

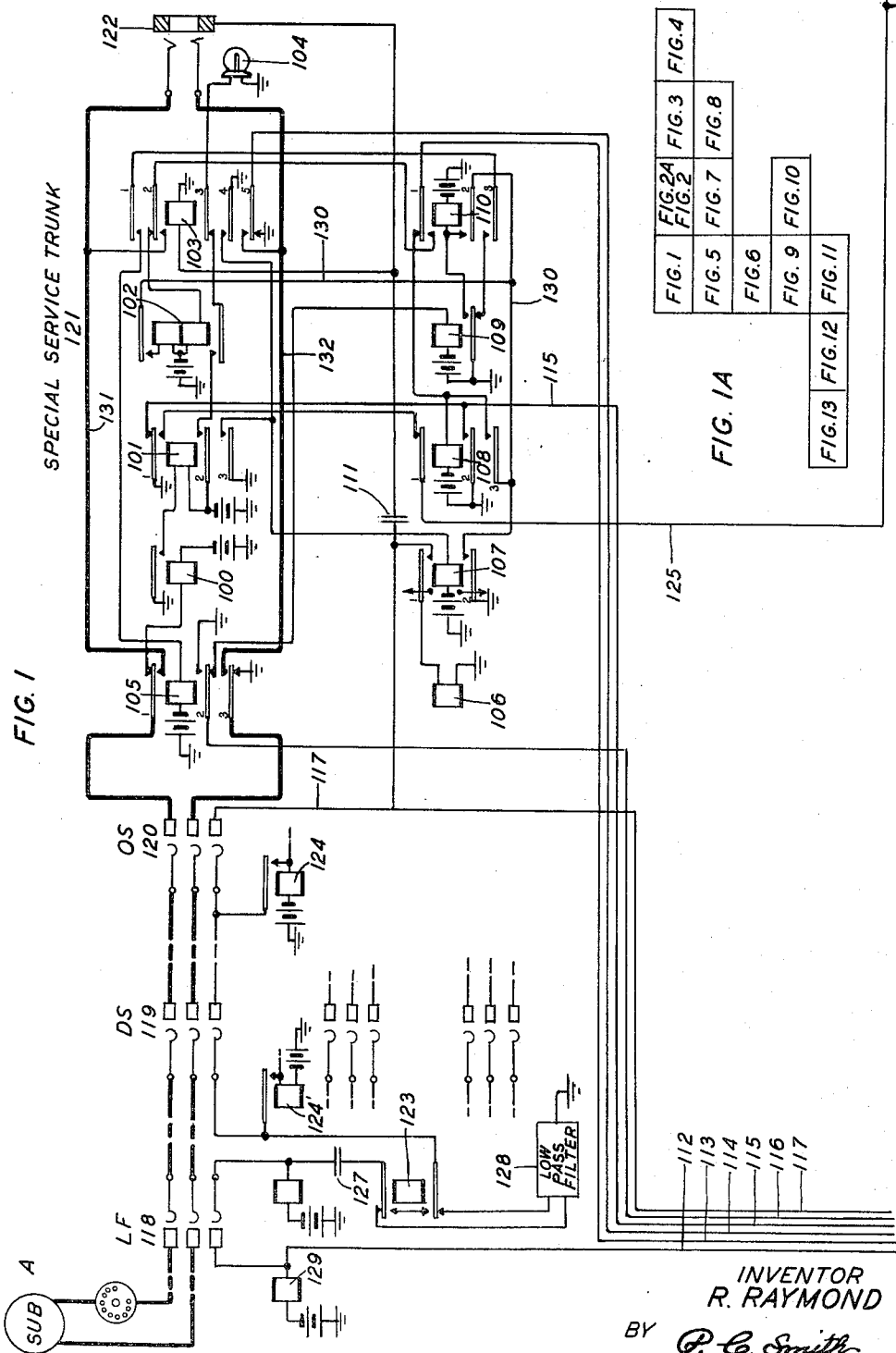
Dec. 10, 1940.

R. RAYMOND
TELEPHONE SYSTEM

2,224,696

Filed May 13, 1939

13 Sheets-Sheet 1



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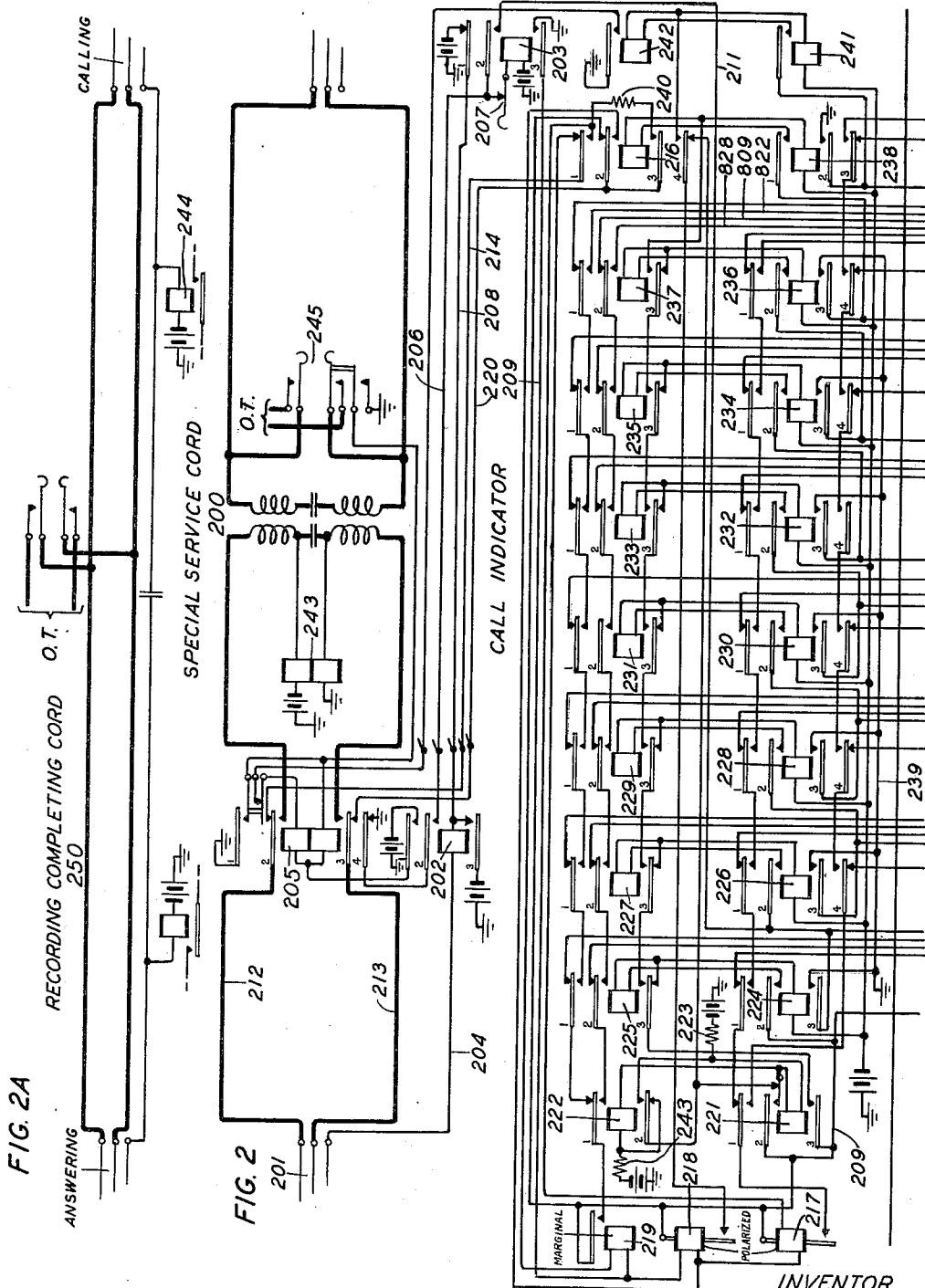
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TELEPHONE SYSTEM

Filed May 13, 1939

13 Sheets-Sheet 2



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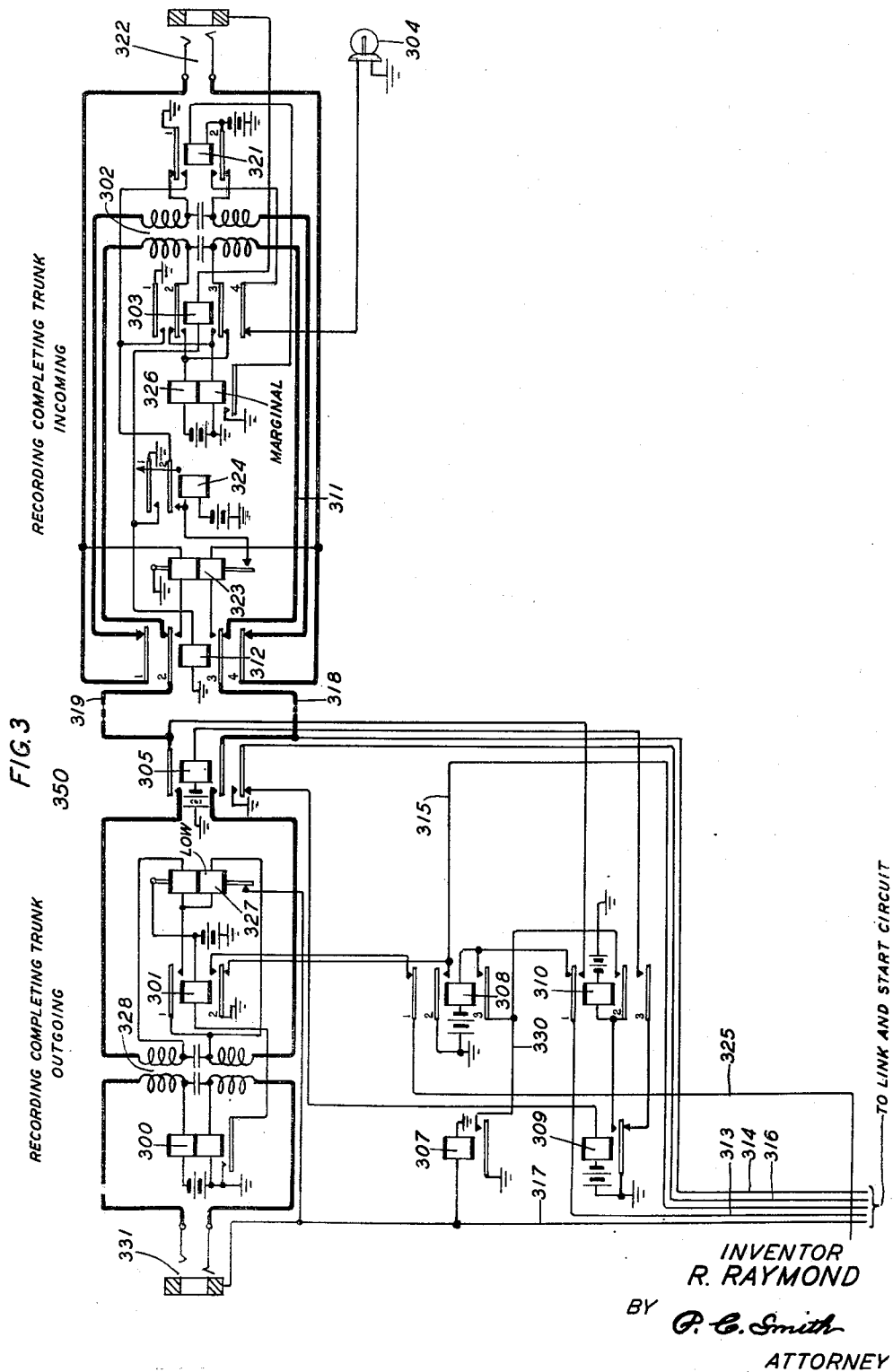
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Filed May 13, 1939

13 Sheets-Sheet 3



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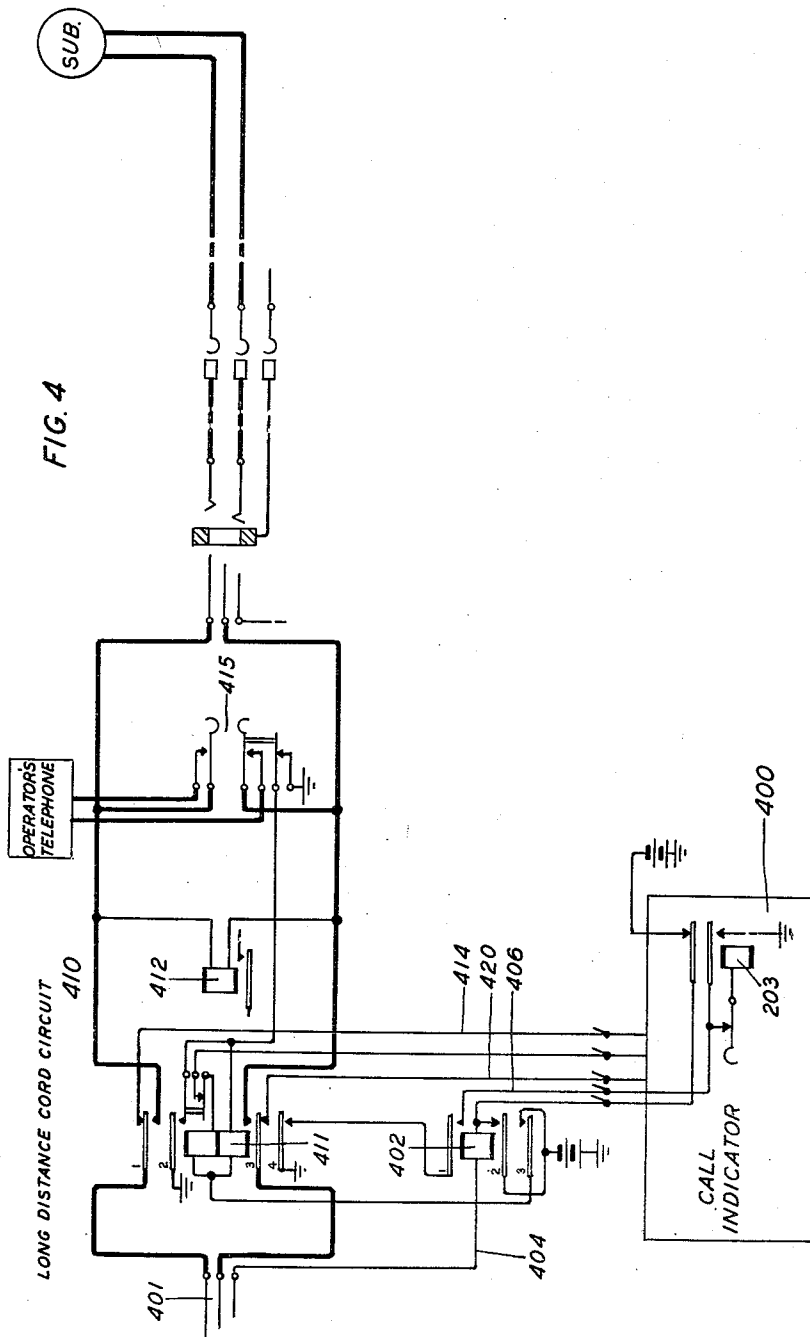
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13 Sheets-Sheet 4



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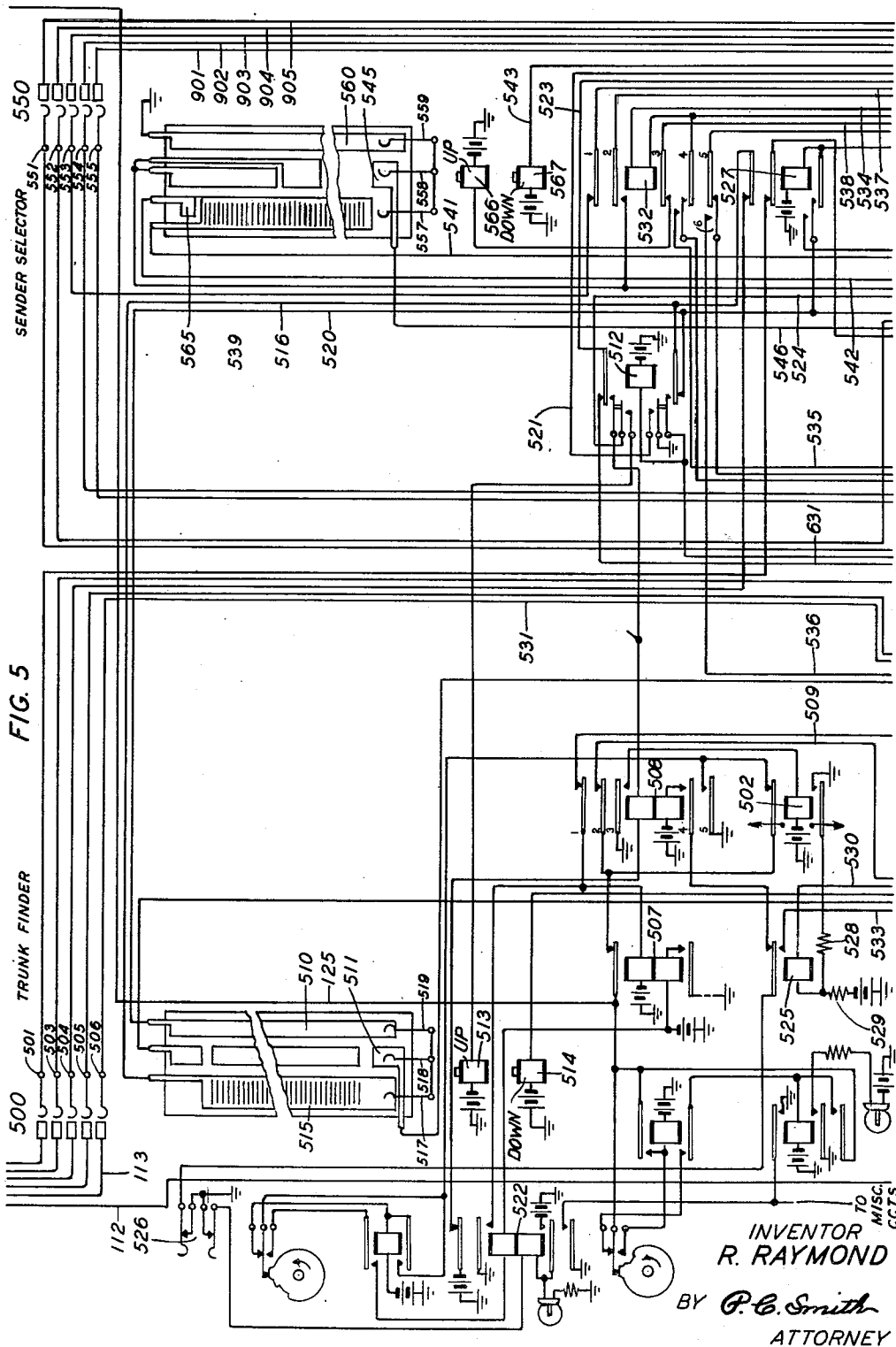
R. RAYMOND

