal 1823. The respectively associated contacts 1916, 1917 and 1918 of the route relay are connected in this order to contact 3 of relay 1707, contact 4 of relay 1708 and contact 6 of relay 1709. The armatures associated with the latter contacts are connected serially with conductor 1741, through contact 3 of relay 1609 to ground on conductor 960 so that as relays 1707, 1708 and 1709 are successively operated, this ground lead is successively connected to a different contact of the route relay and thus to a differently numbered lead extending through the contacts of relays 1800 to 1805. The lead from the route relay contact is connected to lead 1843 only when one or two of the relays 1802 to 1805 operates corresponding to the last pulse of the digit to be transmitted.

Since route relay 1902 is a three-digit route relay, the circuit is arranged so that relay 1707 is first operated. As previously stated, a combination control circuit is arranged through the association of relays 1618, 1619 and 1620 with relays 1707, 1708 and 1709. Contact terminal 1911

of route relay 1902 is connected to ground or through one of several relays to ground as outlined, depending upon the class of service. The associated contact is connected to terminal 1910 which is arranged for cross-connection to the windings of either relay 1618, 1619 or 1620 for operating the relays so connected. In this example, for transmitting three digits to select the outgoing trunk, terminal 1910 is cross-connected to the winding of relay 1620 for operating the latter relay. A combination of wiring is thus effected from the windings of relays 1707, 1708 and 1709 through the contacts of relay 1620 to the outside and inside contacts of contact assembly 1 of relay 1621 which is connected to a circuit through its armature to ground on contact 4 of relay 1607. As will be remembered, relay 1607 is operated when the last pulse of each digit is transmitted.

Relay 1620 when operated for this three-digit code, establishes a circuit for operating relay 1707 to connect ground to the No. 4 lead 1824 which is connected to lead 1843 when relay 1803 operates. As herein related, the first pulse sent out causes the operation of relay 1617 which operates relay 1800. The second pulse releases relay 1617, which operates relay 1801. The third pulse reoperates relay 1617 which operates relay 1802 and the fourth pulse sent out releases relay 1617 which operates relay 1803. A circuit is thus established for relay 1607 through contact 4 of relay 1803 and contact 5 of relay 1805 and the out-pulsing is terminated for the first digit. During the interdigital period, relay 1621 is operated which establishes a circuit for relay 1708 through contact 2 of relay 1620 which is made effective as soon as relay 1607 is released after it was operated to terminate the pulses for the first digit. The release of relay 1803 during the interdigital period opens the circuit for relay 1607 which releases to establish a circuit for relay 1708 to establish circuits for designating the number of pulses for the second digit.

Relay 1708 connects ground through its contact 4 to the terminal 1917 of route relay 1902 extending to the lead 1829 and, therefore, the second digit comprises nine pulses. The sixth pulse of ten pulses causes the operation of relay 1805 which locks and the tenth pulse causes the operation of relay 1803. Lead 1829 extends through contact 4 of relay 1802 and contact 4 of relay 1805 to lead 1843 which causes the operation of relay 1607 to terminate the out-pulsing of the second digit. Between digits, relay 1621 is released and relay 1600 operated and relays 1802 and 1805 are released. The circuit for relay 1607 is thus open which releases and now establishes a circuit for relay 1709 for designating the number of pulses for the third digit. Relay 1709 operates over a circuit traced from battery through its winding, contact 1 of relay 1710, contact 1 of relay 1712, contact 2 of relay 1613, contact 1 of relay 1705, contact 1 of relay 1708, contact 1 of relay 1620, contact 1 of relay 1621, to ground on contact 4 of relay 1607. Relay 1709, when operated, connects ground from its contact 6 through the contacts of the route relay 1902 to the No. 3 lead 1823 and, therefore, three pulses are sent out before the pulses are terminated by the operation of relay 1802 which operates and establishes a circuit for relay 1607 when the third pulse is transmitted.

When only one digit is used for selecting the outgoing trunk the winding of relay 1618 is cross-connected to a terminal the same as terminal 1910. The inner contact 6 of relay 1709 is connected through the contacts 1918 to 1921 of the route relay to one of their number terminals 1820 to 1829 on relays 1800 to 1805 depending upon the number of pulses required for selecting the outgoing trunk. Relay 1709 which was used for the third digit when three digits are transmitted for selecting a trunk is now used for the first and only digit transmitted. Relay 1709 is operated through contact 2 of relay 1618, back contact 1 of relay 1621 to ground on contact 4 of relay 1607. Under this condition relays 1707 and 1708 are not used.

If two digits are transmitted for selecting the outgoing trunk, the winding of relay 1619 is cross-connected to a terminal the same as terminal 1910. The inner contact 4 of relay 1708 and inner contact 6 of relay 1709 are connected to contacts of the route relay and thence to numbered terminals connected to the contacts of relays 1800 to 1805. Relay 1708 is operated through contact 2 of relay 1619 with relay 1621 normal for the first digit and relay 1709 is operated through contact 1 of relay 1619 with relay 1621 operated for the second digit.

The progress of the digits after the digits for trunk selection is determined by relays 1710 to 1712 and 1706 to 1700 some of which, however, may be omitted when certain digits are not to be dialed.

When the 1—1 prefix is used as hereinbefore described relay 1529 or 1526 is operated. Under this condition relays 1710 and 1711 will follow the last trunk-selecting digit relay 1709. However, with relays 1529 and 1526 unoperated the circuit for operating the next relay after the last trunk-selecting digit relay 1709 is extended to relay 1712 and relays 1710 and 1711 are omitted. The office code digit A under this routing follows the last trunk selecting digit for panel or crossbar office routings. Relay 1529 or relay 1526 is operated as herein described by cross-section to contact 1911 or a similar contact on any route relay for the selection of trunks in different dialing areas.

Reversed selector or trunk conductor

It will be remembered that relay 1608 is operated during each between-digits interval. Relay 1511 is also operated over an obvious circuit from ground on contact 2 of relay 1608. Relay 1511 connects the lower winding of relay 1512 in the circuit of the fundamental ring leads 790, 1553, 1592, contact of relay 1514 and thence to the tip fundamental lead 1591 and closes a local circuit through the upper winding of relay 1512. The windings of relay 1512 are oppositely poled and the current through these windings is approximately equal in strength and therefore the relay does not operate in this circuit. If, however, the tip and ring leads of any associated selector or trunk are reversed the current through the windings of relay 1512 is placed in series and this relay will operate establishing a circuit for relay 1521. The circuit for relay 1521 may be traced from battery through its winding, contact 3 of relay 1701, contact 1 of relay 1305, contact 6 of relay 1527, contact 1 of relay 1512 to ground on lead 963. Relay 1521 locks to ground on lead 963 and connects ground with winding terminal 5 of pulsing relay 1500 to prevent further out-pulsing at this time. Relay 1521 also establishes an operating circuit for relay 823 which causes the release of the sender when reversed selector leads or trunk leads are encountered. The detailed operation of the relays after the operation of relay 823 will be

described under "Time controlled release of the sender."

Control of relay 1521

The circuit for operating relay 1521 is opened by the F digit relay 1701 and the G digit relay 1702 whichever is used for dialing the units digits with relay 1305 either released or operated. This condition applies to the selection of a private branch exchange routed through a level hunting connector so that the private branch exchange may be selected and the call answered by reversing the current flow before the units digit is dialed.

The circuit for operating relay 1521 is also controlled by contacts of relays 1527 and 1528 so that false operation of relay 1521 will be avoided when a distant sender reverses the current flow to transmit the start pulsing signal.

Continuing with the progress relays if a called office is a two-digit or three-digit step-by-step office either relay 1612 or relay 1613 is connected to the route relay and operated in series with relay 1619 or 1620, so that the next digit following the trunk selection digit will be the C digit or the D digit using relay 705 or 704 starting the transmission of the numerical digits for operating the step-by-step selectors. Relay 1612 or 1613 is cross-connected to the route relay terminal 1911 as previously explained.