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TELEPHONE SYSTEM

Filed May 13, 1939

13 Sheets-Sheet 5



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R. RAYMOND
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Filed May 13, 1939

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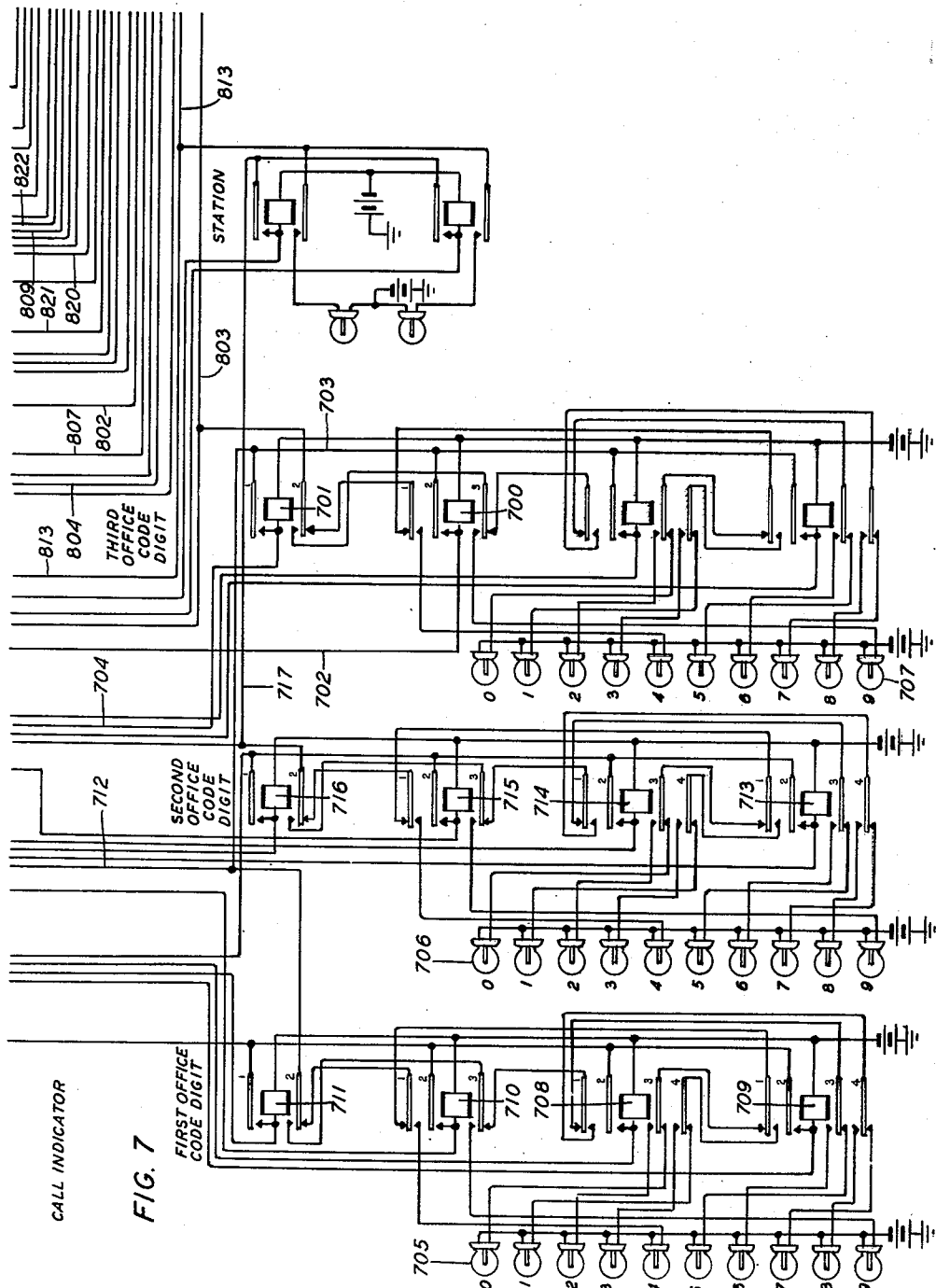


FIG. 7

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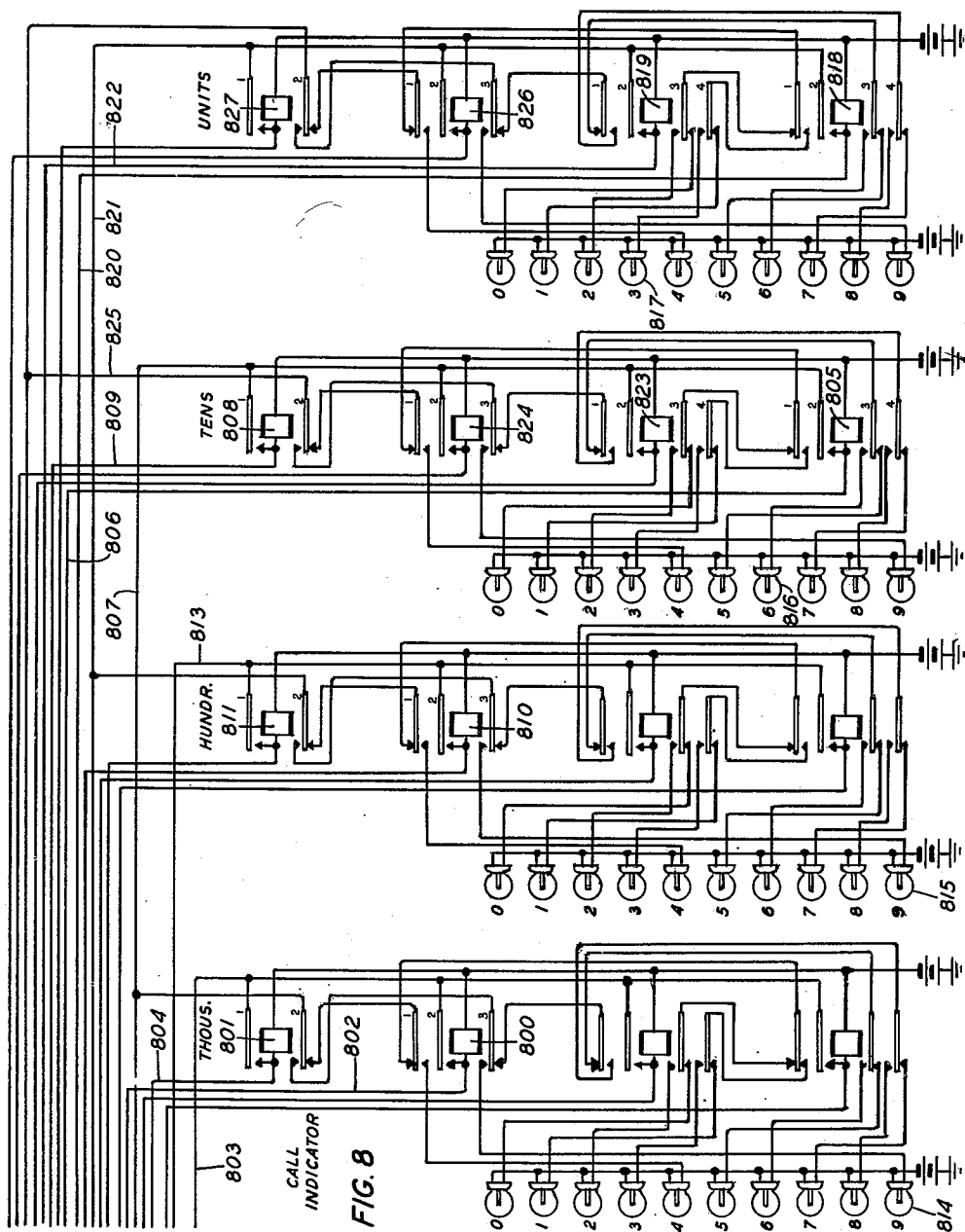
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13 Sheets-Sheet 8



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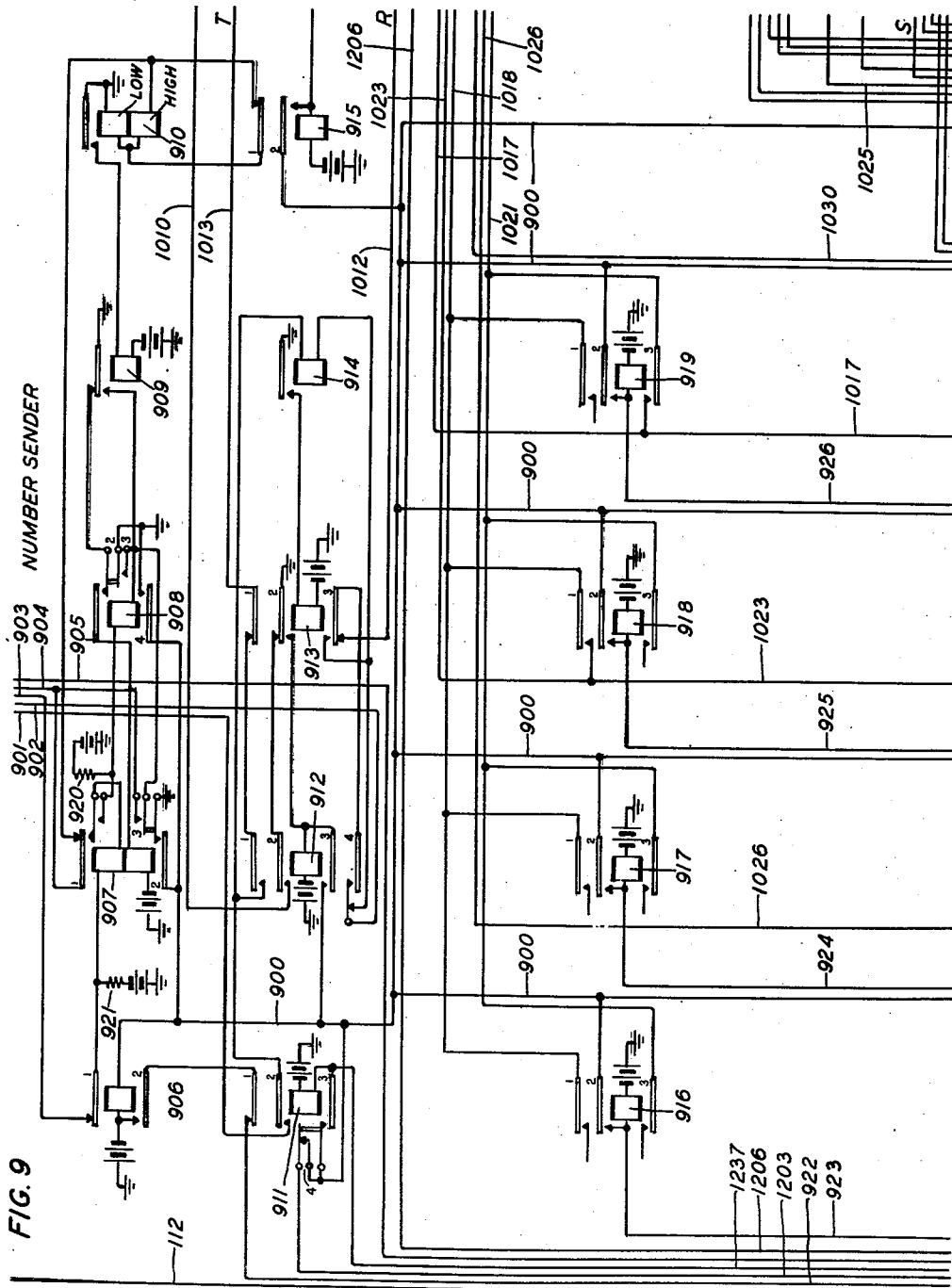
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13 Sheets-Sheet 9



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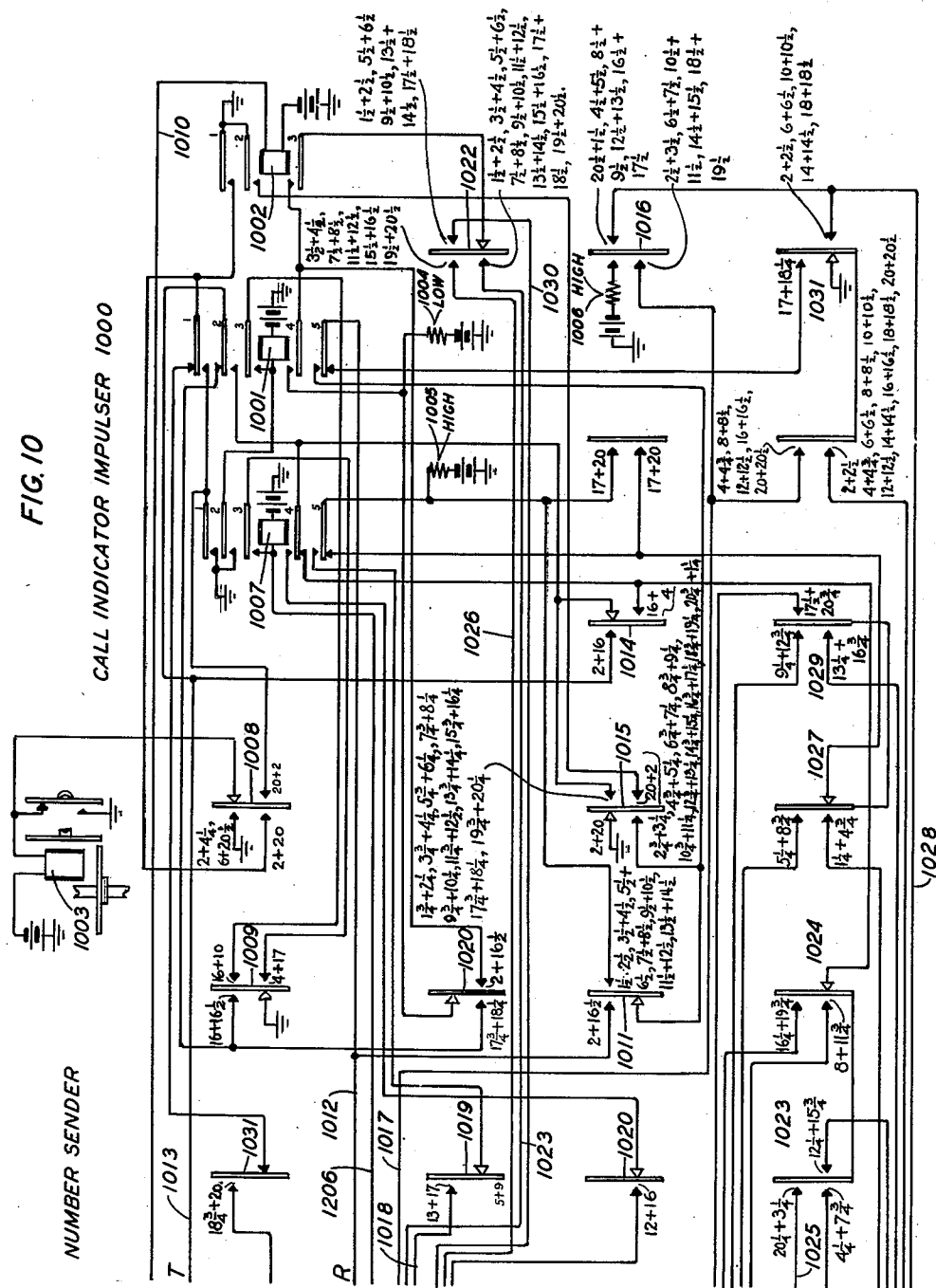
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13 Sheets-Sheet 10



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Filed May 13, 1939

13 Sheets-Sheet 11

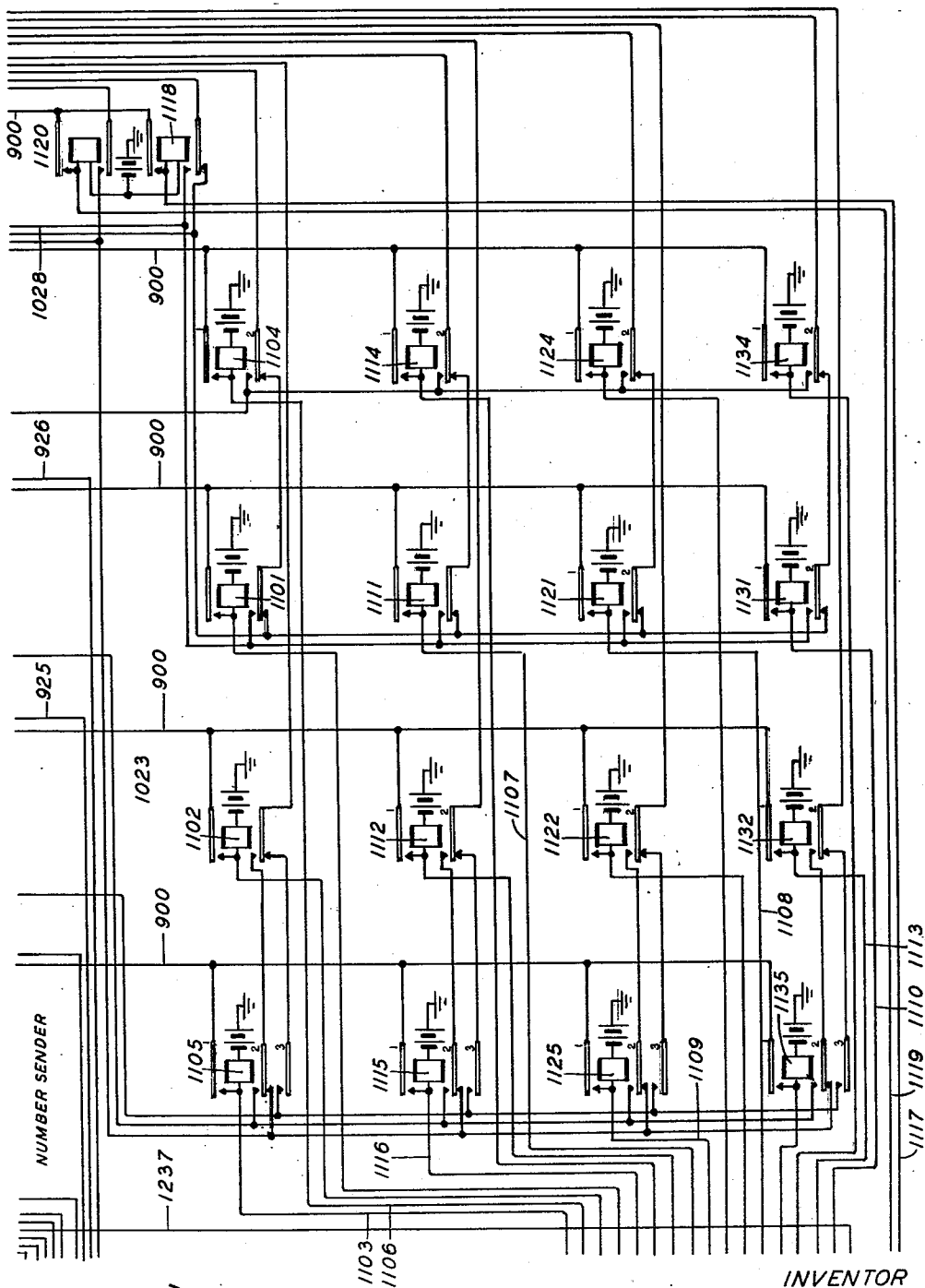


FIG. 11

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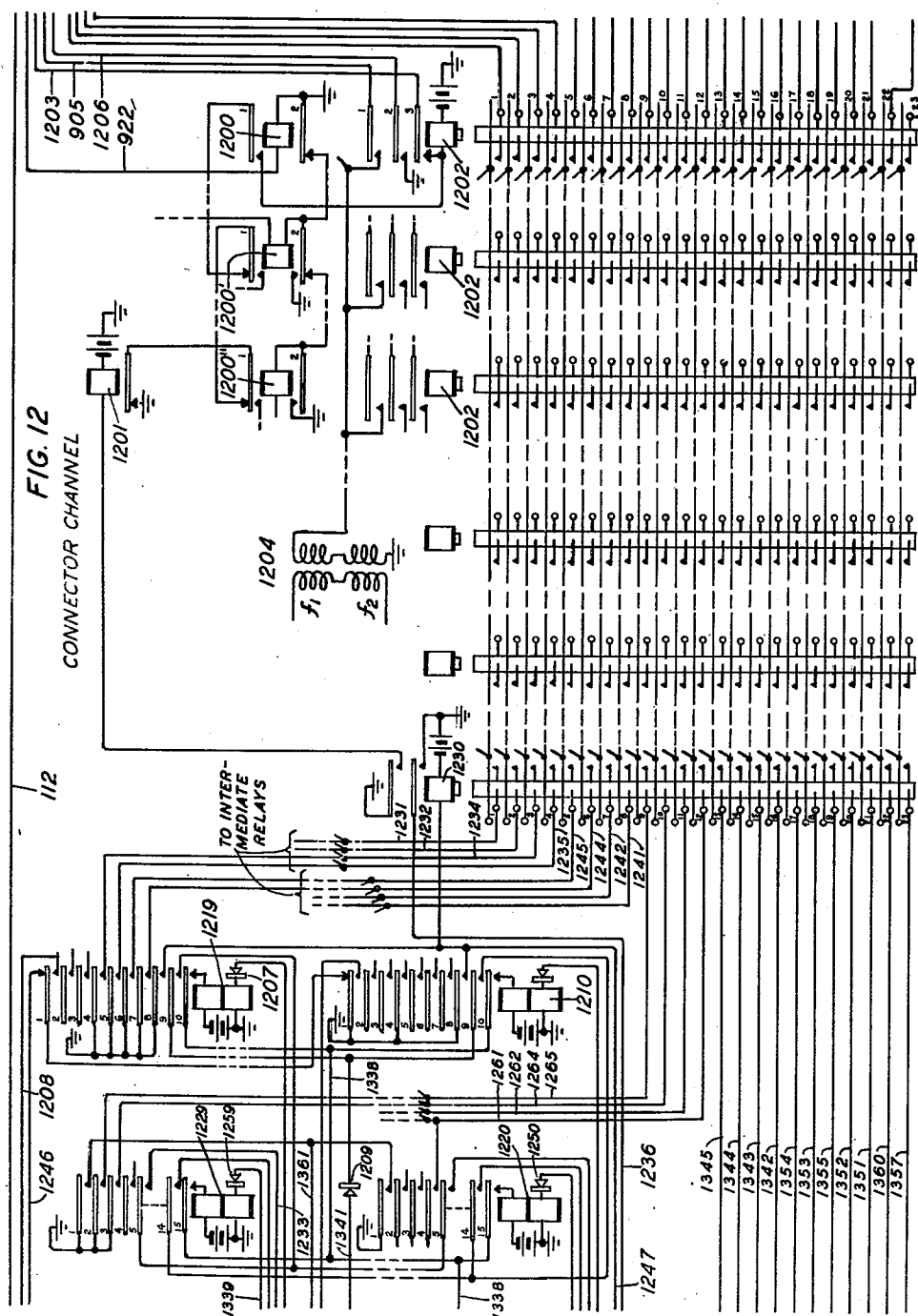
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13 Sheets-Sheet 12



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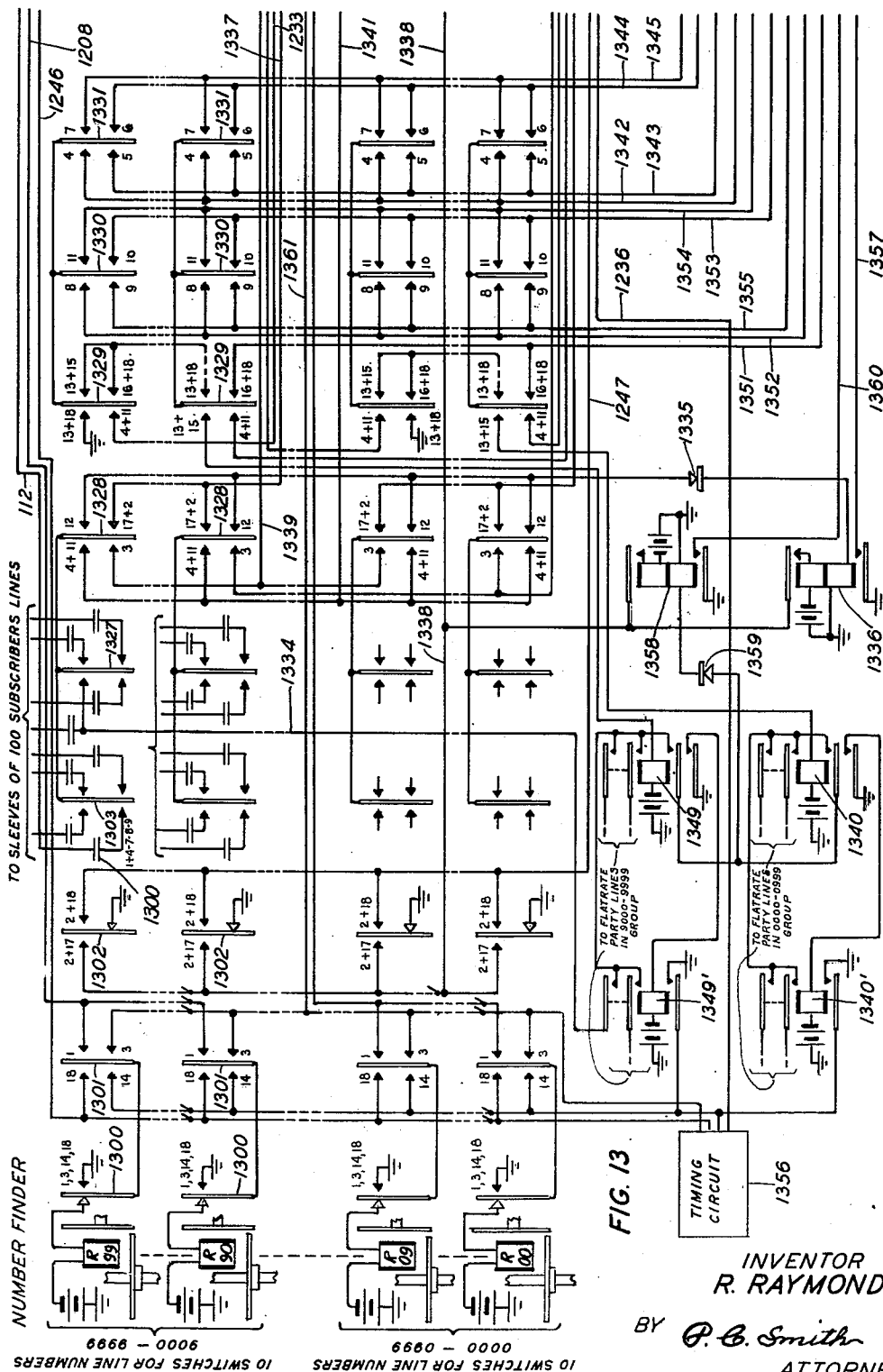
R. RAYMOND

2,224,696

TELEPHONE SYSTEM

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13 Sheets-Sheet 13



UNITED STATES PATENT OFFICE

2,224,696

TELEPHONE SYSTEM

Ralph Raymond, Nyack, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application May 13, 1939, Serial No. 273,387

13 Claims. (Cl. 179—27)

This invention relates to telephone systems and more particularly to line number indicating devices used in such systems.

In telephone systems employing line extending switches for completing a part of a telephone connection, it becomes necessary on certain types of calls, such as a toll call, to supply the operating company with information as to the identity of the calling line number. Under such circumstances the line extending switches controlled by the calling subscriber serve to connect the line to an operator's position where facilities are provided to further extend the connection to the wanted station after the operator has been apprised by the calling subscriber of the identity of said station. This information is necessary to permit the operating company to bill the calling station for the cost of the toll call. Facilities are usually provided for verifying or "checking" the line number, as given by the calling subscriber, so that the operating company will make no error in properly charging the toll call to the station from which the call is made.

At the present time, number checking is accomplished in divers ways among which is the well-known checking multiple method whereby the operator, upon being apprised of the calling line number, applies the tip conductor of a "checking" cord to the sleeve conductor of the calling line in the checking multiple; the method whereby the operator, after having been given the number by the subscriber, sets a train of switching selectors to select the terminal of the line number as given by the calling subscriber and thereafter impresses a tone over the sleeve conductor of the extended connection that is picked up again over the sleeve of the switch train if the number as given by the subscriber over the extended connection coincides with the line terminal reached by the switch train; and other methods whereby a lamp display is given of the calling line number, the lamp display circuit being set by trains of impulses characteristic of the calling line.

These and other means have been used with varying degrees of success. The difficulty is, however, that all these methods and means either require the operator to obtain the line number from the calling subscriber, thereby slowing down the service, or else involve a comparatively large amount of equipment of a character costly to maintain.

The object of the present invention is to provide a more direct and efficient method for determining the calling subscriber's line number,

which depends upon a circuit structure and related apparatus which are both reliable in operation and economical to maintain.

The apparatus and organization of circuits described in the present invention comprise means for number checking which are based upon the use of a positive hunting circuit for locating a conductor individual to the calling line and in response to which a sequence of circuit operations is started that results in the display of the corresponding line number on an indicating device before the operator. In accordance with the invention, therefore, one specific embodiment of which is disclosed herein by way of illustration, this is accomplished in the following improved manner:

There is provided a "number finder" circuit for each central office unit of ten thousand subscriber numbers, and if two or more such units make common use of the same outgoing trunk groups to long distance or special service operators, their several number finders may be preferentially arranged to operate one at a time over common equipment in the manner hereinafter set forth. The number finder is adapted to record the number of the calling line by locating a discriminating tone applied to the sleeve conductor thereof at the operator's position to which the calling line has been extended, after which, over a suitable connector channel, the line record is transferred to a number sender of which a number may be provided depending upon the needs of the traffic. Inasmuch as the long distance operator's position may be located in a different office from that in which the call originates, the number finder is adapted to record and the number sender is adapted to receive a calling office designation as well as the calling subscriber's numerical designation. Thus, where a plurality of number finders are provided, one for each office unit, each of them identifies the name or number of the office with which it is associated, and this identification is then transmitted into the sender which may be common to a plurality of such finders. The number finder is further adapted to record and transmit into the sender the line number of an individual or private branch exchange line, the registration number of a two-party message rate line with a special indication when it is the tip station calling, and some one of the station numbers of a flat rate party line, with a special indication that it is a flat rate party line.

A clearer conception of the scope and purpose of the invention may be obtained from a consid-

eration of the following description and attached drawings Figs. 1 to 13, inclusive, which, when arranged as shown in Fig. 1A, disclose all the essential elements of a typical telephone system with which the invention may be adapted to operate, and in which:

Fig. 1 shows a special service trunk accessible to the calling lines of a typical telephone system via the usual switching selectors;

Fig. 2 shows two service cords with which calls over the service trunk may be accepted, and a positional call indicator steering circuit;

Figs. 7 and 8 show the positional call indicator register and display circuit which cooperates with said steering circuit;

Fig. 3 shows an operator's recording completing trunk accessible to special service operators;

Fig. 4 shows a long distance operator's cord and a schematic showing of a call indicator located at the long distance position, the former being used to accept calls incoming over the recording completing trunk;

Figs. 5 and 6 show a link circuit;

Figs. 12 and 13 show a number finder and a connector channel; and

Figs. 9, 10 and 11 show a number sender.

Fig. 1 shows, schematically, a subscriber's line A terminating on the bank terminals of a group of line finders LF of the type schematically indicated at 118 any one of which is adapted to operate and connect with the terminals of a calling line such as A, for instance, when such a line initiates a call. The line finders are paired with what are ordinarily known as district selectors on frame DS which have accessibility to terminal sets of a plurality of terminal banks to which are connected trunk groups that extend in various outward directions for completing calls thereover to wanted destinations. In cases where the quantity of traffic is limited in certain directions and the trunks for such service are relatively few in number, they are not terminated on the banks of the district selector frame DS but on those of an office selector frame OS, accessibility to which is then obtained by guiding the district selector 119 to the terminals of the wanted group of office selectors from which an idle one is selected, such as 120 for instance, to hunt over and choose an idle trunk in the wanted direction. In Fig. 1 it is assumed that the trunks to an operator's position, say the special operator's position, terminate on the office frame OS, and that the subscriber A in reaching such a position dials a specified code assigned to long distance service, which code is adapted, through recording and controlling equipment, to guide the district selector 119 paired with a chosen line finder 118 to the terminals of an office selector 120 that will be selectively moved into position to cause its brushes to engage the terminals of an idle position trunk 121.