No outgoing pulses are transmitted on calls direct to an operator after the trunk selecting digits are transmitted; consequently, after the last trunk selecting digit, the next closure of the contacts on relay 1622 operates relay 808 through a contact of relay 1530. Relay 1530 is operated from ground on contact 4 of relay 800 through contact 1911 of the route relay winding of relay 1618 to battery, the route relay being cross-connected for the selection of the trunk to an operator. Calls through tandem or local crossbar or panel offices to a trunk connected to an operator's position are routed thereto by first transmitting the outgoing trunk selecting digits using any of relays 1707, 1708 and 1710 and through the distant office code A, B and C digits using relays 1712, 1706 and 1705 and thereafter operating relay 808 to release the sender.

Out-dialing signal

On calls to tandem or local crossbar or panel offices a test check is made after the outgoing trunk has been selected to indicate when the distant sender is ready to receive dial pulses. Relay 1525 is operated through contact 5 of relay 1709 to ground on contact 2 of relay 1608 when the last trunk selecting digit is being dialed. Relay 1525 in operating establishes an obvious locking circuit for itself. As will be remembered relay 1511 operates at the end of the digit which establishes a circuit for relay 1527 through a series of contacts comprising contact 2 of relay 1530, contact 3 of relay 1613, contact 2 of relay 1612, contact 1 of relay 1525 to ground on contact 4 of relay 1511. Relay 1527 in operating establishes a locking circuit for itself and closes a circuit to the winding terminal 5 of relay 1500 to prevent dialing into the distant sender until the sender is ready to receive dial pulses. Relay 1511 is held operated by contact 7 of relay 1527 so that relay 1512 may be operated when the distant office reverses the current flow over the trunk conductors. When the distant sender is attached to the trunk, the outgoing repeater at the step-by-step office reverses the direction of current flow to this sender which operates relay 1512. This operates relay 1501 over a circuit to ground on contact 3 of relay 1527. Relay 1501 locks through its contact 2 and when the distant circuit again reverses the current to the original direction through the windings of relay 1512, relay 1512 releases. The release of relay 1512 operates relay 1528 through contact 1 of relay 1501. Relay 1528 locks and opens the holding circuit of relay 1511 and also opens the circuit to winding terminal 5 of relay 1500 to allow pulses to be sent to the distant sender.

Speed of dial pulses

When a call is routed from this sender to a sender in a distant office which is capable of registering pulses at the high speed of twenty pulses per second over the trunk conductors, relay 1524 is cross-connected to a terminal of the route relay such as terminal 1911 and operated through the winding of one of relays 1618, 1619 or 1620, depending upon whether the call is a one, two or three-digit call. After the digits have been dialed for the section of the outgoing trunk a circuit is established for the operation of relay 1527 as described above and relay 1502 then operates in parallel with relay 1527. The operation of relay 1502 alters the network associated with the pulsing relay 1500 by disconnecting resistance 1509 and connecting resistance 1506 in series with resistance 1508 through contact 4 of relay 1502 and connecting resistance 1503 in series with resistance 1507. Resistance 1510 is placed in series with lead 1544 and thus the network is altered for increasing the speed of pulses so that relay 1500 will generate pulses at eighteen to twenty pulses per second. Contacts of relays 1502 and 1527 control the number of cycles of relay 1500 to be counted during the interdigital period. With relays 1527 and 1502 unoperated six cycles are counted which equal .6 second. With relay 1527 operated and relay 1502 unoperated three cycles are counted which equal approximately .3 second. With both relays operated six cycles are counted but since the pulsing speed is higher this period again equals .3 second. Therefore, when dialing into step-by-step switches at the slower speed, the between-digits interval is approximately .6 second and when dialing into crossbar or panel office senders the interval is .3 second. The above speeds are approximate and are given for the purpose of comparison when dialing into the mechanism of different characters of offices and should not be considered as fixed values.

Simultaneous incoming and outgoing transmission of digit pulses

The sender may at times send pulses out for the selection of an outgoing trunk and for positioning the distant switches in a step-by-step office or the registers of a sender in panel or crossbar offices faster than the pulses are received from the calling subscriber. If the outgoing pulsing circuit of the sender transmits all of the digits which have been registered on the crossbar switch relay 1500 is prevented from further pulsing until the next digit has been registered. For this purpose relay 1614 is operated whenever the hold magnet has not yet operated corresponding to an operated out-dialing progress relay. It will be noted that the operating circuit for relay 1614 extends through the contacts of the progress relays of Fig. 17 to ground on the

corresponding hold magnet. For example, if the C progress relay 1705 is operated before the C hold magnet 1404 is operated a circuit is established for relay 1614 through contact 3 of relay 1705 to ground on contact 2 of hold magnet 1404. Thus if any of the progress relays, Fig. 17, are operated before the corresponding hold magnet relay 1614 is operated to arrest the transmission of out-dialing pulses, the contact of relay 1614 closes a circuit from the winding terminal 5 of pulsing relay 1500 through contact 3 of relay 1608 to ground on lead 1543 thus preventing relay 1500 from operating until such time as the hold magnet has operated and relay 1614 released.

Sender release

The release of the sender after a local code is dialed has been discussed herein which sets forth that the sender is released by the operation of relay 808 immediately after the code is dialed. The following covers the release of the sender after calls over trunk connections in which the sender is released after the selection of an outgoing trunk or after the trunk has been selected and the numerical digits dialed for either positioning step-by-step switches in a distant office or for registering digits in a sender of a distant panel office or a distant crossbar office.

On calls direct to trunks over which operators are reached, relays 1530 and 800 are operated through route relay contacts. The circuits for the foregoing relays may be traced as follows: The circuit for relay 800 extends through contact 3 of relay 817. It will be remembered that the circuit for relay 817 is established to ground on contact 2 of hold magnet 1400 after the first digit is registered in order that the digit 1 may be registered thereafter. The circuit for relay 800 may, therefore, be traced from battery through its winding, contact 3 of relay 817, contact of a route relay which is so connected to the C vertical bar and contact to ground on contact 7 of relay 901. The circuit for relay 1530 may be traced from ground on contact 4 of relay 800, contact of the route relay as previously described to battery through the winding of relays 1618, 1619 or 1620 depending upon which of these relays are connected to the route relay contact. A circuit is thus established for the sender release relay 808 from ground on contact 4 of relay 1607 through contact 1 of relay 1621 and contacts of relays 1530 and 800 as soon as the last digit for selecting the trunk has been dialed. The circuit for relay 808 may be traced from ground on contact 4 of relay 1607, contact and armature of relay 1621, thence through a contact of relay 1619 or 1620, whichever relay was connected to the route relay contact. Assuming that this relay is 1619, the circuit may be traced through contact 2 of the latter relay, contact 2 of relay 1709, contact 1 of relay 1612, contact 1 of relay 1613, contact 1 of relay 1530 which, as previously stated, is operated, contact 1 of relay 800, contact 1 of relay 1511, winding of sender release relay 808 to battery. The above circuit is extended through the progress relays so that the sender is only released after the last pulse of the last digit has been sent by the sender for selecting the trunk. In all circuit arrangements for releasing the sender the circuit for the sender release relay 808 is carried through the closed contact 1 of relay 1511 so that if the calling subscriber is dialing or moving the switchhook, these pulses will not be added to the last digit transmitted by the sender. For this purpose relay 1511 operates at the end of the last digit for selecting a trunk or for operating selectors or for operating senders and does not release until the receipt of the last digit is recognized at the distant end. Relay 1511 is thus released and the sender release circuit is made effective. By reference to the interdigital period it will be seen that relay 1608 is operated at this time and since this cooperates with the progress relays to indicate the last digit dialed, the control arrangement of relay 1511 will be understood.

On calls to full selector offices where numerical digits are dialed, whether this office is a crossbar office, panel office or step-by-step office, and also to manual offices with no station letter and no numbers above 9999, relay 800 is operated through a contact on the route relay when the units digit has been registered on the crossbar switch, Fig. 14. When the units digit has been sent out by the sender to the distant office, a circuit is established for the sender release relay 808 from battery through its winding, contact 1 of relay 1511, contact 1 of relay 800, contact 1 of relay 802, contact 2 of relay 803, contact 3 of relay 1305 operated to ground on contact 2 of the G progress relay 1701. This controls the release of the sender after the pulses for the units digit have been transmitted by the sender to the distant office.