Inasmuch as the setting of the selectors and the controlling equipment therefor to reach a special service trunk form no part of this invention, the description of the various apparatus structures and the connecting circuits to operate them have been omitted, reference being made to Patent 1,862,549 issued to R. Raymond et al. on June 14, 1932, which discloses and describes the automatic extension of a calling line over line finders, district and office selectors of a well-known panel type equipment of the kind used in the present invention to illustrate one of its specific embodiments. It is understood, however, that while the invention is herein disclosed for

purposes of illustration in connection with a telephone system employing well-known panel equipment, no restriction is intended thereby, it being obvious to any one skilled in the art of telephony that the invention may be easily adapted, with slight or no modification, to any other type of telephone equipment used for extending calling lines without in the slightest departing from its scope or functions.

In the following description of the operation of the invention it will be assumed then that the subscriber A has dialed a special service trunk and that, as a result, the train of switching selectors comprising line finder 118, district selector 119 and office selector 120 have been operated to extend a connection from the line finder terminals of the calling line A to the office frame terminals of the special service trunk 121, and that, in the manner described in the above-mentioned patent, the line relay 124' of the district selector 119 and relay 124 of the office selector 120 are operated to hold their respective selectors in the position indicated in the figure.

The extension of the calling line to the special service trunk 121 results in the operation of relay 100 therein over a circuit extending from battery through the winding of relay 100, No. 1 back contacts of relay 105, over the tip side of the extended connection, station loop, ring side of said connection, to ground on the No. 3 back contacts of relay 105. Relay 100 operates and closes an obvious circuit for relay 101 which, on operating, closes an obvious circuit for relay 107 over its No. 3 contacts, connects ground over its No. 1 contacts and over the No. 1 contacts of relay 108 to conductor 125 to start the link (Figs. 5 and 6), connects battery over its No. 2 contacts in partial preparation of the circuit of the "calling" line lamp 104 and disconnects ground over its individual test conductor 115 to the links so that the trunk finder of the link will stop on the selected service trunk as hereinafter set forth. Relay 107, in operating, grounds the selector sleeve conductor 117 through retardation coil 106 to hold locked relays 124 and 124' of the office and district selectors, respectively, and thereby hold these selectors in an operated position, and further connects holding ground to conductor 130.

The ground on conductor 125 completes a signal to an idle link circuit to start hunting for the calling trunk. The ground on said conductor, therefore, completes a circuit over the upper contacts of relay 507, No. 2 contacts of relay 508, conductor 509, right springs of cam 603 of the first idle link in the group, conductor 607, winding of relay 512 to battery. Relay 512 operates, locks over its No. 4 front contacts to ground on the left upper springs of cam 615 via conductor 516, commutator segment 515, brushes 517 and 519, commutator segment 510 of the trunk finder, conductor 520, right lower spring of cam 616, to ground on the left upper spring of cam 615, closes an obvious circuit over its No. 3 contacts and conductor 521 for relay 626 which operates and then locks over its upper winding and No. 3 contacts and lower right spring of cam 623 to the above traced ground on cam 615. Relay 626 then closes a circuit for relay 508 extending from battery over the upper outer contacts of relay 522, upper winding of relay 508, No. 1 front contacts of relay 512, conductor 523, No. 4 contacts of relay 626, left upper spring of cam 616 to ground on cam 615. This relay locks to ground

over its No. 4 contacts, back contacts of relay 525 and the contacts of key 526.

The operation of relay 512 closes a circuit for the up-drive magnet 513 of the trunk finder extending from battery through the winding of said magnet, No. 2 contacts of relay 512, conductor 524, right lower spring of cam 623 to the aforetraced ground on cam 615. This magnet now controls the upward movement of the selector elevator in the known manner and causes the brushes 501 to 508, inclusive, to engage the corresponding bank terminals to which are extended the trunk conductors and among which is to be found the seized trunk to the operator's position which is characterized by the absence of ground on conductor 115. As the elevator moves upwardly, brushes 517 to 519, inclusive, likewise move upwardly, engaging the segments of the commutator in the known manner. In the interval that the brushes 501 to 506 are between bank terminals, relay 512 remains locked to the aforetraced ground on cam 615 over an uninsulated portion of commutator 515, whereas when the brushes are engaging a set of terminals and brush 517 engages an insulating segment, relay 512 will be held operated to ground on conductor 115 of an idle trunk, which ground traces to the winding of relay 512 over the following path: brush 504, upper outer back contacts of relay 527, No. 4 contacts of relay 512 to the winding thereof. Hence the brush elevator will continue its upward drive until the wanted set of terminals is reached, at which time the absence of locking ground on conductor 115 for relay 512 will cause this relay to unlock which, upon releasing, releases in turn up-drive magnet 513, thereby causing the brush elevator to stop on the selected set of terminals.

The release of relay 512 opens the operating circuit of relay 508 and that of relay 626, both of which are locked, and further connects the aforetraced ground on cam 615 over its No. 4 contacts to the test terminal of the trunk via brush 504 to prevent another hunting link from stopping on the terminals of the selected trunk, and completes a circuit for sequence switch magnet 600 extending from battery through the winding of said magnet, conductor 631, No. 1 back contacts of relay 512, conductor 523, No. 4 contacts of relay 626, left upper spring of cam 616 to the aforetraced ground on cam 615. Magnet 600 operates and advances the switch into position 2 or 11 depending upon whether the switch is originally in normal position 1 or normal position 10.

In position 2 or 11 a series path is closed through the left upper and right lower springs of cam 606, top normal springs of jack 630, the first link in the chain after the one taken into use which is in the "awaiting allotment" position 18 or 9, left lower and right upper springs of cam 630 in said link corresponding to cam 630, thence to the winding of a relay corresponding to relay 626 of the link in the awaiting allotment position. This relay locks and closes a circuit for magnet 600 of said link which extends from ground on cam 615 of said link, left upper spring of cam 616 of said link, No. 4 contacts of relay 626, conductor 523, No. 1 back contacts of relay 512 of said link, conductor 631, winding of magnet 600 to battery. Magnet 600 operates and drives the switch into position 1 or 10, there to await the next calling trunk the identifying conductor of which (conductor 509) is advanced over the lower springs of cam 603 to the link in position 1 or 10. At the time relay 508 operated, it closed an ob-

vious circuit for relay 502 which operates and connects ground to resistance 528 connected through resistance 529 to battery, and the combined network is now completed over a path extending through the winding of relay 525, conductor 530, upper springs of cam 609, bottom contacts of relay 629, left lower and right upper springs of cam 601, conductor 531, brush 506 and the terminal engaged thereby, conductor 113, No. 1 back contacts of relay 110, winding of relay 108 to battery. Relay 108 operates in this circuit which, over its No. 3 contacts, locks to ground on conductor 130 and connects ground to conductor 113 the effect of which is to operate relay 525. Relay 108, in operating, also removes ground 15 from conductor 125.

Relay 525, in operating, unlocks relay 508 thereby preparing the start circuit to handle the next call and also completes a circuit for relay 532 which extends from ground on the upper 20 contacts of key 526, front contacts of relay 525, conductor 533, right upper and left lower springs of cam 602, conductor 633, winding of relay 532, conductor 534, resistance 632 to battery. Relay 532 operates, locks over its No. 4 contacts to 25 ground on the upper springs of cam 615, connects the same ground to the upper winding of relay 629 via conductor 535, No. 1 contacts of relay 626, causing said relay 129 to operate, to release relay 525 and to perform functions noted hereinafter, 30 and completes a circuit for magnet 600 which extends from ground on cam 615, left upper spring of cam 617, conductor 634, No. 6 contacts of relay 532, conductor 536, upper springs of cam 605, winding of magnet 600 to battery. Magnet 600 35 operates and advances the sequence switch to position 3 whereupon relay 532 releases.

Relay 628 operates as the switch passes through position 2 or 11 over a circuit extending from battery through its lower winding, lower 40 springs of cam 618, top back contacts of relay 627, left upper spring of cam 617 to ground on cam 615. It, however, performs no function at this time. Moreover, since relay 627 is normal, a path is provided for advancing the switch into 45 position 4 or 13, the circuit being from ground as aforetraced to the top back contacts of relay 627, right lower spring of cam 613, positioning cam 635, winding of magnet 600 to battery.

As the switch advances from position 3 1/4 to 4, relay 626, which was unlocked as the switch left 50 position 2, reoperates from ground on cam 615 via the left lower spring of cam 616, while relay 628 reoperates over its previously traced circuit, also completed in position 4 of the switch.

Upon the operation of relay 628, relay 629 operates over a path which extends from battery through its upper winding, lower springs of cam 609, left lower and right upper springs of cam 619, lower contacts of relay 628, bottom back 60 contacts of relay 627, No. 5 and No. 6 contacts of relay 532, conductor 634, left upper spring of cam 617 to aforetraced ground on cam 615. The operation of relay 629 completes the circuit of the sender selector up-drive magnet 566 from battery through the winding of said magnet, No. 3 65 contacts of relay 532, conductor 538, top outer contacts of relay 629, left lower spring of cam 616 to the aforetraced ground on cam 615. The sender selector elevator, carrying terminal 70 brushes 551 to 555, inclusive, and commutator brushes 557 to 559, inclusive, starts hunting over the terminal bank 550 in quest of an idle sender, the condition of which is determined by the presence of resistance battery on the terminal which 75

will be engaged by the brush 553 while the condition of all busy senders will be characterized by the presence of ground thereon.

Now since relay 532 was unlocked in position 3, then when the switch reaches position 4, the upper winding of relay 627 is connected to brush 553 of the sender selector via the No. 1 contacts of relay 532, conductor 537 and the right springs of cam 622, while the operation of relay 628 grounds the middle winding of relay 627 and the operation of relay 626 serves to connect the lower winding to the middle and upper windings via battery through the lower winding, No. 2 contacts of relay 626 to the ungrounded side of the middle winding.

It is further evident that while relay 629 holds up over its original operating circuit through the back contact of relay 627 it also has a supplementary locking path from ground on commutator strip 560 over commutator brushes 559 and 557, commutator strip 539, conductor 541, lower springs of cam 624, top inner contacts of said relay. Since the commutator strip is designed to present a conducting strip to the terminal engaging brush while the brush is between terminals and an insulating strip when said terminal brush engages a terminal of a terminal set in the bank 550, it is clear that when an idle sender is encountered and, as a result, relay 627 operates in a circuit presently to be described, relay 629 releases, in turn opening the circuit of the up-drive magnet 566 and thereby causes the selector elevator to come to rest with the terminal brush set engaged with the terminals of an idle sender.

Idle number senders are characterized by battery through 270 ohms resistance and, assuming that the sender shown in Fig. 9 is the first idle one encountered, a circuit will be closed from battery through resistance 921, No. 1 contacts of relay 906, conductor 903, brush 553 through the upper and lower windings of relay 627 as previously traced, to ground on the upper inner contacts of relay 628. Relay 627 operates in this circuit, short-circuits its middle winding with ground on the No. 5 contacts of relay 626 via its own top front contacts, and closes a locking circuit through its lower winding to the aforetraced ground. This circuit so alters the potential on brush 553 that no other link circuit which may be hunting can stop on the seized number sender. The operation of relay 627 opens the circuit of relay 629, in turn stopping the selector from hunting as before described.

When relay 627 operates, it opens the operating path of relay 628 which, upon releasing, advances the sequence switch to position 5 or 14 over a circuit path extending from the aforetraced ground on conductor 634, No. 5 and No. 6 contacts of relay 532, bottom front contacts of relay 627, top back contacts of relay 628, left lower spring of cam 613, positioning cam 635, winding of magnet 600 to battery. Relay 628 is made slow in releasing so that if another link should be hunting over the same sender terminals before relay 627 is fully operated, relay 627 will release, the brush elevator will move off the terminal, the link will continue hunting, relay 628 will remain operated and the switch will not be advanced out of the hunting position.

If the selector brush elevator travels to the top of the bank without finding an idle number sender, relay 532 will operate in a circuit extending from battery through resistance 632, conductor 534, winding of relay 532, conductor 633, upper springs of cam 625, conductor 542, com-

mutator segment 565, brush 57, brush 59 to ground on commutator segment 60. Relay 532 locks to a previously traced circuit, opens the circuit of the up-drive magnet 566, thereby stopping the upward movement of the selector, opens the test circuit to test brush 553, and closes the circuit of the down-drive magnet 567 over a circuit path which extends from battery through the winding of said magnet, conductor 543, lower springs of cam 620, conductor 536, No. 6 contacts of relay 532, to the aforetraced ground on conductor 634. The selector is driven back to its normal position in which brush 558 engages commutator segment 545 to short-circuit relay 532 by extending ground to resistance 632 via the right springs of cam 621. The release of relay 532 releases the down-drive magnet 567, operates the up-drive magnet 566 as before, closes once again the test circuit to brush 553 and the link starts to hunt as before.

The seizure of the sender will cause the removal of ground from conductor 903 in the manner hereinafter set forth whereupon relay 627 will release, which closes a circuit from battery through the winding of sequence switch magnet 600, lower right spring of cam 613, top back contact of relay 627, left upper spring on cam 617 to ground on cam 615. Sequence switch 600 is advanced to position 6 in this circuit. In position 5 the sender and the special service trunk 121 are connected together by the trunk and sender selector brushes over paths that will be detailed henceforth in connection with circuits to be traced thereafter.

As already stated, the link seizes the first number sender whose conductor 903 is connected to resistance battery 921 through the No. 1 contacts of relay 906. The link, in position 6, cuts through conductors 901, 902, 904 and 905 from the sender to the trunk, whereupon a series circuit is completed between relay 109 in the trunk, relay 628 in the link and the low winding of relay 910 in the sender. This circuit traces from battery through the winding of relay 109, No. 2 back contacts of relay 105, conductor 116, brush 503, left contacts of cam 614, upper winding of relay 628, brush 552, conductor 904, No. 1 back contacts of relay 907, No. 1 contacts of relay 915, upper low resistance winding of relay 910 to ground. The current flowing in this circuit is sufficient to operate relays 109 and 910 but not relay 628, whereupon relay 110 in the trunk operates over an obvious circuit completed over the front contacts of relay 109, and relay 909 in the sender operates over an obvious circuit completed over the contacts of relay 910, relay 908 then operating over an obvious circuit completed from the front contacts of relay 909 and locking to ground over its No. 3 contacts. Relay 908, in operating, closes an obvious circuit to the winding of relay 906 which operates to perform functions hereinafter noted. Relay 110 in the trunk, upon operating, locks over its No. 2 contacts to ground on conductor 130.

In the meanwhile ground is removed from conductor 113 in the link and, due to the operation of relay 110, this conductor is switched from the winding of relay 108 which is locked, to the lower winding of relay 102 via the No. 2 back contacts of relay 103.

Following the operation of relay 906 in the 70 sender, a circuit is completed for relay 1200 in the connector extending from battery on the No. 2 contacts of relay 906, No. 1 contacts of relay 911, conductor 922, winding of relay 1200, to ground. As shown in Fig. 12, relay 1200 is the 75

first of a group of relays 1200 to 1200'' each of which is individual to a sender. These relays are disposed in a preference lock-out circuit arranged so that only one relay in the group can be operated at a time. Thus if the sender of which relay 1200' is a part were to have been the one seized, the circuit path of its relay 1200' would have been traced through its winding (as for relay 1200) but the ground would be connected thereto over a series chain of back contacts of other relays intermediate relay 1200' and relay 1200, the first relay in the chain which supplies the operating ground. Should another sender in the chain of preference have its own relay 1200' operated, relay 1200 of the first sender will, of course, operate but nothing occurs in consequence thereof because of the operated condition of the relay 1200' ahead of relay 1200 which breaks the upper ground chain to operate relay 1202 as subsequently set forth. When relay 1200' releases (assuming that it is operated when relay 1200 operates), a circuit is completed for multicontact 1202 extending from ground on the contacts of relay 1201, No. 1 back contacts of each of the relays 1200'', etc., No. 1 front contacts of the operated relay 1200, winding of relay 1202 to battery. Relay 1202 operates and locks over its No. 3 contacts, conductor 1203, No. 4 normal contacts of relay 911 to ground on conductor 900.

Thus as a result of the extension of the calling line to a special service trunk terminating at the operator's position, an idle number sender has been connected to the trunk via the link and to the connector channel, the other side of which will be connected to a number finder disclosed in Figs. 12 and 13 in the manner to be described shortly. As a result of these connections the sender will transmit a tone signal over the sleeve conductor of the connection which the number finder will proceed to identify. Relay 1202, on operating, connects the secondary of tone source 1204 of two frequencies f_1 and f_2 through the No. 1 contacts of relay 1202, conductor 905, brush 551, upper springs of cam 620, top inner contacts of relay 527, brush 501, conductor 117, sleeve conductor of the extended connection, bottom contacts of relay 123, low-pass filter 128, upper contacts of relay 123, condenser 127, line-finder brush and terminal of the calling line, conductor 112, condenser 1300 and thence to the spring of cam 1303 in the sequence switch of the number finder of the office unit to which the calling line belongs. If relay 123 of the district selector is operated as a signal that the tip party of a two-party message rate line is calling, the low-pass filter 128 is removed from the line and both frequencies f_1 and f_2 will pass to conductor 112 of the number finder. Otherwise the low-pass filter will be in circuit and one frequency only is transmitted, the other being shunted to ground. Relay 1202, on operating, further closes an obvious circuit over its No. 2 contacts and conductor 1206 to the winding of relay 1007 which operates to perform functions noted hereinafter.

Relay 1202 closes one set of channel contacts between the register relays of the sender and the recording equipment of the finder which began functioning to record the calling line number when tone was transmitted thereto over the sleeve of the connection.

In the organization of the number finder, shown in Fig. 13 and in the left portion of Fig. 12, each block of one thousand consecutive line

numbers is assigned to ten sequence switches, inclusive, of known construction and to a set of party line multicontact relays, there being one sequence switch for each one hundred consecutive number subdivision of the one thousand numbers. Thus considering Fig. 13, there are shown two groups of switches, a lowermost group comprising ten switches R00 to R09 assigned to the lines having numbers 0000 to 0999, inclusive, and an uppermost group comprising ten switches R90 to R99 assigned to the lines having numbers 9000 to 9999, the other intermediate eight groups of switches being omitted for simplicity.

To each group of ten switches is assigned a thousands multicontact relay indicated by the group of relays 1210 to 1219 in Fig. 12, and two additional relays which, in Fig. 13, are illustrated by relays 1340 and 1340' for the lowermost group of switches R00 to R99, and relays 1349 and 1349' for the uppermost group of switches R90 to R99, the intermediate relays being omitted from the drawings. There is also provided a common group of ten hundreds relays 1220 to 1229, one for each hundred subdivision for the thousand block of lines which are arranged for operative cooperation with their respective hundreds switch in each of the ten groups of switches in the manner hereinafter set forth.

Each switch in each group is allocated to a particular one-hundred line subdivision of the entire one-thousand line group, the lowest switch preferably being assigned to the lowest subdivision and other switches, ascendingly, to the other and higher subdivisions. Each switch is provided with thirty-one cams of which cams 1303 to 1327, inclusive, for example, are collared together according to the known method and the springs thereof are each connected to a conductor, like conductor 112, for instance, extending to the winding of the cut-off relay of the subscriber's line in the one-hundred subdivision assigned to the particular switch.

The disposition of the line sleeve conductors in the various springs of the cams 1303 to 1327, inclusive, is made according to the hundreds, tens and units designations of each individual line represented by a sleeve conductor, and the face of the cam engaging each particular spring is cut correspondingly to produce, as the switch is rotated through one revolution as hereinafter described, a group of pulses which designates the number of the line.

Each of the springs which represents a flat rate party line as, for instance, the line represented by conductor 1334, is also extended to a contact in one of the two relays associated with the same thousand line numbers as, for instance, relay 1349' of the uppermost group of switches R90 to R99.

Mention has already been made of the fact that when the sender becomes attached to the special service trunk and to the connector channel, a tone of two frequencies is applied back over the sleeve conductor of the extended connection, and that this conductor further extends to a spring of a sequence switch in the number finder in the block of ten switches assigned to the thousand numbers containing the calling number, and particularly to the switch containing the hundreds subdivision thereof which includes the hundreds digit of the calling number. In the description and for purposes of illustration, the sleeve was traced through to conductor 112 which is the extension of the sleeve of the

calling line A. Now let it be further assumed that the calling line A belongs in the last thousands group and in the last hundreds of the group, thereby having 9 for its thousands digit and 9 for its hundreds digit. This being the case, conductor 112 is extended to a cam, say cam 1303, in the switch R99, to which the tone circuit was last traced. And this switch is, of course, in the group of switches provided for lines 9000—9999, the last switch in the group, and is provided for the last group of one hundred lines.

At the time the tone is transmitted over the sleeve connection, the number finder is, of course, normal and, therefore, all of its switches are in position 1. Consequently, the tone circuit on conductor 112 is further extended over the right lower contact of cam 1328, conductor 1337, rectifier 1207, lower winding of relay 1219 to ground. Had the calling line belonged in any other hundreds subdivision of the thousand line block, then the conductor 112 would have been extended to a spring in the appropriate one of the ten sequence switches assigned to this block, and the tone circuit would then have been extended over cam 1328 of the appropriate switch, and thence to conductor 1337 over which the previously described circuit is completed to the winding of relay 1219.

If the calling line is located in any other thousand block, its sleeve conductor 112 would have been extended to the appropriate group of switches and to the one switch therein provided for the one-hundred line subdivision thereof. Since there is one group relay for every thousand lines (1210 to 1219) with its energizing circuit completed to every one of the switches in the thousand block, the operated relay in the group of relays 1210 to 1219 will mark the thousands designation of the calling line number.

For the purpose of illustrating the operation of the invention as a whole, let us assume that the calling line number is 9963. This means that the sleeve conductor 112 of the line is extended to the last switch R99 in the uppermost block of switches R90 to R99, and is connected to a spring 1303 in this switch. According to the operations already described, the presence of tone on this conductor causes the operation of the thousands group relay 1219.

Relay 1219, upon operating, connects ground from the No. 1 back contact of relay 1210 serially through the No. 1 back contacts of intermediate relays 1211 to 1218, No. 1 front contact of relay 1219, conductor 1208, right upper contact of cam 1301, cam 1300, winding of switch magnet R99 to battery. Similar parallel circuits are established over the other nine cams corresponding in cam 1301 to each of the other nine switch magnets R90 to R98, so that the entire block of ten switches advances out of position 1 and into position 2. Relay 1219 further closes a locking circuit over its upper winding and No. 10 contacts to ground on off-normal conductor 1338, which ground, however, is not effective until the ninth block of switches has advanced to position 2, at which time ground is connected to conductor 1338 by the cams 1302; it further closes an obvious circuit for multi-contact relay 1230 which operates; and further grounds a group of conductors to designate the office code and thousands digit of the calling line in the manner to be shortly described.

Relay 1230, upon operating, closes an obvious circuit for relay 1201 which removes operating ground for the sender connector relays 1202, con-

nects ground to conductor 1236 which initiates the operation of any suitable timing circuit 1356 that counts off a predetermined time for the number finding and sending operations to take place, and closes the channel through between the number finder and number sender over channel leads 1 to 23, inclusive.

It has already been stated that one finder circuit is assigned to each office unit of ten thousand lines. Since each of these units may be in a different building or in a different telephone area and may canalize all long distance calls into one common long distance center, it will be necessary for the recording operator to ascertain the particular office in which the calling line is located. For this purpose the circuits are arranged to provide an office indication, in addition to the indication of the called line member, with each finder identifying its own office unit by the permanent connection of ground to one or more of four conductors 1231, 1232, 1234 and 1235 extending over channel leads 1 to 4, inclusive, to relays 916 to 919, inclusive, of the number sender, over the respective conductors 923 to 926, inclusive. The particular relay or the combination of relays operated by the grounded conductors determines, of course, the identity of the calling office. Thus, with the four relays 916, 917, 918 and 919, nine separate office code indications may be obtained as follows:

Conductors grounded Fig. 12	Conductors grounded Fig. 9	Relays operated Fig. 9
1231.....	923.....	916 (office 1).
1232.....	924.....	917 (office 2).
1231—1232.....	923—924.....	916—917 (office 3) ..
1234.....	925.....	918 (office 4).
1235.....	926.....	919 (office 5).
1231—1235.....	923—926.....	916—919 (office 6).
1232—1235.....	924—926.....	917—919 (office 7).
1231—1232—1235.....	923—924—926.....	916—917—919 (office 8).
1234—1235.....	925—926.....	918—919 (office 9).

If the number of office units having access to the common special service or toll center is greater than nine, the number of identifications may be increased by adding as many relays as required and by adding between these relays and the thousands relay 1219 as many additional conductors over the connector channel as may be required. For the purpose of illustration, however, it will be assumed that the number of office units does not exceed nine and that the identification of the unit associated with the finder of Figs. 12 and 13 is established by the connection of ground to conductors 1234 and 1235. Therefore, when relay 1219 operates and the connecting channel between the finder and sender is closed through, a circuit is completed which extends from ground on the No. 4 contacts of relay 1219, conductor 1234, No. 3 contacts of relay 1230, conductor 925, winding of relay 918, to battery. Relay 918 operates and locks over its No. 2 contacts to ground on conductor 900. Another circuit is completed which extends from ground on the No. 5 contacts of relay 1219, conductor 1235, No. 4 contacts of the connector channel, conductor 926, winding of relay 919 to battery. Relay 919 operates and locks over its No. 2 contacts to ground on conductor 900. The operation of relays 918 and 919 records the identification of the calling office according to the above code.

Relay 1219 further grounds one or more of the four conductors 1241, 1242, 1244 and 1245 which are multipled to the other nine thousands relays in an appropriate combination for each thousands

digit, to operate one or more of the four corresponding relays 1101, 1102, 1104 and 1105 in the number sender to record therein the thousands designation of the calling subscriber's number. Since there are but ten designations in this case, the identification of each of the ten one-thousand groups is as follows:

Thousand group	Conductors grounded	Relays operated
0000-9999	None	None
1000-1999	1241	1101
2000-2999	1242	1102
3000-3999	1241-1242	1101-1102
4000-4999	1244	1104
5000-5999	1245	1105
6000-6999	1241-1245	1101-1105
7000-7999	1242-1245	1102-1105
8000-8999	1241-1242-1245	1101-1102-1105
9000-9999	1244-1245	1104-1105

It has been assumed that the calling line is in the 9000-9999 block. Since, for the identification of this block of lines, it becomes necessary to operate relays 1104 and 1105 in the sender, the operation of relay 1219 causes ground to be connected to conductors 1244 and 1245 and the following two circuits are thereby completed (1) ground on the No. 7 contacts of relay 1219, conductor 1244, No. 6 contacts of the connector channel, conductor 1106, winding of relay 1104 to battery, causing this relay to operate and lock over its No. 1 contacts to ground on conductor 900; (2) ground on the No. 6 contacts of relay 1219, conductor 1245, No. 5 contacts of the connector channel, conductor 1103, winding of relay 1105 to battery, causing said relay to operate and lock over its No. 1 contacts to ground on conductor 900.

Thus to recapitulate the operation of the number finder following the operation of relay 1219 in response to the appearance of the tone current impressed on the sleeve extension 112 of the calling line A located in the 9000 to 9999 block of lines, the thousands relay grounds a selection of one or more of four conductors 1231, 1232, 1234 and 1235 to register the code of the calling office by the operation of one or more relays 916, 917, 918 and 919; it grounds a selection of one or more of four conductors 1241, 1242, 1244 and 1245 to register the code of the thousands digit by the operation of one or more of the relays 1101, 1102, 1104 and 1105 except for the digit 0 in which no relays are operated in registration of the digit. a circuit is closed to the block of switch magnets to advance their respective sequence switches into position 3, and a locking circuit is provided for the thousands relay through positions 2 to 17, inclusive.

In position 3 of the switches R90 to R99, the tone conductor 112 is switched from the right lower to the left lower spring of cam 1328 whereupon it is effective to complete a circuit to operate the hundreds relay in the group of relays 1220 to 1229 to indicate the subscriber's hundreds designation. Since the sleeve conductor of the subscriber's line is disposed on one of the ten switches R90 to R99 in accordance with the line hundreds designation, it is obvious that the relay operated will identify the hundreds digit of that number. Thus, if the subscriber's hundreds designation is 9, as it has been assumed, the sleeve conductor will be connected to one of the springs of switch R99. Since the operating winding of relay 1229 is connected to the left lower spring of cam 1328 of this switch, then, when this switch, along with the other nine of the group, advances

to position 3, a circuit is completed from conductor 112 over said cam, conductor 1339, rectifier 1259, lower winding of relay 1229 to ground, causing this relay to operate and then lock over its upper winding and No. 15 contacts to ground on conductor 1338. Relay 1229, in operating, grounds a selection of four conductors, 1261, 1262, 1264 and 1265, to register on the relays 1111, 1112, 1114 and 1115 of the number sender, the hundreds digit of the calling line, the ten switches R90 to R99 in the meanwhile advancing out of position 3 by a circuit established from ground on the No. 1 contact of relay 1229, conductor 1361, lower right springs of cams 1301 and the springs of cams 1300 to battery through the sequence switch magnets, and continuing to advance into position 14 under the control of cams 1300.

It has been assumed that the subscriber's hundreds designation is 9 and that, for this reason, the sleeve conductor relating thereto was extended to a spring associated with a cam on the switch R99 which, in turn, resulted in the operation and locking of relay 1229. The recording of the hundreds digit 9 is carried out on the same basis as the thousands registration. That is to say, four relays 1111, 1112, 1114 and 1115 are provided which are operated singly or in combination for each one of the digits except 0 over conductors extending to separate sets of contacts on each of the ten relays 1220 to 1229. The order of the combinations is the same as for the thousands so that, for the registration of the hundreds digit 9, it becomes necessary to operate relays 1114 and 1115. The circuits for these two relays are as follows: one circuit may be traced from ground on the No. 3 contacts of relay 1229, conductor 1264, No. 10 channel lead, conductor 1107, winding of relay 1114 to battery. The other circuit may be traced from ground on No. 2 contacts of relay 1229, conductor 1265, No. 9 channel lead, conductor 1116, winding of relay 1115 to battery. Both of these relays operate to record the digit 9 and lock over their respective No. 1 contacts to ground on conductor 900.

In passing through positions 4 to 11, the tone path from the sleeve extension 112 of the calling line is carried through the left upper contacts of cam 1328, conductor 1341, rectifier 1209, No. 9 contacts of operated thousands relay 1219, No. 5 contacts of the operated hundreds relay 1229, conductor 1233, to the left lower spring of cam of 1329. From this point, the path is extended over each of the eight separately numbered positions on cams 1330 and 1331 to produce a group of from 0 to 3 pulses in positions 4 to 7, inclusive, of the switch over conductors 1342 to 1345, inclusive, to operate the appropriate combination of the four relays 1121, 1122, 1124 and 1125 for recording the tens digit of the line number, and to produce another group of from 0 to 3 pulses in positions 8 to 11, inclusive, of the switch over conductors 1352 to 1355, inclusive, to operate the appropriate combination of relays 1131, 1132, 1134 and 1135 for recording the units digit of the line number.

It will be observed that each spring connected to a sleeve conductor engages the face of an associated cam which is cut in certain different positions for each of the engaging springs. These cuttings are designed to produce a number of impulses indicative of the tens and units designation of the line indicated by the sleeve conductor. Since the registration of the tens and units digits in the sender is, like that of the thousands

and hundreds digits, carried out by operating one or more of four relays for each digit (except zero for which no relays are operated) it becomes necessary to produce a maximum of six impulses, three for the tens and three for the units, to operate the maximum number of relays in each group to record the digit 8. Thus the cuttings from 4 to 7, inclusive, are reserved for the generation of impulses to record the tens digit and the cuttings from 8 to 11, inclusive, are reserved for the production of impulses to record the units digit. The cuttings of that portion of the face of the cam which engage the spring of a line will depend, of course, upon its combined tens and units designation, having in mind the fact that a pulse must be produced for each relay that must be operated. Thus, if the line has a 1 for its tens digit there will be a cutting in position 4 of the surface of the line cam contiguous to the engaging spring in order to produce a pulse that will operate relay 1121 in the manner to be described hereinafter, while if it has the digit 3 for its tens designation, the cam will be cut in positions 4 and 5 to cause the operation of relays 1121 and 1122. On the other hand, if the tens digit is 7, there will be a cutting in position 5 and another cutting in position 7 to cause the operation of relays 1122 and 1125, while if the tens digit is 9 there will be a cutting in positions 6 and 7, respectively, to cause the operation of relays 1124 and 1125. In a similar way, the cuttings 8 to 11, inclusive, are reserved for the units digit. Position 8 is for a pulse that will operate relay 1131, position 9 for one that will operate relay 1132, position 10 for relay 1134 and position 11 for relay 1135. The cuttings for each digit are provided, of course, singly or in combinations of two or three depending upon the digit to be recorded. In other words, the line cutting on the cam is in accordance with the following code:

Tens digit	Conducting positions on line cam	Relays operated
0	None	None
1	4	1121
2	5	1122
3	4-5	1121-1122
4	6	1124
5	7	1125
6	4-7	1121-1125
7	5-7	1122-1125
8	4-5-7	1121-1122-1125
9	6-7	1124-1125

Units digit	Conducting positions on line cam	Relays operated
0	None	None
1	8	1131
2	9	1132
3	8-9	1131-1132
4	10	1134
5	11	1135
6	8-11	1131-1135
7	9-11	1132-1135
8	8-9-11	1131-1132-1135
9	10-11	1134-1135

It has been assumed that the calling line's tens and units digits are 6 and 3 respectively. Hence the left lower portion of cam 1303 associated with the spring connected to conductor 112 will be cut in positions 4, 7, 8 and 9. Therefore, when the switch R99 advances into position 4, the tone circuit as traced to conductor 1341 will be extended through rectifier 1209, No. 9 contacts of relay 1219, No. 5 contacts of relay 1229, conductor 1233, left lower cam of 1329, thence to left upper con-

tact of cam 1331, conductor 1342, No. 16 channel lead, conductor 1108, winding of relay 1121 to battery, operating said relay which then locks over its No. 1 contacts to ground on conductor 900. In advancing through positions 5 and 6 no circuits will be closed through cam 1303 inasmuch as there is no cutting in the portion of its surface which engages with the left lower spring. When, however, switch R99 reaches position 7 the tone circuit is extended to cam 1321 as already traced, thence over the right upper contact thereof, conductor 1345, channel conductor 13, conductor 1109, winding of relay 1125 to battery. Relay 1125 operates in this circuit and locks over its No. 1 contacts to ground on conductor 900. The operation of these two relays records the tens digit 6. When the switch R99 advances to position 8, the tone circuit previously traced to the upper spring of cam 1331 is now extended over the left upper spring of cam 1330, conductor 1352, channel conductor 20, conductor 1110, winding of relay 1131, to battery. Relay 1131 operates in this circuit and locks up over No. 1 contacts to ground on conductor 900. As the switch passes through position 9, the tone circuit is transferred to the left lower spring of cam 1330, whence it traces over conductor 1355, channel conductor 19, conductor 1113, winding of relay 1132 to battery, operating this relay, which then locks over its upper contacts to ground on conductor 900. The operation of relays 1131 and 1132 records the units digit 3.