On calls to manual offices with station letters or numbers above 9999, relay 803 is operated through the contact of a route relay connected to terminal 831. Relay 803 is operated when the units digit is registered on the crossbar switch, Fig. 14, or when the tens digit is registered if the number is above 9999. This causes the timing circuit to measure a short time interval, and after this time interval to operate relays 802 and 800. Relay 802 is operated from battery through its winding, contact 2 of relay 800, contact 1 of relay 803, contact 805 of timing control cam 804 to ground on contact 1 of relay 901. The circuit for relay 800 extends from battery through its winding, contact 3 of relay 817 to ground on contact 2 of relay 802. This timing interval is included in this character of connection so that if during this interval the calling subscriber starts dialing a station digit, the timing circuit stops and when the digit has been registered, relay 800 operates. If relay 800 has operated due to the station digit or units digit if the number is above 9999 being delayed too long the sender release relay 808 operates through contact 1 of relay 800, contact 1 of relay 802, contact 2 of relay 803, contact 3 of relay 1305 to ground through the contacts of the out-pulsing progress relays when this last digit has been transmitted. If relay 800 has operated due to the station's delay timing circuit, relay 808 operates through contact 1 of relay 800, contact 1 of relay 802, contact 3 of relay 1305 to ground through the contact of the G progress relay 1701 for two-digit codes or contact 5 of relay 1700 for three-digit codes.

Zone charge

The two-zone, multiregistration feature of this sender is shown in Fig. 18. Routes requiring multiregistration have the route relay contact terminals, such as 1925 cross-connected to terminal 1835. This furnishes a circuit through the windings of relay 1806 to lead 1838. Lead 1838 may be traced through the sender circuit, contact 3 of relay 707, to lead 246 extending to Fig. 2, contact 2 of relay 211, contact 1 of relay 339,

winding of relay 340 to battery. Relay 1806 operates over lead 1838 in series with relay 340 in the line-finder selector trunk circuit, Fig. 3, but the trunk relay 340 will not operate due to the high resistance of relay 1806. Relay 1806 operates relay 1807 which locks and short-circuits one winding of relay 1806. This increases the current over lead 1838 which operates the line-finder selector trunk relay 340 which locks to ground on relay 202. The operation of relay 340 thus connects ground from its locking circuit through contact 1 of relay 339, contact 2 of relay 211, to lead 2461 which extends through the sender circuit to lead 1333. The operation of relay 340 and the locking of relay 340 thus short-circuit the winding of relay 1806. Relay 1806 releases and in releasing causes the operation of relay 1808 from battery through the winding of relay 1808, contact 1 of relay 1807, contact 1 of relay 1806, over lead 1839 to ground on contact 11 of relay 901. The operation of relay 1808 disconnects ground from contact 3 extending over lead 1837 which now permits the tens digit to be dialed. After the called subscriber has answered, a zone charge controller is connected to the line-finder selector trunk circuit by the registration circuit 354 diagrammatically shown. For routes which do not require multiregistration the route relay terminal 1925 is cross-connected to terminal 836, operating relay 1808 which prevents sending the signal over lead 1838.

All trunks busy

This sender does not recognize the all trunks busy when encountered on calls to step-by-step offices and continues to dial into the selector which is on its eleventh rotary step. When the sender has completed transmitting the out-dialing pulses and is disconnected from the line-finder selector trunk, the calling subscriber will receive the all-trunks-busy signal. The same is true on calls directed to operator trunks on calls to crossbar or panel offices. This sender will continue to transmit out-dial impulses until sufficient digits have been dialed to select the trunk to the distant office. At this point the sender waits for a momentary current reversal to indicate that the trunk has been selected and to indicate that the distant sender is ready to receive the called office code in numerical digits. If one of the selectors has reached the eleventh rotary step in the selection of the trunk, this reversal does not take place and thus is not received by the sender. The timing circuit of the sender is thus operated which causes the line-finder selector trunk to transmit the all-trunks-busy signal to the calling subscriber. In doing this the sender provides a circuit from the fundamental tip lead through a condenser to the calling subscriber's line lead, while the sender is waiting for the above-mentioned reversal, thus saving holding time in the sender. The busy tone from the eleventh rotary step of the selector which has found all trunks busy is thereby transmitted to the calling subscriber so that the calling subscriber disconnects and may cause the release of the sender previous to its timing-out period.

Abandoned calls

In many instances a call is abandoned when partly dialed and the calling subscriber replaces his receiver on the switchhook. In some instances the calling subscriber replaces the receiver on the switchhook for a sufficient time for the sender to readjust itself and in other instances the calling subscriber may place the receiver on the switchhook and remove it again before the sender has had time to make an adjustment. This is the case if at this time the off-normal relay 901 is operated but the L relay 905 has not as yet operated.

When the subscriber replaces the receiver on the switchhook for a sufficient time to cause the L relay 905 and relay 909 to release, the release of the sender takes place in the following manner. The release of relay 909 and the release of relay 916 as previously described operate relay 904 from battery through its windings, contacts of relays 909 and 916 to ground on contact 10 of relay 901. Relay 904 at its contact 1 opens the leads extending to the tip and ring leads of the subscriber's line so that reclosure of the line at the calling station will not again operate the L relay 905. The operation of relay 904 also causes the fundamental tip and fundamental ring leads outgoing to selectors to be opened at its contact 3 to cause the release of any selectors or distant sender that may have been moved off-normal or operated in any manner. Contact 4 of relay 904 connects ground from contact 3 of relay 808 through resistance 819 to lead 643 to operate relays 210 and 211 to cause the line-finder selector trunk to connect the A relay 402 of the dual selector or a similar relay in an outgoing repeater circuit to the fundamental tip and fundamental ring leads 644 and 645 extending to the sender, if this has not already been done by the normal means over circuits, as previously described. The release of the outgoing selectors or senders causes the release of the selector relays 402 and 403 which removes ground from sleeve lead 455 and brush 427 causing the release of the dual selector, line finder and line-finder trunk circuits. The off-normal relay 901 of the sender then releases as previously described and causes the sender to restore to normal.

In some cases the subscriber may abandon the initiation of a call after the sender has been selected and the off-normal relay 901 has been operated but before the L relay 905 has operated over the line conductors. In this case relay 916 operates from ground on a contact of relay 901 and as herein described relay 916 starts to release when the sender has been connected to a trunk and relays 902 and 917 have operated. Relay 916 is a slow-releasing relay which allows relay 905 to operate before closing the circuit for operating relay 904. However, if relay 905 does not operate by the time relay 916 releases, relay 904 will operate and perform the functions above described. When the call has not progressed far enough to cause the operation of relay 904, it is apparent that distant selectors or senders have not been operated and, therefore, the abandonment of the call normally disconnects the trunk finder and line finder causing the release of the dual selector and the sender as previously described.

Sender timing mechanisms

The sender timing mechanisms are shown in Fig. 8 and consist in a synchronous motor 815 which by a train of gears, not shown, drives a cam shaft whose cams 804, 806, 810 and 812 actuate four contacts 805, 807, 811 and 813 at different shaft positions and, therefore, at different time intervals. One contact, 813, is normally closed and is opened when the shaft rotates from its normal position upon the energization of the synchronous motor. This contact is used to indicate that the cam shaft is in its normal posi-

tion and serves to prevent restarting the timing mechanism until it is normal. Cam 810 closes its contact 811 approximately 20 seconds after the cam shaft is started from its normal position and this contact is used for permanent signal and stuck sender timing to release the sender after a predetermined interval. Cam 806 requires approximately six seconds to close its contact 807 and is used to release the sender after a call is partly dialed. The cam 804 requires approximately four seconds to close its contact 805 and is used for station delay timing. The motor armature shaft for driving motor 815 is normally disengaged from the gear train but when the motor circuit is closed the armature moves actually and engages the gear train. The gears and cam shaft thus rotate while the motor circuit is closed and when the motor circuit is opened and the motor stops the shaft is disengaged from the gear train at a certain speed of the motor. A retractile spring causes the cam shaft and gear train to rotate back to the normal position for causing the cam 812 to close contact 813.