Thus the code of the calling office and the calling line therein have their separate designations recorded in the registers of the number sender which is now ready to dismiss the finder and transmit by impulse codes the office and calling line designations over the trunk to the receiving equipment therefor at the operator's position.

Should the calling line be a party line with a tip station and a ring station, and the tip station is the one which originated the call and, therefore, the one for which two frequencies f_1 and f_2 were transmitted to the finder, then, when switch R99 passes through position 12 the second frequency f_2 passes over a circuit extending through the right upper spring of cam 1328, rectifier 1335, lower winding of relay 1336 to ground, causing this relay to operate and lock over its upper winding and contacts to ground on conductor 1338. Therefore, while the switches are passing through position 12 and if the line is a tip party line, relay 1336 will close a circuit extending from ground on its lower contacts, conductor 1357, channel conductor 23, conductor 1117, winding of relay 1118 to battery. This relay operates and locks over its top contacts to ground on conductor 900 to register in the sender the character of the calling line.

When all ten switches have reached at least as far as position 13, a circuit is closed for relay 1349 which extends from battery through the winding of said relay, upper springs of cam 1329 serially through corresponding cams in all the ten switches of the block, to ground on the upper left spring of cam 1329 of switch R99. Relay 1349 operates and closes an obvious circuit for relief relay 1349' of which there may be as many as necessary. There is one such relay 1349 for every group of one thousand lines and as many relief relays as are necessary to provide a set of contacts for each flat rate party line in the group. One contact of each set is extended to the sleeve of such a flat rate party line in the group while the other contacts in all the sets are multiplied to-

gether and extended, through a rectifier 1359, to the winding of relay 1358. Should the calling station be one located on a flat rate party line as, for example, the line represented by the upper left spring of cam 1327, the sleeve conductor would be extended via conductor 1334 to a contact on either the relief relay 1349' or relay 1349. Since these relays are operated, all flat rate sleeves would be joined and the tone current on the sleeve of the line would flow through rectifier 1359 to the lower winding of relay 1358 which would operate and lock over its upper winding and contacts to conductor 1338, and further establish a circuit which extends from ground on its lower contacts, conductor 1360, channel conductor 22, conductor 1119, winding of relay 1120 to battery. Relay 1120 operates and locks over its top contacts to ground on conductor 900 to register the fact that the calling line is a flat rate party line. Relay 1349' closes a circuit over its lower contacts to the magnets of each of the switches via parallel paths thereto over the left lower springs of cam 1301 of each of the switches thereby causing the switches to advance out of position 14 into position 18. Upon the switches leaving position 15, relay 1349 will release and, also, the relief relay 1349'.

When all ten switches have reached at least as far as position 16, ground is connected to conductor 1351 from the left upper spring of cam 1329 of the last switch, serially through the right springs of corresponding cams in the entire switch block. The path is then extended through channel conductor 21, conductor 1237, winding of relay 911 to battery. Relay 911 operates and locks over its No. 3 inner set of contacts to ground on conductor 900. The further functions of this relay will be discussed shortly except to note the fact that its operation will release relays 1200 and 1202 to cause the two frequencies to be removed from the line and, therefore, from the sleeve conductor.

As the switches advance through position 17 over circuits completed by cams 1300, the operating winding of the thousands relay 1219 is again connected to the sleeve of the line from which, as already stated, the alternating current has been removed. Beyond position 17 ground is removed from holding conductor 1338 which causes all the relays locked thereto to release. When the thousands relay 1219 releases, a series circuit is completed extending from ground on the No. 1 back contacts of relay 1210, serially through similar contacts of the other thousands relay including relay 1219, conductor 1246, left upper spring of cam 1301 in all the switches of the group which were rotated, that is, switches R90 to R99, the windings of their separate magnets to battery. The magnets now operate to return their respective switches to position 1. As the switches leave position 18, relay 1230, which was provided with an auxiliary operating path over conductor 1247 to ground through the right springs of cam 1302, releases, in turn removing guard ground from the timing circuit 1356 which restores to normal, and also releasing relay 1201. With relays 1230, 1200 and 1202 released the connector channel is free to join once more a number sender connected to a trunk and a number finder taken into operation for locating the sleeve of a calling line in the manner described.

If any switch is moved off normal by hand, or if it stays off normal an undue length of time on account of a trouble condition, relay 1230 will,

of course, operate and hold over conductor 1247 in turn holding the channel busy by keeping relay 1201 operated which, in turn, removes operating ground for all sender connecting relays 1202. The time alarm circuit 1356 is not disconnected in this case since ground is maintained over conductor 1236 by relay 1230. This time alarm circuit may be adapted to restore the switches to normal after a desired interval and sound an alarm to indicate the abnormality of the switches. Since such timing devices are old expedients in the electrical arts, no specific design is disclosed.

It will be recalled that the grounding of conductor 1237 resulted in the operation of relay 15 911. Upon operating, this relay together with relay 912, bridge the winding of relay 914 across conductors 901 and 902 via the No. 2 contacts of the former relay and No. 4 normal contacts of the latter, respectively. Inasmuch as relay 110 in the trunk is in an operated condition, relay 914 in the sender and relay 102 in the trunk are serially connected over the following circuit path: battery through the lower winding of relay 102, No. 2 back contacts of relay 103, No. 1 front contacts of relay 110, conductor 113, brush 506, conductor 531, right springs of cam 611, brush 555, conductor 901, No. 2 contacts of relay 911, winding of relay 914, No. 4 normal contacts of relay 912, conductor 902, brush 554, right contacts of cam 612, brush 505, conductor 114 to ground on the No. 5 back contacts of relay 103. Relay 914 closes an obvious circuit for relay 913 which operates, in turn closing an obvious circuit for relay 912 which also operates and then locks over its No. 3 contacts to ground on conductor 900. The operation of relay 912 opens the operating circuit of relay 914 at its No. 4 back contacts, but inasmuch as relay 913 is operated, the circuit of relay 914 is now maintained over the No. 3 front contacts of relay 913, No. 4 front contacts of relay 912 to conductor 902.

The operation of relay 102 in the trunk circuit causes it to be locked over its upper winding and contacts to ground on conductor 130, connected thereto by the lower contacts of relay 107. It further closes a circuit for trunk lamp 104 which may be traced from ground through lamp 104, No. 3 contacts of relay 103, lower contacts of relay 102, No. 2 contacts of relay 101 to battery. Lamp 104 lights as a signal to the operator that a subscriber's line has been extended to the trunk and that service is awaited thereon.

The operator plugs the answering plug 201 of the special service cord 200 into the trunk answering jack 102, as a result of which relay 103 in the trunk and relay 202 in the cord operate in series over the following circuit: ground through the winding of relay 103, sleeves of the jack 122 and cord plug 201, winding of relay 202, conductor 208, No. 1 contacts of relay 203 to battery. Relay 202 operates, connects battery to its own winding through its No. 3 contacts thereby making it independent of the battery on the No. 1 contacts of relay 203, and further connects ground on the No. 4 contacts of relay 205 and through its own No. 2 contacts to starting conductor 206, which completes a circuit through release key 207 and winding of relay 203 to battery. Relay 203 operates, disconnects battery from conductor 208, and connects ground to conductors 209 and 211 through its Nos. 3 and 2 contacts, respectively. Relay 103 in the trunk, upon operating, extinguishes the trunk lamp 104 by opening its No. 3 contacts and trans-

fers conductors 113 and 114 to the tip and ring of the trunk over its No. 2 and No. 5 front contacts, respectively. On the tip side of the trunk the path extends over the tip of the plug 201, conductor 212, No. 2 back contacts of relay 205, conductor 214, No. 1 back contacts of relay 216, winding of positively polarized relay 217, winding of negatively polarized relay 218, winding of marginal relay 219, No. 2 back contacts of relay 216, conductor 220, No. 3 back contacts of relay 205, conductor 213, rings of the cord plug 201 and jack 122, No. 5 front contacts of relay 103 to conductor 114. Now inasmuch as relay 914 in the sender is serially connected with conductors 113 and 114 the entire loop is devoid of any current source whereupon relay 914 releases followed by the release of relay 913 which cuts off the winding of relay 914 and connects conductors 901 and 902 (connecting with conductors 113 and 114, respectively) to the contacts No. 2 and No. 5, respectively, of relay 1001 of the call indicator impulse switch 1000.

It will be recalled that when relay 1202 operated, an obvious circuit was closed for relay 1007 which operated and further closed an obvious circuit for relay 1001 which also operated. Relay 1007 further closed a circuit from ground over its No. 1 contacts, right springs of cam 1008 of the impulse switch to battery through the winding of magnet 1003. Magnet 1003 operates and moves the impulse switch out of position 1 while the ground on the left upper spring of cam 1008 will advance it to its starting position 5. Now when relay 913 releases, as a result of the dry circuit over the call indicator loop previously described, relay 1002 operates over a circuit which extends from battery through the winding of said relay, conductor 1010, No. 2 contacts of relay 912, No. 2 back contacts of relay 913 to ground. Relay 1002 operates and closes a circuit over its No. 1 contacts, lower left spring of cam 1008 to the switch magnet 1003 which, on thus remaining operated, causes the switch to continue to revolve. As the switch leaves position 17 relay 1007 releases. Relay 1001, however, remains locked to ground through the upper right and lower left springs of 1009 so that when the switch reaches position 1 after the first revolution, it is again advanced out of position 1 to rotate for a second revolution. As it leaves position 10 in the second revolution, relay 1001 releases so that the switch stops at the end of this revolution.

As the switch revolves through two revolutions it sends out a train of light positive and light and heavy negative pulses according to the setting of the register relays of the number sender, and finishes with a heavy positive pulse. These impulses are received by relays 217, 218 and 219, relay 217 responding to positive impulses, relay 218 to negative impulses and relay 219 to heavy impulses of either polarity, although the code does not include heavy positive impulses except as a final pulse.

It is well known in the telephone art that the call indicator code consists of light positive pulses and light or heavy negative pulses under the control of the registered designation. The light positive pulses are generated by connecting ground to the ring conductor and battery through a high resistance to the tip conductor while the light negative pulses are generated by connecting ground to the tip conductor and battery through a high resistance to the ring conductor, the heavy nega-

tive impulses being generated by connecting battery through a low resistance in parallel with the battery through a high resistance to the ring conductor. The light and heavy negative impulses are used for operating the polarized relays 218 and 219 in the indicator and are transmitted on the even positions of the impulse switch, the light and heavy positive impulses are used to operate relays 217 and 219 and are transmitted in the odd positions of the impulse switch.

The train of impulses first transmitted is that for the calling office code and consists of three sets of impulses, one for each digit. Since it has been assumed that the calling codes are restricted to a total of nine and that the calling code used to illustrate the operation of the invention is nine, as designated by the operation of relays 918 and 919, the code transmitted will be for the number 009 of which the first is transmitted while switch 1003 advances through positions 5 to 8, inclusive, the second while it advances through positions 9 to 12, inclusive, and the third while it advances through positions 13 to 16, inclusive, of its first revolution. Since for the first two codes only the digit 0 will be displayed, only four light negative impulses will be transmitted to operate relay 218 and no digit impulses (heavy negative and light positive) will be transmitted.

Therefore when switch 1003 is in position 5 no impulse will be transmitted, but in position 6 battery through high resistance 1005 is connected over the springs of cam 1011, conductor 1012, No. 3 back contacts of relay 913, No. 4 front contacts of relay 912, conductor 902, thence as previously traced through the windings of relays 217, 218 and 219, over conductor 901, No. 2 contacts of relay 911, No. 1 contacts of relay 912, No. 1 contacts of relay 913, conductor 1013, upper springs of cam 1014, upper springs of cams 1015 to ground. Relay 218 operates. The circuit above traced is further closed in positions 8, 10 and 12 causing relay 218 to operate four times to perform functions noted hereinafter.

The positions 13 to 16, inclusive, are reserved for the transmission of the code of the third digit of the office designation, in this case digit 9, which consists of a light negative pulse in position 14, a light positive pulse in position 15 and a heavy negative pulse in position 16. Consequently when the switch reaches position 13, conductor 1013 is open so that no pulse circuit is completed. In position 14, ground is connected to conductor 1013 over the previously described path and battery through high resistance 1005 is connected to conductor 1012 also over the previously described path, thus completing the light negative pulse loop that results in the operation of relay 218. In position 15 a light positive pulse is transmitted so that ground is connected to conductor 1012 via the left springs of cam 1015 and left springs of cam 1011 while light battery is connected to conductor 1013 via battery through high resistance 1006, left springs of cam 1016, conductor 1017, No. 3 contacts of relay 919 which is operated, conductor 1021, springs of cam 1020, No. 4 front contacts of relay 1007 and No. 2 front contacts of relay 1001. Since the loop is closed through the pulse relays 217, 218 and 219 of which relay 217 is positively polarized, this relay will operate on the positive pulse to perform functions hereinafter described.

As the switch advances into position 16 wherein a heavy negative impulse is to be transmitted, the previously described light negative circuit path is again closed, but to the light battery connected

to conductor 1012 there is paralleled battery through low resistance 1004 via the upper and lower right springs of cam 1020, No. 3 contacts of relay 1002, lower springs of cam 1022, conductor 1023, No. 1 contacts of relay 918 which is operated for the digit 9, conductor 1018, springs of cam 1019, No. 5 front contacts of relay 1007 to resistance 1005 which is connected as previously traced to conductor 1012. Since this pulse current is heavy, relays 218 and 219 operate to perform functions noted hereinafter.

The next four pulse positions 17 to 20, inclusive, of the first revolution are reserved for a party letter designation, if any there be, and which would be recorded on relay 1118 or an indication of a flat rate party, in which event the indication would be recorded on relay 1120. Since it has been assumed that the calling line is not a party line but an individual line, relays 1120 and 1118 will be normal in which case the 0 digit code will be transmitted and consisting, as before stated, of two light negative pulses in positions 18 and 20 over a previously traced path causing relay 218 to operate twice.

The code of the thousands digit 9 of the subscriber's number is transmitted in positions 1 to 4, inclusive, of the second revolution of switch 1003, and it will be remembered that on this second revolution relay 1007 is in a released position (it having been released in position 18 of the first revolution) and that relay 1001 will release in position 11 of the second revolution. The code of the thousands digit 9 is a light negative pulse in position 2, a light positive pulse in position 3 and a heavy negative pulse in position 4. Consequently in position 1 the pulsing loop is open, in position 2 the previously traced light negative circuit path is closed which results in the operation of relay 218; in position 3, the positive pulse circuit, which consists of a ground on conductor 1012 and battery through high resistance on conductor 1013, is closed by connecting ground to conductor 1012 via the left springs of cam 1015 and left springs of cam 1011, and battery through high resistance 1006 via the left springs of cam 1016, conductor 1017, No. 2 front contacts of relay 1104 which is operated for digit 9, conductor 1025, left upper spring of cam 1023, right lower spring of cam 1024, No. 4 back contact of relay 1007, No. 2 front contacts of relay 1001 to conductor 1013. The pulse causes the operation of positively polarized relay 217. A heavy negative pulse is transmitted in position 4 and, therefore, to the battery through high resistance 1005 which is connected to conductor 1012 in position 4 there is paralleled battery through low resistance 1004 via the No. 4 front contacts of relay 1001, No. 3 front contacts of relay 1002, right lower and left upper springs of cam 1022, conductor 1026, No. 3 front contacts of relay 1105, back contacts of relay 1102, lower springs of cam 1027, No. 5 back contacts of relay 1007, to resistance 1005. Relays 218 and 219 both operate on this pulse.

The hundreds digit is also 9 and its code is the same as above but is transmitted in positions 5 to 8, inclusive; the light negative pulse path being closed in position 6 as already traced; the following light positive pulse path is closed in position 7, ground being connected to conductor 1012 as before and battery being connected to conductor 1013 via high resistance 1006, left springs of cam 1016, conductor 1017, No. 2 front contacts of relay 1114 which is operated for the hundreds digit 9, lower left spring of cam 1023, right spring

of cam 1024, No. 4 back contacts of relay 1007, No. 2 front contacts of relay 1001, to conductor 1013. Relay 217 operates on this pulse. In position 8 a heavy negative pulse is transmitted, battery through low resistance 1004 being paralleled to battery through high resistance 1005 of the light negative pulse path, via the No. 4 front contacts of relay 1001, No. 3 contacts of relay 1002, lower right and upper left springs of cam 1022, conductor 1026, No. 3 contacts of relay 1115 which is operated for the digit 9, No. 2 back contacts of relay 1112, left upper and right springs of cam 1027, No. 5 back contacts of relay 1007 to resistance 1005. Relays 218 and 219 operate on this pulse.

The tens digit code is transmitted in positions 9 to 12, inclusive. The code of the digit 6 is light positive, transmitted in position 9, light negative transmitted in position 10, and heavy negative transmitted in position 12. In position 9, therefore, previously traced ground is connected to conductor 1012, and battery through high resistance is connected to conductor 1013 via resistance 1006, upper springs of cam 1016, conductor 1028, No. 2 front contacts of relay 1121 which is operated for the tens digit 6, No. 2 back contacts of relay 1124, lower springs of cam 1024, No. 4 back contacts of relay 1007, No. 2 front contacts of relay 1001, to conductor 1013. Positively polarized relay 217 operates on this pulse. In position 10 the usual light negative pulse path is closed, resulting in the operation of relay 218. As the switch 1003 advances out of position 10, relay 1001 releases, and in position 11 no pulse is transmitted. In position 12 a heavy negative pulse is transmitted over a circuit completed by paralleling battery through low resistance 1004 to battery through high resistance 1005 of the light negative pulse path. This connection is made via the upper and right lower springs of cam 1020, No. 3 contacts of relay 1002, right lower and left upper springs of cam 1022, conductor 1026, No. 3 front contacts of relay 1125 which is operated for digit 6, No. 2 back contacts of relay 1122, left upper spring of cam 1029, cam 1027 and right spring thereof, No. 5 back contacts of relay 1007, to resistance 1005. On this heavy negative pulse relays 218 and 219 operate.

The code of the units digit is transmitted in positions 13 to 16, inclusive. The units digit of the calling number was assumed to be 3 and the code of this digit is a light positive pulse in position 13, a heavy negative pulse in position 14 and a light negative pulse in position 16. Hence, when switch 1003 reaches position 13, ground is connected to conductor 1012 in the usual manner and battery through high resistance 1006 is connected to conductor 1013 via the upper springs of cam 1016, conductor 1028, No. 2 front contact of relay 1131 which is operated for the units digit 3, No. 2 back contact of relay 1134, right lower spring of cam 1023, right lower spring of cam 1024, No. 4 back contacts of relay 1007, upper springs of cam 1014 to conductor 1013. Positively polarized relay 217 operates on this pulse.

In position 14 a heavy negative pulse is transmitted by paralleling battery through low resistance 1004 to the regular battery through high resistance 1005 of the light negative impulse, via the left upper and right springs of cam 1020, No. 3 contacts of relay 1002, right springs of cam 1022, conductor 1030, No. 2 back contacts of relay 1135, No. 2 front contacts of relay 1132 which is operated for the units digit 3, left lower spring

of cam 1029, right spring of cam 1027, No. 5 back contacts of relay 1007 to resistance 1005. Relays 218 and 219 operate on this heavy negative pulse. No pulse is transmitted in position 15, but in position 16 the usual light negative pulse circuit path is closed through resulting in the operation of relay 218.

The complete office and line designation pulse codes have been transmitted by the time that switch 1003 has passed position 16 of the second revolution. In position 18 a final heavy positive pulse is transmitted for signaling purposes, the path of which is closed from ground on the left springs of cam 1031, No. 5 back contacts of relay 1001, conductor 1012, thence as traced through the pulse loop back to conductor 1013, No. 2 back contacts of relay 1001, left springs of cam 1020, low resistance 1004 to battery. This pulse will cause both relays 219 and 217 to operate as an indication that impulse transmission is complete, and these relays will, in response, perform functions to be noted hereinafter.

Impulse switch 1003 will complete the second revolution by virtue of the ground supplied through the upper springs of cam 1008 through position 20½. However, since relay 1007 is now released, there is no starting circuit for another revolution of the switch.

The train of pulses transmitted by switch 1003 operates relays 217, 218 and 219 in the combinations required for each pulse code to register the corresponding digit. It will be recalled that the office code was transmitted in the form of three digits 0—0—9, that the zero code pulse consists of two light negative pulses (four in all for two zeros) and a light negative, light positive and heavy negative pulse for the digit 9.

The first time that relay 218 operated in response to a light negative pulse, it closed a circuit from grounded conductor 209 over its contacts, the No. 4 back contacts of relay 216, No. 2 normal contacts of relay 221, winding of relay 221, resistance 223, to battery. Relay 221 operates in this circuit, locks through its No. 2 contacts to ground on conductor 209 and, at the same time, relay 222 is short-circuited by ground on both sides of its winding, one side through its own No. 2 back contacts, No. 4 back contacts of relay 216 to the contacts of relay 218, and the other side through the No. 2 front contacts of relay 221. When the pulse terminates, ground is removed over the contacts of relay 218 and relay 222 now operates in series with resistance 243 to ground on conductor 209. When relay 218 operates again on the second light negative pulse, relay 221 is short-circuited by the pulse ground traced through the No. 2 front contacts of relay 222 to resistance 223, whereupon relay 221 releases and relay 222 is held to the pulse ground until the negative pulse terminates.

Through this cycle of operations of relays 221 and 222 for each pair of light negative pulses per code, the contacts of relay 219, responsive to the heavy negative pulse, and relay 217, responsive to the light positive pulse, are connected to numerical register relays over paths completed through a train of steering relays which follow the pulsing operations of relays 221 and 222.

Thus, for each set of two negative impulses per digit, relays 221 and 222 operate and release. Now, as already noted, a light positive impulse may be transmitted either before the first negative impulse or between the two negative impulses and this positive impulse and the heavy negative impulses serve to operate the lamp reg-

isters. The first time that relay 221 operates, a circuit is closed from battery through the winding of relay 224, No. 3 back contacts of relay 225, No. 3 contacts of relay 221 to grounded conductor 209. When relay 221 releases at the termination of the digit, the locking circuit closed by relay 224, which extends from battery through the winding of relay 224, winding of relay 225, No. 2 front contacts of relay 224 to grounded conductor 209, becomes effective and relay 225 operates. At each operation of relay 221, one pair of the transfer relays is operated, relays 224 and 225 being operated following the reception of the first office code digit, relays 226 and 227 following the second office code digit, relays 228 and 229 following the third office code digit, relays 230 and 231 following the stations digit, relays 232 and 233 following the thousands digit, relays 234 and 235 following the hundreds digit, relays 236 and 237 following the tens digit and relays 238 and 216 following the units digit. Each of the seven registers (excluding the stations register) consists of four relays which, when operated in the appropriate combination by the heavy negative and positive impulses of a digit code, will close through the circuit of a lamp in the group reserved for that particular digit, except that the lamp for the digit zero for which the impulse code contains no light positive or heavy negative impulses will be closed through with none of the registers operated. Thus, the transmission of the pulse codes for the two zero digits of the office code resulted only in the operation of the transfer relays 224 to 227, inclusive, whereupon no circuits were completed for any of the relays of the first and second office code digit registers shown in Fig. 7 since the operation of each of the relays therein shown depends upon either a heavy negative impulse, that is, upon the operation of relay 219, or a light positive pulse, that is, upon the operation of relay 217. It will be recalled, however, that the code of the office digit 9, which is the digit of the assumed office from which the subscriber 9963 originated the call used to describe and illustrate the operation of the invention, contains a first light positive pulse followed by a heavy negative pulse. The light positive pulse, following as it does a preceding negative impulse, causes the operation of relay 217 when relay 228 is operated and relay 229 is short-circuited, whereupon a circuit is completed for relay 700 extending from battery through the winding of relay 700, conductor 702, No. 4 back contacts of relay 230, No. 4 front contacts of relays 228 and 226, No. 1 front contacts of relay 221, contacts of relay 217 to ground on conductor 209. Relay 700 operates and locks over its No. 2 contacts, conductor 703, No. 3 front contacts of relay 226, to ground on conductor 239. On the following heavy negative pulse, relay 222 will be operated in addition to relay 221 so that, upon the energization of marginal relay 219, a circuit is completed for relay 701 extending from battery through the winding of said relay, conductor 704, No. 2 back contacts of relay 229, No. 2 front contacts of relays 227 and 225, No. 1 front contacts of relay 222, contacts of relay 219 to ground on conductor 209.

The code of the stations digit which follows that of the last digit of the office code is, of course, two light negative impulses since it was assumed that the calling line 9963 was an individual line. Therefore, these two impulses only

resulted in the operation of the transfer relays 231 and 230.

The code of the thousands digit 9 of the subscriber's number is the same as that for the office code digit of similar value and, therefore, on the light positive pulse following the first light negative, a circuit is completed for relay 800 extending from battery through the winding of said relay, conductor 802, No. 4 back contacts of relay 234, No. 4 front contacts of relays 232 and 230 and thence, as previously traced, to ground on conductor 209 through the contacts of relay 217. Relay 800 locks over its No. 2 contacts, conductor 803, No. 3 contacts of relay 230 to ground on conductor 239. In the same way, upon the reception of the heavy negative impulse a circuit is completed for relay 801 extending from battery through its winding, conductor 804, No. 2 back contacts of relay 233, No. 2 front contacts of the preceding chain of relays, contacts of relay 219, ground on conductor 209. Relay 801 then locks to ground on conductor 803.

The hundreds digit 9 has the same pulse code as the thousands digit 9 and, therefore, relays 810 and 811 corresponding, respectively, to relays 800 and 801 will operate over traced paths extending, respectively, to the No. 4 front contact of relay 234 and No. 2 back contacts of relay 235. Both of these relays now lock over conductor 813, No. 3 front contacts of relay 232 to ground on conductor 239.

The tens digit of the subscriber's number is 6 and its code is a light positive pulse followed by a light negative pulse followed by a heavy negative pulse. Since the light positive pulse precedes the first steering light negative pulse, relays 221 and 222 will both be normal and relays 236 and 237 will be deenergized. Hence, when relay 217 operates, a circuit is completed from ground on its contacts, No. 1 back contact of relay 221, No. 1 front contacts of relays 224, 226, 228, 230, 232, 234 and No. 1 back contact of relay 236, conductor 806, winding of relay 805 to battery, causing said relay to operate and lock over its No. 2 contacts, conductor 807, No. 3 contacts of relay 234 to ground on conductor 239. The heavy negative pulse follows the light negative pulse so that when relay 219 operates on this pulse a circuit is completed from ground on the contacts of relay 219, No. 1 front contacts of relay 222, No. 2 front contacts of relays 225, 227, 229, 231, 233, 235 and No. 2 back contact of relay 237, conductor 809, winding of relay 808 to battery. Relay 808 operates and locks over its No. 1 contacts to ground on conductor 807.

The units digit of the subscriber's number is 3 and its code is a light positive pulse followed by a heavy negative pulse followed by a light negative pulse. The light positive pulse precedes the first steering light negative pulse. Hence, when relay 217 operates in response to the light positive pulse, a circuit is completed from ground on the contacts of relay 217, No. 1 back contacts of relay 221, No. 1 front contacts of relays 224, 226, 228, 230, 232, 234 and 236, conductor 820, winding of relay 818 to battery. Relay 818 operates and locks over its No. 2 front contacts, conductor 821, No. 3 front contacts of relay 236 to ground on conductor 239. On the following heavy negative pulse, relay 219 will operate so that a circuit is completed from ground on its contacts, No. 1 back contact of relay 222, No. 1 front contacts of relays 225, 227, 229, 231, 233, 235 and

237, conductor 822, winding of relay 819 to battery. Relay 819 operates and locks over its No. 2 front contacts to ground on conductor 821.

With the register relays operated in response to the office code and of the calling subscriber number therein who originated the call, these relays complete circuits to lamps that will display to the operator the number 009—9963 as follows: zero lamp 705 has a circuit which traces from battery through the lamp 705, No. 3 back contacts of relay 708, No. 1 back contacts of relay 709, No. 1 back contacts of relay 710, No. 2 back contacts of relay 711, conductor 712, No. 3 front contacts of relay 226 to ground on conductor 239. The circuit for zero lamp 706 similarly traces from battery through the lamp 706, No. 3 back contacts of relay 714, No. 1 back contacts of relay 713, No. 1 back contacts of relay 715, No. 2 back contacts of relay 716, conductor 717, No. 3 contacts of relay 228 to ground on conductor 239. The circuit for the No. 9 thousands lamp 707 of the third digit office code register traces from battery through the lamp 707, No. 3 front contacts of relay 700, No. 2 front contacts of relay 701 to ground on conductor 803. The circuit of the No. 9 thousands lamp 814 of the numerical register traces from battery through the lamp, No. 3 front contacts of relay 800, No. 2 front contacts of relay 801, to ground on conductor 807. The circuit of the No. 9 hundreds lamp 815 traces from battery through the lamp, No. 3 front contacts of relay 810, No. 2 front contacts of relay 811, to ground on conductor 821. The circuit of the No. 6 tens lamp 816 traces from battery through said lamp, No. 3 front contacts of lamp 805, No. 1 back contacts of relay 823, No. 3 back contacts of relay 824, No. 2 front contacts of relay 808, conductor 825 to ground on the No. 2 contacts of relay 238. The circuit of the No. 3 units lamp 817 traces from battery through said lamp, No. 4 front contacts of relay 819, No. 1 front contacts of relay 818, No. 1 back contacts of relay 826, No. 2 back contacts of relay 827 to ground on conductor 825. These lamps which light immediately upon their respective circuits being closed, display to the operator the number 009—9963, being that of the office and number of the calling subscriber.

When relay 221 operates on the first negative pulse of the last or units digit, relay 238 is operated, closing a locking circuit through relay 216 to grounded conductor 239 which becomes effective for this set of relays upon the operation of relay 236. Relay 216, in operating, rearranges the impulsing circuit so that the negative relay 218 may respond to the final heavy positive pulse. For this purpose, the circuit extends from conductor 214, as previously traced, No. 1 front contact of relay 216, through the winding of relay 218, No. 2 front contact of relay 216, back to the ring conductor 220 instead of in series through the windings of the three pulsing relays. Relay 216 also connects resistance 240 in parallel with the winding of relay 218 to protect said relay. Since relay 216 is now operated, the operation of relay 218 connects ground from conductor 209 over the front contact of relay 218, No. 4 front contacts of relay 216, through the winding of relay 241 to battery. Relay 241 closes a locking circuit for itself through the winding of relay 242 to ground at the No. 2 front contact of relay 238. When the final heavy positive pulse is terminated, relay 218 releases and relay 242 operates, closing a circuit for relay 205 extending from ground

on its contacts, No. 2 normally made contacts of relay 205, upper winding thereof, No. 1 contacts of relay 202 to battery. Relay 205 operates, locks over its lower winding and No. 1 contacts, disconnects ground from conductor 206 which permits the restoration of the call indicator circuit at any time thereafter by operating key 207, which releases relay 203 to disconnect ground from conductor 209, transfers the tip and ring conductors 212 and 213, respectively, of the answering plug 201 from conductors 214 and 220 extending to the call indicator to the repeating coil and therethrough to the winding of relay 243.

15 Returning, now, to the number sender, when impulse switch 1003 advances to position 18 $\frac{3}{4}$, a circuit is completed for relay 915 which extends from battery through the winding of relay 915, springs of cam 1031, No. 1 back contacts of relay 1001, No. 1 contacts of relay 1002 to ground. Relay 915 operates, locks to grounded conductor 900 and removes the short circuit around the "high" resistance winding of relay 910. Thereupon relay 109 in the trunk releases, thereby completing a circuit for relay 105 extending from ground on the back contacts of relay 109, No. 3 contacts of relay 110, No. 1 contacts of relay 103, winding of relay 105 to battery. Relay 105, upon operating, disconnects relay 100 from the line and cuts the tip and ring conductors 131 and 132 straight through to the repeating coil of the cord circuit 200. Relay 105 further opens the circuit of relay 109 and grounds conductor 116, causing relay 910 to be shunted and released which, in turn, releases relay 909. A circuit is now completed for relay 907 extending from battery through its lower winding, No. 2 contacts of relay 908, back contacts of relay 909 to ground. Relay 907 operates and locks over its upper winding to conductor 904, grounded by conductor 116. Ground on conductor 904 is now connected over the contacts of relay 907 to resistance 920, the effect of which is to shunt relay 908 and cause it to release. Conductor 116 now has direct ground connected at one end of it by relay 105 in the trunk and battery through low resistance 920 at the other end of it via conductor 904 and, since this circuit path includes the serial connection of relay 628 in the link, it operates and, in turn, operates relay 629 over a previously traced path in position 6 of switch 600. Relay 629 locks over its upper winding to ground in cam 615 via the right lower spring of cam 617 and advances the switch to position 7 or 16 over a path extending from battery through the winding of magnet 600, right upper spring of cam 613, lower front contacts of relay 629, right upper spring of cam 623 to the aforetraced ground on cam 615. As the switch leaves position 6 or 15, relay 629 is unlocked at the right lower contact of cam 617, whereupon the switch is advanced to position 8 or 17 over a circuit for magnet 600 which is completed over the left upper and right lower springs of cam 608, lower back contacts of relay 629, right upper spring of cam 623 to the aforetraced ground on cam 615.