Permanent signal

As herein described, when the sender is seized for extending a call from a calling subscriber to a called subscriber or distant office, the off-normal relay 901 is operated. A circuit is thus closed for operating relay 816 through the normally closed contact 813. This circuit may be traced from off-normal ground on contact 1 of relay 901 through contact 1 of relay 814 and the normally closed contact 813 of the timer mechanism, winding of relay 816 to battery. Relay 816, in operating, locks through its contact 2 and closes the circuit for motor 815. Relays 821, 822 and 900 also are operated from the off-normal ground and establish a circuit for relay 814. This circuit may be traced from battery through the upper winding of relay 814, contact 5 of relay 816, contact 1 of relay 900, contact 2 of relay 821, contact 1 of relay 901 to ground. Relay 814 shifts the holding circuit for relay 816 which now extends through contact 1 of relay 900, contact 2 of relay 821, contact 1 of relay 901 to ground. Under the condition where a subscriber has removed the receiver from the switchhook causing a line finder to find the calling line and associate a sender therewith through the agency of the line finder a selector trunk circuit and a trunk finder circuit, relay 818 is operated after 20 seconds through the contact 811 to ground. The circuit for operating relay 818 may be traced from battery through its winding, contact 6 of relay 816, operated contact 2 of relay 817, normal contact 811 to ground. It will be remembered that relay 817 was not operated until after the first digit has been dialed. Relay 818, in operating, opens the pulsing circuit through contact 5 of the L relay 905 which extends through contact 7 of relay 917, contact 1 of relay 909, contact 5 of relay 800, contact 3 of relay 818, to pulsing relays 1016 and 1022. This prevents registering any dialed pulses and connects ground to lead 643 extending through the trunk-finder circuit and line finder selector trunk circuit. This operates relays 210 and 211 in the line-finder selector trunk which opens the sleeve to restore the trunk finder, Fig. 6, and the sender to normal. The line finder, Fig. 1, the line-finder selector trunk, Figs. 2 and 3, and selectors are held as long as the permanent signal remains and an alarm is given by the selector in the usual way.

Normal operation of timing mechanism during telephone connection

When a calling subscriber has removed the receiver from the switchhook and an idle sender is connected with the calling line, the operation of the off-normal relay operates relay 816, as previously described, from the off-normal ground on contact 1 of relay 901 and the normal contact 813. This closes a circuit for the motor 815 and causes the operation of relays 821, 822 and 900 as described under "Permanent signal" which establishes a circuit for relay 814. At this time the holding circuit for relay 816 is shifted by the operation of relay 814 to contact 1 of relay 900. If at this time dial pulses are received, relay 923 operates causing the release of relay 900. The release of relay 900 releases relays 816 and 814 restoring the timing mechanism to normal. As soon as the timing mechanism reaches its normal position, relay 816 reoperates restoring the timing mechanism. When the first digit is completely dialed, relay 814 operates again shifting the holding circuit of relay 816 to the control of relay 900. It will be remembered that between the dialing of digits by the calling subscriber, relay 923 releases and relay 900 operates. The timing mechanism is thus operated, released and restarted at the beginning of each digit and controls a timing period both during a digit and between digits.

This timing circuit is thus arranged to allow a given amount of time for dialing each digit which is more than ample for the slowest dialing of the digits. If one digit does not follow the preceding digit after a given time interval, the sender is released and a signal given to the calling subscriber. The timing mechanism is arranged in this manner to effect an appreciable saving in the holding time of senders and other telephone mechanism, such as selectors and mechanism which has been moved off-normal in distant offices. This saving in the holding time for senders is of comparative value over the normally recognized practice of allowing a time period of sufficient length for all digits to be dialed before releasing a sender. In some circuit arrangements this timing period is made in two sections, one for registering all digits dialed by the calling subscriber and one time period for transmitting the digits to a distant office which have been registered. In the present sender the timing mechanism controls the release of the sender during the period the digits are being dialed by the calling subscriber. As hereinbefore described, an arrangement is used during the transmission of out-dialing pulses so that the sender receives an indication when the out-pulses are terminated at a given digit. Under this circumstance, the calling subscriber is notified by a signal and the sender is automatically released by the calling subscriber restoring the receiver on the switchhook. When this does not take place, the timing mechanism releases the sender.

Calling subscriber's incomplete dialing

Under the condition when the digits are only partly dialed, the sender operates as previously described and the timing mechanism operates for each digit dialed. After the A or first digit has been registered, a circuit is established for relay 817 as explained with reference to the registration of the first digit. The operation of relay 817 opens the circuit previously traced from the timer contact 811 to the winding of relay 818.

Relay 817 also opens the dial tone circuit and connects timing contact 807 to the winding of relay 823 so that if at any time the contact 807 is established through the cessation of dialing by the calling subscriber, a circuit is established from ground through contact 807, contact 5 of relay 817, contact 1 of relay 816, contact 6 of relay 800, winding of relay 823 to battery. However, as previously explained, the timing mechanism is restarted at the beginning of each digit to control the starting of the timing between digits dialed. If the subscriber allows too much time to elapse between the start of one digit and the start of the next digit, the timer contact 807 establishes the operating circuit for relay 823. Relay 823, in operating, locks under the control of relay 821 and opens the fundamental tip and fundamental ring leads, thereby restoring any selectors or senders in distant offices that have been moved off-normal. Relay 823 also opens the locking circuit for the slow-release relay 822 but before the release of relay 822 a circuit is established through its contact 1 to operate relay 818. Relay 818 locks under the control of relay 823. Since at this time relay 817 is operated, relay 818 connects ground to leads 641 and 643 and connects battery through low resistance 809 to lead 642. A circuit is thus established over leads 643 and 642 to operate relays 209, 210 and 211 in the line-finder selector trunk circuit which causes a busy signal to be sent to the calling subscriber. Relay 818 also connects ground through its contact 6 and contact 8 of relay 817 to the sleeve lead 641 which holds the off-normal relay 901 operated and also holds the trunk finder, Fig. 6, operated even though the line-finder selector trunk relays have removed ground from the sleeve lead extending from the line-finder selector trunk circuit to the trunk finder, Fig. 6. As herein stated, the circuit was opened for slow-release relay 822 previous to the operation of relay 818. The release of relay 822 releases relay 821 which opens the locking circuit for relay 823. Relay 823 recloses the fundamental tip lead through its contact 5 operating the A relay 402 in the dual selector circuit. Relays 821 and 823 are made slow to release so that the A and B relays 402 and 403 of the dual selector or possibly the same relays in an outgoing trunk circuit will release and break down the connection before relay 823 recloses the fundamental tip and fundamental ring leads. When relay 823 has released it opens a circuit for relay 818 causing the release of the latter relay. The release of relay 818 opens the ground connection to the sleeve conductor causing the release of the trunk finder, Fig. 6. As previously related, the ground connection from the line-finder selector trunk, Figs. 2 and 3, to the sleeve conductor of the trunk finder, Fig. 6, has already been opened by the operation of line-finder selector trunk relays. When the subscriber hears the busy tone and replaces the receiver on the switchhook, the dual selector line finder selector trunk and line-finder circuits are released.

Delay in dialing station digits

On calls to manual offices having party letters or numbers above 9999 relay 803 is operated through a route relay contact after the units digit is registered or the tens digit is registered for numbers above 9999, as previously described. This connects the station delay contact 805 of the timer mechanism to the winding of relay 802 to contact 2 of relay 800. If the station digit or fifth numerical digit is not dialed relay 802 operates when cam 804 rotates to a point for closing contact 805. Relay 802 locks to ground on contact 1 of relay 901 and establishes an operating circuit for relay 800 which may be traced from battery through the winding of relay 800, contact 3 of relay 817 operated to ground on contact 2 of relay 802. The functions of relays 800, 803 and 802 have been fully described under the release of the sender and need not be repeated at this time. If the dialing of the station digit starts before relays 802 and 800 have operated, the timing mechanism is restarted by the release of relay 900 under the normal functioning of the registration of the digits as fully described. Under this circumstance the sender is not released until after the station digit has been recorded and relay 800 operated in the normal manner.

Stuck sender

When a sender becomes stuck, a circuit is established for relay 800, as previously traced. The operation of relay 800 opens the circuits of the timing mechanism associated with contacts 805 and 807 and closes the circuit to timing mechanism contact 811 connecting it to the winding of relay 823. If the sender does not complete its functions within a predetermined time period relay 823 operates and performs the functions for releasing the connection and sender as described under "Partly dialed connections."

Automatic make-busy of outgoing trunk causing stuck sender

Since this automatic switching system may be used in an unattended office, an outgoing trunk which did not operate satisfactorily and particularly one which would not permit the completion of a telephone call by the sender would give serious trouble. To prevent recurring difficulties the sender and the outgoing trunk are arranged to cooperate for locking the outgoing trunk out of service which is involved in a connection which does not permit the completion of a switching connection beyond the outgoing trunk. An outgoing trunk of this character is shown as trunk 520 in Fig. 5. This trunk is selected by the dual selector circuit in Fig. 4 for completing connections to step-by-step panel or crossbar offices or to special operators in a local or distant office. Code pulses are transmitted by the sender for the selection of this trunk as herein described.

The selection of this trunk by the dual selector causes the operation of the A relay 536 from battery through its upper winding, contact 2 of relay 521, contact 4 of relay 521, winding 527 of the repeating coil 524, switch terminal 512, brush 426, thence over the ring conductor through the dual selector, conductor 451, line finder selector trunk, fundamental ring conductor 244 to the sender pulsing circuit, contact of pulsing relay 1514 as previously described, returning on the fundamental tip conductor via contact 5 of relay 823, conductor 245, conductor 450 through brush 425, terminal 511, winding 525 of the repeating coil 424, contact 1 of relay 521, contact 3 of relay 521, lower winding of relay 536 to ground. The normal operation of this outgoing trunk for completing a call causes the operation of the B relay 537 responsive to the operation of the A relay 536. The loop toward the called end is closed through the repeating coil and lower winding of relay 530. This may be traced from the tip conductor associated with crossbar office 541, contact 2 of relay 536, contact 2 of relay 534, winding

526 of repeating coil 524, contact 4 of relay 534, lower winding of relay 530, winding 528 of repeating coil 524, contact 3 of relay 534, contact 3 of relay 536, thence over the ring conductor to the crossbar office 541. The tip and ring conductors may extend to a sender in a distance office or to a step-by-step selector or to an operator in which case a relay is associated with the tip and ring leads which functions from the operation of the A relay 536 and the conductors are extended through the lower winding of relay 530 as described. The operation of relay 537 also establishes a circuit from battery through the upper winding of relay 530 to ground on contact 2 of relay 537. The current through the windings of relay 530 is, however, at this time opposing and relay 530 is not operated. The operation of relay 537 connects ground through its contact 4 to the sleeve conductor for maintaining the circuit busy to other selectors.

When the loop extending from the pulsing equipment of the sender is opened for transmitting pulses for the first digit, relay 536 releases and opens the loop toward the called office or operator's circuit. This causes the operation of relay 534 from battery through its winding, contact 5 of relay 537, contact 1 of relay 536 to ground. The operation of relay 534 disconnects the repeating coil windings 526 and 528 and the lower winding of relay 530 from the trunk conductors 551 and 552 and substitutes battery and ground through resistances 532 and 533. When relay 536 reoperates because of a closed pulsing loop to the sender it establishes a circuit from this battery and ground through resistances 532 and 533 toward the called circuit shown as crossbar office 541. Assuming that a similar A relay is used at the distant office this battery and ground will be supplied in such a way as to aid the battery and ground of the distant office to quickly reoperate the A relay in the distant office over the trunk loop. The A relay 536 on successive pulses transmitted by the sender pulsing mechanism for a digit, interrupts this current through the aforementioned resistances. Relays 537 and 534 are slow to release and remain operated during the pulsing of a digit. After the digit is completed the A relay 536 remains operated over the loop through the fringe office sender pulsing relay and after an interval relay 534 releases. The release of relay 534 reconnects the bridge through the repeating coil windings and lower winding of relay 530 to the trunk extending to office 541 disconnecting battery and ground through the resistances 532 and 533. When the called party answers or the trunk is connected with a distant sender ready to receive further digits the current received from the called end is reversed so that the current through the lower winding of relay 530 aids the current through the upper winding to cause the operation of relay 530. This establishes a circuit from ground on a contact of relay 530 through the winding of relay 521 which operates relay 521. Relay 521 reverses the current to the calling station or to the fringe office sender for signaling purposes or for operating charge registers.

When an outgoing trunk such as 520 does not operate satisfactorily and the sender cannot proceed with its normal pulsing operations, the timing circuit previously described becomes effective. Relay 800 operates as previously described and in so doing connects interrupter contact 811 through its contact 6 to the winding of stuck sender relay 823. After an interval of time which may vary within predetermined intervals according to the position of cam 810, relay 823 is operated by the closure of contact 811.

Relay 823 in operating establishes a locking circuit for itself through its contact 3 to ground on contact 1 of relay 821 which at this time is operated. Relay 823 opens the locking circuit for the slow-releasing relay 822 but before the latter relay is released a circuit is established from ground on contact 1 of relay 823, contact 1 of relay 822, winding of the sender release relay 818 to battery. Relay 818 locks to ground on contact 1 of relay 823. The operation of relay 823 and relay 800 establishes a circuit for the trunk lock-out relay 538 through a contact on a route relay which was used for this switching condition. This circuit may be traced from battery through the winding of trunk lock-out relay 538, conductor 563, contact 1 of route relay 1905, or any of the route relays so connected, contact 3 of relay 800 to ground on contact 4 of relay 823.

It will be remembered that the fundamental circuit for operating the A relay 536 was traced through contact 5 of relay 823 and consequently the operation of relay 823 opens the fundamental circuit causing the release of relay 536. The release of trunk relay 536 opens the circuit for relay 537 and the release of relay 537 opens the circuit for relay 534. Relay 534 is slow in releasing and after relay 537 has released and before relay 534 releases, a circuit is established from ground through contact 2 of relay 538, contact 1 of relay 534, contact 3 of relay 537, lower winding of relay 535 to battery. Relay 535 in operating establishes a locking circuit for itself from battery through its upper winding to ground on a similar relay 560. Relay 560 is the same as relay 535 but part of another trunk in the same trunk group, each trunk in the trunk group having this relay therein. This arrangement provides a locking circuit for relay 535 to ground on the contact of any trunk in the group which is not locked out of service. The operation of relay 535 connects ground through its contact 2, contact 5 of relay 534 to the sleeve conductor 550 and terminal 513 making this trunk busy to all selectors. This prevents the selection of this trunk for a service call until such time as it has been placed in service again.

Unattended offices

In offices of this type which are unattended offices an unusual trouble might cause the relays such as 535 in each trunk of the trunk group to become operated during the process of completing trunk connections. Under this condition the last relay to be operated would find no locking circuit to a similar relay in the other trunk circuits and would open the locking circuits of similar relays already operated and consequently all such relays would be released. These trunks would therefore again be available for trunk connections. This method of operation takes into consideration the probability that the fault which caused the trouble in the first place had disappeared. If the trouble has not disappeared in any trunk seized by a selector it is again locked out of service as above described. When all of the lock-out relays such as 535 become operated in the trunks of a trunk group, a circuit is momentarily established through their contacts and contact 3 of the common lock-out relay 538 to operate relay 564. This relay remains operated until the slow-release relays 535, 560 and the other similar relays of the group release. During the time that relay 564 is

operated a circuit is closed for a lock-up alarm circuit in an office having an attendant, to indicate that there is trouble in a particular group of trunks in the unattended office. A condition of this character is unusual and ordinarily a very limited number of trunks are locked out of service during the period between visits of an attendant to an unattended office so that any trunk out of service would be quickly repaired and placed back in service.