In position 8 or 17, relay 527 operates over a circuit extending from battery through the winding of said relay, right lower and left upper springs of cam 625, upper right and lower left contacts of cam 618, top back contacts of relay 627, left upper spring of cam 617 to aforetraced ground on cam 615. Relay 532 also operates in a circuit to ground as aforetraced to the right upper spring of cam 618. The operation of relay

527 completes a circuit path for the trunk selector down-drive magnet 514 extending from battery through the winding of said magnet, left springs of cam 611, bottom contacts of relay 527, right lower spring of cam 616 to ground as aforetraced at cam 615. The down-drive magnet operates and restores the selector to normal, in which position ground on commutator segment 511 traceable thereto from the off-normal ground on cam 615 via commutator 510, is further extended through the upper springs of cam 608 to the winding of switch magnet 600, thus advancing the link switch to position 9 or 18 from which it is further advanced to position 1 or 10 in the manner described when a preceding link is taken into use.

The connection is now completed from the calling subscriber's line to the position of the special service operator who has knowledge of his number and accessibility to his line over her telephone circuit OT which may be connected thereto by operating key 244.

When the operator disconnects by pulling out the cord plug 201 from the trunk jack 122, relay 103 releases, followed by relay 105 which has the effect of reconnecting relay 100 to the line. If the subscriber has restored or does so at once, relays 100 and 101 will not operate or will operate and release again, followed by relay 107 which restores all locked-up relays in the trunk and line relays 124 and 124' in the district and office selector.

If the subscriber does not restore, relays 100 and 101 will reoperate upon the release of relay 105. Relay 107, being slow to release, remains up and the trunk lamp will light again, whereupon the operator will plug the cord back into the trunk jack but will not, of course, receive another trunk indicator display. Relay 202 in the cord and relay 103 in the trunk will operate, however, when the previous display is wiped out.

When the special service operator answers a call on a special service trunk 121 with a special service cord 200, receives a call indicator display and then learns that a connection is desired which must be made through the long distance switchboard located, say, in a different exchange building, she disconnects the special service cord and reconnects the trunk with the answering plug of the recording completing cord 250, the calling plug of which is inserted in jack 331 of a recording completing trunk 350, the incoming jack 322 of which appears at the long distance position.

When this type of trunk is seized, sleeve relay 307 operates in series with cord sleeve relay 244 over an obvious circuit and grounds conductor 330. Relay 300 will operate over the line loop in the same manner as relay 100 of the special service trunk 121, whereupon an obvious circuit is completed for relay 301. Relay 301 short-circuits the "high" winding of relay 327, and grounds starting conductor 325 to the link and start circuit which starts the trunk finder of an idle link, and removes ground from the individual test conductor 315 to the links, so that the trunk finder will stop on this trunk in the manner described. The link will then ground conductor 313, operating relay 308 which locks to ground on conductor 330, removes ground from conductor 325 and reconnects ground to conductor 315. As before, the sender selector hunts an idle number sender, after the selection of which the link cuts through conductors 317, 316, 313 and 314 between the trunk and sender. Relay 309 in the trunk, relay 7

628 in the link and the low winding of relay 910 in the sender are now in series, causing relays 910 and 909 to operate and perform functions hereinbefore described to prepare the sender for connection to the number finder over the channel, to transmit the identifying tones over the trunk to the finder via the condenser in the sleeve of the recording completing cord and a condenser in the sleeve of the special service trunk, and to receive back over the channel the identifying designations of the office and calling subscriber's number therein as hereinbefore described. Thereafter, the sender bridges relay 914 across conductors 313 and 314 and, since relay 310 is operated, a series circuit is completed to relay 326 in the incoming end of the trunk at the long distance position. This circuit is as follows: battery through the upper winding of relay 326, No. 3 back contacts of relays 303, left lower winding of repeating coil 302, conductor 311, No. 3 back contacts of relay 312, conductor 318, conductor 314 to conductor 902, as previously traced, No. 4 normal contacts of relay 912, winding of relay 914, No. 2 contacts of relay 911, conductor 901 to conductor 313 as previously traced, No. 1 front contacts of relay 310, conductor 319, No. 2 back contacts of relay 312, conductor 320, left upper winding of repeating coil 302, No. 2 back contacts of relay 303, lower winding of relay 326 to ground. Relay 914 operates to function as before while relay 326 operates to close an obvious circuit for relay 321 which, in turn, operates to close a circuit for trunk lamp 304 extending from ground through the lamp filament, No. 4 contacts of relay 303, No. 2 front contact of relay 321 to battery. Upon noting the lighted lamp, the operator resets the indicator at her call indicator 400 at her position which indicator is identical in every respect to the one disclosed in Figs. 2, 7 and 8 located at the special service position and, therefore, is shown only schematically, and then inserts the calling plug 401 of cord 410 into the trunk jack 322, whereupon relays 402, 303 and 312 operate over the following series circuit path: battery on the No. 1 contacts of relay 203 in the call indicator circuit, winding of relay 402, plug and jack sleeves, winding of relay 303, winding of relay 312 to ground. Relay 402 operates and, by connecting ground to conductor 406 and thereby closing the circuit of relay 203, starts the operation of the call indicator as before described for the special service position; relay 303, upon operating, extinguishes the trunk lamp 304, while relay 312, over its No. 2 and No. 3 front contacts, transfers the incoming trunk conductors 318 and 319 from the windings of relay 326 to those of the polarized relay 323 and the tip and ring of the trunk jack whence, through the No. 1 and No. 3 back contacts of relay 411 of the cord 411, they connect to the call indicator circuit. Relay 914 in the sender releases and causes the production of call indicator pulses as before but which, in this case, are transmitted over the two-wire trunk to set the call indicator 400 in a long distance position.

The final heavy positive pulse operates relay 323 which, in turn, closes an obvious circuit for relay 324 which operates, locks to ground over its No. 2 contacts to the No. 1 contacts of relay 303 and short-circuits relay 312, by connecting ground to the ungrounded side of its winding through its No. 1 contacts. Relay 312, upon releasing, cuts the repeating coil 302 back into the incoming trunk circuit.

After the reception of the heavy positive pulse,

relay 411 in the cord 410 operates, as before, from ground on the contacts of relay 242 of the call indicator to free said indicator and to connect the tip and ring of the line to the tip and ring of the cord. The sender then releases in the manner described.

Relay 300, in the outgoing part of the trunk, provides talking battery to the calling subscriber and supervision to the operator over the switchhook as follows: as long as his receiver is off the hook, relays 300 and 301 in the outgoing trunk are operated, the low resistance winding of polarized relay 327 is bridged across the trunk inside of the repeating coil 328 through the No. 1 contacts of relay 301. Relays 326 and 321 in the incoming end of the trunk are also operated over the trunk conductors through the relay 327 and supervisory relay 412 in the cord 410 is normal. When the subscriber restores or flashes the switchhook, relays 300 and 301 in the outgoing trunk release, the high resistance winding of relay 327 is inserted across the trunk, and relay 326 in the incoming trunk is released as a consequence thereof. Relay 326 releases relay 321 and relay 412 in the cord, then operates in the circuit extending from ground through the No. 1 back contacts of relay 321, upper right winding of repeating coil 302, No. 1 contacts of relay 312, tip of trunk jack 322 and cord plug 401, No. 1 front contacts of relay 411, winding of relay 412, No. 3 front contacts of relay 411, ring of said cord plug and trunk jack, No. 4 contacts of relay 312, right lower winding of repeating coil 302, No. 2 back contacts of relay 321 to battery. Relay 412 operates to control any suitable supervisory signal.

When the long distance operator disconnects the cord from the jack, relay 303 releases, reversing the winding connections of relay 326, with the result that the polarized relay 327 releases and connects battery to conductor 317 to shunt sleeve relay 244 as a signal to the special service operator that the called end of the connection is down. If the calling subscriber has restored or does so at once, relays 300 and 301 are normal or will release. With both relays 327 and 300 normal, relay 307 releases, restoring the link circuit. If the subscriber does not restore, relays 300, 301, 307 in the outgoing trunk will remain operated and, consequently, relays 326 and 321 in the incoming trunk will remain operated also, and the release of relay 303 lights the trunk lamp 304 again. When the operator replugs into the jack, having wiped out the call indicator display, relay 402 in the cord, relay 303 in the trunk, but not relay 312 in the incoming trunk, will operate. No new display will be made, but relay 411 in the cord circuit will operate and lock when the listening key is thrown.

What is claimed is:

1. In a telephone system, the combination with a telephone line having a numerical designation and means for extending said line to an operator's position and through said position to a second operator's position, of a number finder adapted to select said calling line and produce signals characteristic of its numerical designation, a numerical register responsive to said signals for recording said numerical designation, visual display means at each of said operator's positions, and means for operating said number finder and said numerical register both in succession from each of said positions to produce a display of said designation at each of said positions subsequent to the extension of said telephone line from one position to the other.

2. In a telephone system, a calling line having an arbitrary multisymbol designation, an identifying conductor for said line, means for impressing an electric potential thereon, and a number finder for selecting said calling line through said identifying conductor comprising a plurality of circuits selectable responsive to said electric potential to designate a corresponding plurality of symbols of said designation, and impulsing means adapted with said identifying conductor to produce a plurality of groups of impulses to designate the remaining symbols of said designation.

3. In a telephone system, a plurality of telephone lines each having an arbitrary designation, a first operator's position, a second operator's position, means for extending a calling telephone line to said first operator's position, a number finder for selecting said telephone line, means in said number finder for determining the arbitrary designation of said line, a number sending means responsive to said designation determining means in said number finder for recording said arbitrary designation, means for connecting said number sending means to said first operator's position via the calling line extension thereof, means at said first operator's position for visibly indicating the arbitrary designation recorded in said number sending means, means responsive to the further extension of said calling line to said second operator's position for reoperating said number finder to select said calling line and to redetermine the arbitrary designation of said calling line, means responsive to the further extension of said calling line to said second operator's position for reoperating said number sending means to record said designation, and means at said second operator's position for visibly indicating said arbitrary designation as recorded in said number sending means.

4. In a telephone system, a plurality of telephone lines each having a multidigit designation, an identifying conductor for each of said lines, means for impressing an electric potential on the associated identifying conductor of a calling line, and a number finding circuit comprising a plurality of circuits selectable responsive to said electric potential for designating a number of digits of said designation, an impulse producing means adapted with said identifying conductor to produce a number of groups of impulses for designating the remaining digits of the designation, and a number sender connectable to said number finder responsive to said plurality of circuits and to said groups of impulses for recording therein each of the digits of said calling line.

5. In a telephone system, a plurality of groups of telephone lines, each of said lines having a numerical designation, an identifying conductor for each calling line, means for impressing an electric potential on the associated identifying conductor of a calling line, a number finder comprising an impulse producing means for each group of lines, said identifying conductors being extended and distributed in each of said impulse producing means according to its group location and according to the value of the last two digits of each of the designations, means responsive to said electric potential for recording the group including the calling line, means responsive to said operated recording means for operating the impulse producing means containing the calling line to produce a group of pulses designating each of the last two digits of the calling line

designation, and a number sender connectable to said number finder and responsive to said operated recording means and to the groups of impulses produced by said impulse means for recording the numerical designation of the group and the numerical designation of the last two digits of the calling line.

6. In a telephone system, a calling line having an arbitrary multisymbol designation, an identifying conductor for said line, means for impressing an electric potential thereon, a number finder for selecting said calling line through said identifying conductor comprising a plurality of circuits selectable responsive to said electric potential, registers connectable to said number finding circuit and responsive respectively to each of said plurality of circuits therein for recording each of the symbols of said arbitrary designation, an operator's position, means for connecting said registers to said position, a number indicating circuit at said position, and impulse means responsive to an operative connection between said registers and said operator's position for operating said number indicating circuit in accordance with the setting of said registers.

7. In a telephone system, a calling line having an arbitrary multisymbol designation, an identifying conductor for said line, a first operator's position and a second operator's position, means for impressing an electric potential on the identifying conductor of said line, a number finder circuit comprising a plurality of circuits each responsive to said electric potential, a register circuit responsive to said circuits in accordance with the symbols of said arbitrary designation, means for extending said calling line to said first operator's position, a number indicating circuit at each of said positions, means for operatively connecting said register circuit to any one of said positions, means responsive to the operative connection of said register circuit to said first operator's position for operating its associated number indicating circuit in accordance with the setting of said register circuit as determined by said number finder circuit, means for extending said calling line to said second operator's position via said first operator's position, and means responsive to said calling line extension for reoperating said number finder circuit.

8. In a telephone system, a plurality of telephone lines each having a numerical designation, an identifying conductor for each calling line, means for impressing an electric potential thereon, a number finder circuit including a plurality of impulse switches to each of which a plurality of said identifying conductors extend, said conductors being distributed and arranged in said switches in accordance with the digit grouping of each conductor, a plurality of relays each responsive to said electric potential on said identifying conductor for identifying the first and second digits of the numerical designation of said calling line, means responsive to an operation of the impulse switch containing the identifying conductor of the calling line and responsive to the potential on said identifying conductor for identifying the third and fourth digits, respectively, of the numerical designation of said calling line, and means for recording said digit identities and adapted to produce for each digit a group of impulses characteristic of the digit.

9. In a telephone system, a plurality of groups of telephone lines each having an arbitrary designation, a number finder comprising a plurality of groups of sequence switches, a test conductor

for each of said telephone lines extending to a contact of one of said sequence switches of the group reserved for a group of lines, an operator's position, means for connecting a calling telephone line to said operator's position, means responsive to an operation at said position for connecting a potential to the identifying conductor of said calling line, means responsive to the connection of said potential to said conductor for producing a group of signals characteristic of a part of said arbitrary designation and for operating the sequence switches of the calling line group in said number finder for causing the switch in the group containing the calling line conductor to produce a plurality of groups of signals characteristic of the remainder of said designation, means responsive to said signal producing means for recording all of said arbitrary designation as determined by said signals, and means responsive to said recording for transmitting over said established connection a group of impulses for each recorded part of the designation for visibly indicating said designation at said operator's position.

10. In a telephone system, a plurality of telephone lines each having an arbitrary designation, a number finder comprising a plurality of sequence switches, test conductors for said plurality of telephone lines extending to contacts of said switches, an operator's position having a connecting cord, an indicating device at said operator's position, a trunk line for connecting a calling telephone line with said operator's position, means responsive to a connection of said calling line with said trunk line and with said connecting cord for applying a source of alternating current to the test conductor of said calling line, means in said number finder responsive to said alternating current on the test conductor of said calling telephone line for producing a plurality of groups of signals characteristic of a portion of the designation of said line and for operating the sequence switch containing the test conductor for producing a number of other groups of signals characteristic of the remainder of the designation, means for recording said signals, and means responsive to said recording means for transmitting over said trunk line a plurality of groups of impulses for operating said indicating device at said operator's position to display said arbitrary designation.

11. In a telephone system, a plurality of telephone lines each having a numerical designation, an identifying conductor for each of said lines, an operator's position, a number indicating circuit at said position, means for extending a calling line to said operator's position, means for impressing an electric potential on the identifying conductor of said calling line via said position, a number finder to which said identifying conductors extend, said conductors being distributed and arranged in said number finder in groups and subdivisions thereof in accordance with each digit of the numerical designations of said telephone lines, a plurality of circuits in said number finder comprising a circuit for each group and subdivision of said lines and adapted to respond to the electric potential on said identifying conductor in accordance with the group and subdivisions of the calling line having the potential

on its test conductor, a register responsive to each of said circuits for recording the numerical designations of said group and subdivisions thereof, means for operatively connecting said register to the operator's position to which said calling line has been extended, and means responsive to such an operative connection for operating said number indicating circuit at said position from said register of said calling line test conductor for indicating at said position the numerical designation of said calling line.

12. In a telephone system, a plurality of telephone lines each having a four-digit numerical designation, an identifying conductor for each calling line, a number finder comprising a plurality of sequence switches to the contacts of which said identifying conductors are extended, said switches being arranged in as many groups as there are major divisions of said plurality of telephone lines as indicated by the various first digits of all of said numerical designations, and each of said groups of switches being further arranged so that each switch in the group accommodates a minor subdivision of one hundred identifying conductors in accordance with the second digit of all of said numerical designations, while the order of said identifying conductors on the contacts of each of said switches is in accordance with the tens and units digits of the numerical designation of the lines associated with said identifying conductors, means for applying an alternating current potential to the identifying conductor of a calling line, a plurality of circuits responsive to said potential for selecting the major and minor subdivisions and tens and units divisions of said calling line and a register responsive to each of said plurality of circuits for recording said major division and minor division and said tens and units designation as the four-digit numerical designation of said calling line.

13. In a telephone exchange system, a plurality of first offices, telephone lines terminating in each of said offices and each having an identifying conductor, a plurality of operator's positions at another office, means for establishing a connection from a line in any one of said offices to any one of said operator's positions, means responsive to the establishment of said connection for applying a potential to the identifying conductor of the calling line, a number finder in each of said first offices, means for associating the finder of an office with a calling line therein, means in said finder to produce a group of signals to identify the office of the calling subscriber and means responsive to potential on the calling line identifying conductor to produce signals characteristic of the numerical designation of the calling line therein, a plurality of register senders common to said number finder, means for associating an idle register sender with any one of said finders, means responsive to the connection of a number finder with a register sender for registering therein said office identifying and line characterizing signals, a number indicator at said operator's position, and means in said sender for transmitting impulses in accordance with the registrations therein for displaying the designation of the calling office and calling line.

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