In the foregoing it was stated that relay **818** of the sender is locked under control of relay **823** for causing the release of the sender. Since at this time relay **817** is operated the operation of relay **818** connects ground to leads **641** and **643** and connects battery through low resistance **809** to lead **642**. A circuit is thus established over leads **643** and **642** to operate relays **209**, **210** and **211** in the line-finder selector trunk circuit which causes a busy signal to be sent to the calling subscriber so that this calling subscriber will replace the receiver on the hook and attempt again to make the call. Relay **818** also connects ground through its contact **6** and contact **8** of relay **817** to the sleeve lead **641** which holds the off-normal relay **901** operated and also holds the trunk finder, Fig. 6, operated even though the line-finder selector trunk relays have removed ground from the sleeve lead extending from the line-finder selector trunk circuit, Figs. 2 and 3, to the trunk finder, Fig. 6. As herein stated, the circuit was open for slow-release relay **822** previous to the operation of relay **818**. The release of relay **822** opens the circuit of slow-release relay **821** which opens the locking circuit for slow-release relay **823**. Relays **821** and **823** are made slow to release so that the connection to the calling line is broken down and the A and B relays **402** and **403** of the dual selector will not be operated when this fundamental circuit is again closed by the release of relay **823**. When relay **823** has released it opens the circuit for slow-release relay **818** causing the release of the latter relay which removes the holding ground from the sender and from trunk finder, Fig. 6. This ground as previously stated has already been opened by the line finder selector trunk circuit, Figs. 2 and 3. The calling subscriber upon hearing the busy tone replaces the receiver on the switchhook and redials the call.

What is claimed is:

1. In an automatic switching telephone system, a local automatic switching telephone office, other automatic switching telephone offices, local subscribers' lines having dials in the subscriber's station mechanism, outgoing trunks from said local office to said other offices, line switches in said local office each having a line-finder trunk and a first selector permanently connected thereto, said selector having pulse responsive mechanism, senders each having a trunk finder permanently connected thereto, said senders having pulse responsive mechanism including registers and pulse transmitting mechanism, means responsive to an incoming call over a local line for starting a line finder hunting for the calling line and for starting a trunk finder hunting for the trunk connected to the hunting line finder, thus connecting a line finder to said line and a sender to said trunk substantially at the same time, means responsive to the connection of said sender to said trunk for actuating the mechanism of both the sender and the trunk for connecting the pulse responsive mechanism of said sender with the calling line, means in said trunk operated by the connected sender for holding said first selector non-responsive to any character of pulse transmitting device, means in said sender responsive to the initial digit or digits from the calling subscriber's dial for registering the code of the called office, and means in said sender responsive to the registration of the office code digits for automatically removing said holding means and connecting the first selector pulse responsive means either to the calling subscriber's pulse transmitting dial or the sender pulse transmitting mechanism for positioning said first selector.

2. In an automatic telephone switching system, a local automatic switching telephone office, other automatic switching telephone offices, local subscribers' lines having dials in the subscriber's station mechanism, outgoing trunks from said local office to said other offices, line switches in said local office each having a line-finder trunk and a first selector permanently connected thereto, said selector having pulse responsive mechanism, senders each having a trunk finder permanently connected thereto, said senders having pulse responsive mechanism including registers and pulse transmitting mechanism, means responsive to an incoming call over a local line for starting a line finder hunting for the calling line and for starting a trunk finder hunting for the trunk connected to the hunting line finder thus connecting a line finder to said line and a sender to said trunk substantially at the same time, means responsive to the connection of said sender to said trunk for actuating the mechanism of both the sender and the trunk for connecting the pulse responsive mechanism of said sender with the calling line, means to connect a bridge to the pulse responsive mechanism of said first selector to hold it non-responsive to any character of pulsing device, means in said sender responsive to the initial digit or digits from the calling subscriber's dial to register the code of the called office, means in the sender responsive to the registration of the office code digits to automatically remove said bridge and connect the pulse transmitting subscriber's dial to the pulse responsive mechanism of the first selector for positioning said first selector or remove said bridge and connect the pulse transmitting mechanism of the sender to the pulse responsive mechanism of the first selector for positioning said first selector.

3. In an automatic telephone switching system, a local automatic switching telephone office having selectors for completing telephone connections from one subscriber to another, other automatic switching telephone offices, local subscribers' lines having dials in the subscriber's station mechanism, outgoing trunks from said local office to said other offices, line switches in said local office each having a line-finder trunk and a first selector permanently connected thereto, said selector having pulse responsive mechanism, senders each having a trunk finder permanently connected thereto, said senders having pulse responsive mechanism including registers and pulse transmitting mechanism, means responsive to an incoming call over a local line for starting a line finder hunting for the calling line and for starting a trunk finder hunting for the trunk connected to the hunting line finder thus connecting a line finder to said line and a sender to said trunk substantially at the same time, means responsive to the connection of said sender to said trunk for actuating the mechanism of both the sender and the trunk for con-

necting the pulse responsive mechanism of said sender with the calling line, means in said trunk operated by the connected sender to connect a bridge to the pulse responsive mechanism of said first selector to hold it non-responsive to any character of pulsing device, means in said sender responsive to the initial digit or digits from the calling subscriber's dial to register the code of the called office, means in the sender automatically responsive to the registration of the office code digits of a local office for causing the connection of the pulse responsive mechanism of the first selector to the calling subscriber's line for positioning said first selector from dial pulses transmitted for the next digit following the office code digits for completing a connection to another local subscriber and means responsive to the registration of office code digits of one of said other offices for causing the connection of the pulse responsive mechanism of the first selector to the pulse transmitting mechanism of the sender for positioning said first selector for connection with an outgoing trunk to one of said other offices.

4. In an automatic switching telephone system, a local automatic switching telephone office having incoming dial equipped lines and outgoing trunks, line switches in said local office each having a line-finder trunk and a first selector permanently connected thereto, said selector having pulse responsive mechanism, senders each having a trunk finder permanently connected thereto, said senders having pulse responsive mechanisms including registers and pulse transmitting mechanism, means responsive to an incoming call over a local line for starting a line finder hunting for the calling line and for starting a trunk finder hunting for the trunk connected to the hunting line finder, thus connecting a line finder to said line and a sender to said trunk substantially at the same time, means responsive to the connection of said sender to said trunk for actuating the mechanism of both the sender and the trunk for connecting the pulse responsive mechanism of said sender with the calling line, means automatically operated by the connected sender for opening the connection between the calling subscriber's line and the pulse responsive mechanism in the first selector, means in the sender responsive to the initial digit or digits dialed by the calling subscriber for determining whether the initial response of the first selector shall be under the control of the calling subscriber's pulse transmitting dial or under the control of the pulse transmitting mechanism of the sender, and for connecting said first selector pulse responsive means to one of said pulse transmitters, means in said sender responsive to the connection of the calling subscriber's dial with the first selector for releasing said sender from said line-finder trunk, and means in said sender responsive to the connection of the said sender pulsing mechanism with the first selector for holding said sender so connected for completing the switching connection.

5. In an automatic switching telephone system, a local automatic switching telephone office having incoming dial equipped lines and outgoing trunks, line switches in said local office each having a line-finder trunk and a first selector permanently connected thereto, said selector having pulse responsive mechanism, senders each having a trunk finder permanently connected thereto, said senders having pulse responsive mechanism including registers and pulse transmitting mechanism, means responsive to an incoming call over a local line for starting a line finder to hunt for a calling line and for starting a trunk finder to hunt for the trunk connected to the line finder, thus connecting a line finder to said line and a sender to said trunk substantially at the same time, means responsive to the connection of said sender to said trunk for actuating the mechanism of both the sender and the trunk for connecting the pulse responsive mechanism of said sender with the calling line, means in said trunk operated by the connected sender for holding said first selector non-responsive to any character of pulse transmitting device, means in said sender responsive to the initial code digit or digits from the calling subscriber's dial for registering the code of the called office, means in said sender responsive to the dialing of office code digits calling another subscriber in said local office for automatically connecting the first selector pulse responsive means with the calling subscriber's line loop for positioning said first selector responsive to the dialing of numerical digits and for releasing said sender, and means in said sender responsive to the dialing of code digits calling a distant office for connecting said first selector pulse responsive mechanism with the pulse transmitting mechanism of said sender and for operating a route relay to control the number of digit pulses transmitted to said first selector mechanism for positioning said first selector to select an outgoing trunk to said distant office.

6. In an automatic switching telephone system, a local automatic switching telephone office having incoming dial equipped lines and outgoing trunks, other offices, senders in said local office having pulse responsive mechanism and pulse transmitting mechanism, means responsive to an incoming call over a line for connecting a sender with said line, registers in said sender comprising a plurality of verticals of cross bar switches including duplicate cross-points for registering office codes for different offices having the same numerical office code designation, each cross-point being a code point, route relays connected to said code points, select magnets for closing said duplicate cross-points for registering each code digit, one select magnet closing duplicate cross-points having the same numerical designation, means responsive to office code digits dialed by a calling subscriber for operating said pulse responsive mechanism for establishing a circuit for operating a select magnet after each office code digit is dialed for registering said duplicate office codes and means responsive to another digit dialed by said calling subscriber for operating said pulse responsive mechanism to establish a circuit for operating only one of the route relays connected to said duplicate code points.

7. In an automatic switching telephone system, a local automatic switching telephone office having incoming dial equipped lines and outgoing trunks, other offices, senders in said local office having pulse responsive mechanism and pulse transmitting mechanism, means responsive to an incoming call over a line for connecting a sender with said line, registers in said sender comprising a plurality of verticals of cross bar switches including duplicate cross-points for registering office codes for different offices having the same numerical office code designation, each cross-point being a code point, route relays connected to said code points, select magnets for closing said duplicate cross-points for registering each

code digit, one select magnet closing duplicate cross-points having the same numerical designation, means responsive to office code digits dialed by a calling subscriber for operating said pulse responsive mechanism for establishing a circuit for operating a select magnet after each office code digit is dialed for registering said duplicate office codes, and means under the control of said pulse responsive mechanism as operated by said calling subscriber for operating only one of the route relays connected to said duplicate office code points for selecting an outgoing trunk to the desired office.

8. In an automatic switching telephone office, a local automatic switching telephone office having incoming dial equipped lines and outgoing trunks, other offices, senders in said local office having pulse responsive mechanism and pulse transmitting mechanism, means responsive to an incoming call over a line for connecting a sender with said line, registers in said sender comprising a plurality of cross bar switch verticals including office code verticals, duplicate cross-points for registering office codes for different offices having the same numerical office code designation, each cross-point being a code point, route relays connected to certain of said code points, select magnets for closing said duplicate cross-points for registering each code digit, one select magnet closing both contacts having the same numerical designation, means responsive to office code digits dialed by a calling subscriber for operating said pulse responsive mechanism to establish a circuit for operating a select magnet after each office code digit is dialed for registering said duplicate office codes, a prefix digit relay, contacts on said prefix digit relay which are closed when the relay is released for establishing a circuit to one of said duplicate code points to operate a route relay connected thereto for selecting an outgoing trunk to one of said offices, and contacts on said relay which are closed when the relay is operated for establishing a circuit to the other code point for operating another route relay for selecting an outgoing trunk to the other one of said offices having the same numerical office code designation, and means responsive to a prefix digit dialed by the calling subscriber for operating said prefix digit relay.

9. In an automatic switching telephone system, an automatic switching telephone office, subscriber's dial equipped lines, register senders in said office, means responsive to an incoming call over one of said lines for connecting a sender with said calling line, pulse responsive mechanism operated during the transmission of pulses from said subscriber's station dial for registering digits and arrested during the interdigital period, a timing mechanism under the control of said pulse responsive mechanism arranged to allow a predetermined time period for said interdigital period, and means in said timing mechanism for releasing said sender at the termination of said predetermined time period.

10. In an automatic switching telephone system, an automatic switching telephone office, subscriber's dial equipped lines, register senders in said office, means responsive to an incoming call over one of said lines for connecting a sender with said calling line, pulse responsive mechanism operated during the transmission of pulses from said subscriber's station dial for registering digits and arrested during the interdigital periods, a timing mechanism under the control of said pulse responsive mechanism arranged to allow a predetermined time period for said interdigital periods, and means under the control of said pulse responsive mechanism for stopping and restarting said timing mechanism responsive to each reoperation of said pulse responsive mechanism preceding the expiration of said predetermined time allowance for any of said interdigital periods, and means in said timing mechanism for releasing said sender at the expiration of any of said predetermined time periods.

11. In an automatic switching telephone system, an automatic switching telephone office, subscriber's dial equipped lines, register senders in said office, means responsive to an incoming call over one of said lines for connecting a sender with said calling line, pulse responsive mechanism operated during the transmission of pulses from said subscriber's station dial for registering digits and arrested during the interdigital period, a timing mechanism under the control of said pulse responsive mechanism arranged to allow a predetermined normal interdigital time period plus a predetermined time delay period for said arrested period of the pulse responsive mechanism between the dialing of one digit by a calling subscriber and the starting of the pulses of the next successive digit, and means in said timing mechanism for releasing said sender at the termination of said predetermined normal interdigital and delay time periods.

12. In an automatic switching telephone system, a local automatic switching telephone office having incoming dial equipped lines and outgoing trunks, step-by-step switching offices, other automatic switching offices having register senders for controlling switching connections, senders in said local switching offices, means responsive to an incoming call over a line for connecting a sender with said line, a register in said local office sender operably responsive to code and numerical digit pulses from said calling subscriber's dial, outgoing pulse transmitting mechanism in said local sender operated under the control of a device for causing the transmission of slow speed or high speed pulses, a plurality of route relays in said local sender operable according to the setting of said register from code digit pulses, and means operated by said route relays for controlling the selection of outgoing trunks to different offices and for controlling said device for transmitting slow speed pulses for setting the switches of step-by-step offices and high speed pulses for setting the registers in senders of said other offices.

13. In an automatic switching telephone system, a local automatic switching telephone office having incoming dial equipped lines and outgoing trunks, step-by-step switching offices, other automatic switching offices having register senders for controlling switching connections, senders in said local office, means responsive to an incoming call over a line for connecting a sender with said line, registers in said local office sender operably responsive to code and numerical digit pulses from said calling subscriber's dial, a plurality of route relays operable according to the setting of the code registers, means in said sender under the control of a route relay operated from one setting of said registers for selecting an outgoing trunk to a step-by-step office and under the control of a route relay operated from another setting of said registers for selecting an outgoing trunk to an office having a register sender therein, means in said local sender for transmitting slow speed pulses for operating the switches of said

step-by-step office and high speed pulses for operating the sender registers of said other office, and means under the control of the operated route relay for governing the speed of transmitting said pulses.

14. In an automatic switching telephone system, a local automatic switching telephone office having incoming dial equipped lines and outgoing trunks, step-by-step switching offices, other automatic switching offices having register senders for controlling switching connections, members in said local switching office, means responsive to an incoming call over a line for connecting a sender with said line, registers in said local office sender operably responsive to code and numerical digit pulses from said calling subscriber's dial, outgoing pulse transmitting mechanism in said local sender, a device for causing said outgoing pulse transmitting mechanism to transmit slow speed or high speed pulses, step-by-step selectors for selecting outgoing trunks to different offices, a plurality of route relays in said local sender operable according to the setting of said registers, means under the control of a route relay operated by one setting of said registers for causing the transmission of slow speed digit pulses for operating the step-by-step selectors for selecting an outgoing trunk to a step-by-step office and the transmission of slow speed numerical digit pulses for operating the step-by-step switches of said office, and means under the control of a route relay operated by another setting of said registers for causing a transmission of slow speed pulses for operating the step-by-step selectors for selecting an outgoing trunk to another office having regitered senders therein and the transmission of high speed code and numerical digit pulses for operating the registers in a sender of said other office.

15. In an automatic switching telephone system, a local automatic switching telephone office having incoming dial equipped lines, other offices, outgoing trunks to said other offices, senders in said local office having dial pulse responsive mechanism and outgoing pulse transmitting mechanism, means responsive to an incoming call over a line for connecting a sender with said line, route relays in said sender for controlling connections over outgoing trunks to said other offices, registers in said sender comprising a plurality of cross bar switch verticals operably responsive to dial pulses for register-two and three-digit office codes on the A and B or the A, B and C verticals, respectively, the remaining verticals being for registering the numerical and station digits, a three-digit office code translator comprising the A and B registers, ten cross-points on the C register and a plurality of translator relays, each relay having at least ten sets of contacts thereon, one terminal of the ten successive contact sets of the translator relays being connected to ten successive cross bar points on the C office code register, the alternate terminal of said successive contact sets of each translator relay being code points connected to route relays, the winding of said translator relays being connected to a cross-point on said B register, each cross-point on the C vertical thus representing ten code points multiplied by the number of possible two-digit combinations, means responsive to the registration of the first two digits of a three-digit code on the A and B registers for establishing a circuit to operate one of said translator relays corresponding to the cross-points closed on said A and B registers, and means responsive to the registration of the third digit on the C register for establishing a circuit through a contact of the operated translator relay for operating a route relay corresponding to the cross-points closed on the A, B and C registers.

16. In an automatic switching telephone system, a local automatic switching telephone office having incoming dial equipped lines, other offices, outgoing trunks to said other offices, senders in said local office having dial pulse responsive mechanism and outgoing pulse transmitting mechanism, means responsive to an incoming call over a line for connecting a sender with said line, route relays in said sender for controlling connections over outgoing trunks to said other offices, code and numerical registers in said sender each comprising one or more cross bar switch verticals progressively responsive to digits dialed by a calling subscriber, means for operating a two-digit route relay responsive to the setting of the first two office code registers and a simplified three-digit office code translator comprising the first three office code registers and a plurality of translator relays, each translator relay having a plurality of contacts, and means in said translator for operating a translator relay responsive to the setting of the first two code registers from the first two digits dialed of a three-digit code and for operating a three-digit route relay responsive to the setting of the third code register from the third code digit dialed by establishing a circuit for said three-digit route relay through one of the contacts on said translator relay.

17. In an automatic switching telephone system, a local automatic switching telephone office having incoming dial equipped lines, other offices, outgoing trunks to said other offices, senders having dial pulse responsive mechanisms and outgoing pulse transmitting mechanism, means responsive to an incoming call over a line for connecting a sender with said line, route relays in said sender for controlling connections over outgoing trunks with said other offices, code and numerical registers in said sender each comprising one or more cross bar switch verticals operable under the control of said dial pulse responsive mechanism, a simplified three-digit office code translator which comprises the first three office code registers and a plurality of translator relays, each translator relay having a plurality of contacts, means responsive to the dialing of the first two digits of certain numerical value by the calling subscriber to operate the first two code registers in a manner to establish a circuit for a two-digit route relay and of other numerical values to establish a circuit for operating a three-digit translator relay, and means responsive to the dialing of a third code digit for operating the third code register to establish a circuit through a contact of said translator relay for operating a three-digit route relay, the third digit being of any numerical value 1 to 10 and the first two digits being of any possible combination of numerical values of two digits so used.

18. In an automatic switching telephone system, a local automatic switching telephone office having incoming dial equipped lines, other offices, outgoing trunks to said other offices, senders having dial pulse responsive mechanisms and outgoing pulse transmitting mechanism, means responsive to an incoming call over a line for connecting a sender with said line, route relays in said sender for controlling connections over outgoing trunks with said other offices, code

and numerical registers in said sender each comprising one or more cross bar switch verticals operable under the control of said dial pulse responsive mechanism, a simplified three-digit office code translator which comprises the first three office code registers and a plurality of translator relays, each translator relay having a plurality of contacts, means responsive to the dialing of the first two digits of certain numerical value by the calling subscriber to operate the first two code registers in a manner to establish a circuit for a two-digit route relay and of other numerical values to establish a circuit for operating a three-digit translator relay, and means responsive to the dialing of a third code digit for operating the third code register to establish a circuit through a contact of said translator relay for operating a three-digit route relay, the third digit being of any numerical value 1 to 10 and the first two digits being of any possible combination of numerical values of two digits so used, electrically operable mechanism comprising a plurality of devices for controlling the number of code digits transmitted by said outgoing pulse transmitting mechanism, a plurality of progressively operable devices for controlling the number of pulses in each digit, and an interdigital device, contact means on the operated route relay for, first, operating one of said digit controlling devices depending upon the number of digits required for the routing and for operating a device for controlling the number of pulses in the first digit, second, for controlling the operation of said interdigital device for terminating the outgoing pulses of a digit after the designated number of pulses have been transmitted and, third, for progressively operating the pulse number controlling devices for controlling the number of pulses in successive digits.

19. In an automatic switching telephone system, a local automatic switching telephone office having incoming dial equipped lines, other offices, outgoing trunks to said other offices, senders having dial pulse responsive mechanisms and outgoing pulse transmitting mechanism, means responsive to an incoming call over a line for connecting a sender with said line, route relays in said sender for controlling connections over outgoing trunks with said other offices, code and numerical registers in said sender each comprising one or more cross bar switch verticals operable under the control of said dial pulse responsive mechanism, means for operating a route relay as determined by the setting of said registers, electrically operable mechanism comprising a plurality of devices for controlling the number of code digits transmitted by said outgoing pulse transmitting mechanism, a plurality of progressively operable devices for controlling the number of pulses in each digit, and an interdigital device, contact means on the operated route relay for, first, operating one of said digit controlling devices depending upon the number of digits required for the routing and for operating a device for controlling the number of pulses in the first digit, second, for controlling the operation of said interdigital device for terminating the outgoing pulses of a digit after the designated number of pulses have been transmitted and, third, for progressively operating the pulse number controlling devices for controlling the number of pulses in successive digits.

20. In an automatic switching telephone system, a local automatic switching telephone office having incoming dial equipped lines, other offices, outgoing trunks to said other offices, senders having dial pulse responsive mechanisms and outgoing pulse tranmitting mechanism, means responsive to an incoming call over a line for connecting a sender with said line, route relays in said sender for controlling connections over outgoing trunks with said other offices, code and numerical registers in said sender each comprising one or more cross bar switch verticals operable under the control of said dial pulse responsive mechanism, means for operating a one, two or three-digit route relay as determined by the setting of said registers, electrical operable mechanism comprising a plurality of devices X, Y Z for controlling the number of code digits 1, 2 or 3, respectively, to be transmitted by said outgoing pulse transmitting mechanism, a plurality of progressively operable devices U, V and W for controlling the number of pulses in each of three digits, two digits or one digit, respectively, the progressive operation depending upon which device is first operated, an interdigital device, and pulse counting devices, contact means on the operated route relay for controlling the operation of one of relays X, Y or Z and the operation of one of relays U, V or W depending upon the number of digits to be transmitted, the first device operated U, V or W being the lead-off device in the progressive operation of these devices unless the W device is first operated for the transmission of a one-digit code whereby the U and V devices are omitted and progressive operation of these relays is not effected, and contact means on said operated route relay for controlling the operation of said interdigital device to terminate outward pulsing when the designated number of pulses have been transmitted for a digit and for progressively operating the V and W devices for controlling the number of pulses in the second and third digit of a three-digit code or the W device for controlling the number of pulses in the second digit of a two-digit code.

21. In an automatic telephone system, a local automatic switching telephone office having dial equipped lines, other offices, outgoing trunks to said other offices, senders in said local office having dial pulse responsive mechanism, means responsive to an incoming call over a line for connecting a sender with said line, route relays, registers in said sender operated by said dial pulse responsive mechanism, means in said registers for operating a route relay for controlling the selection of an outgoing trunk to another office, means in said sender for operating the mechanism of said outgoing trunk for extending the connection to said other office, an electrically operable lock-nut device in said outgoing trunk, and means in said sender responsive to the non-operation of said outgoing trunk for extending said connection, for operating said lock-out device under the control of the operated route relay to remove said outgoing trunk from service.

22. In an automatic telephone system, a local automatic switching telephone office having incoming dial equipped lines, other offices, outgoing trunks to said other offices, senders in said local office having dial pulse responsive mechanism and outgoing pulse transmitting mechanism, means responsive to an incoming call over a line for connecting a sender with said line, route relays, registers in said sender operated by said dial pulse responsive mechanism, means in said registers for operating a route relay for controlling said outgoing pulse transmitting mechanism for selecting an outgoing trunk to another office, means

in said sender pulsing devices for operating the mechanism of said outgoing trunk for completing an automatic switching connection to said distant office, an electrically operable lock-out device in said outgoing trunk, means in said sender under the control of the operated route relay responsive to the operation of said outgoing trunk mechanism in a manner to prevent completing said automatic switching connection to said distant office for operating the lock-out device in said outgoing trunk, thus preventing the trunk from seizure by another sender.

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