

Dec. 30, 1941.

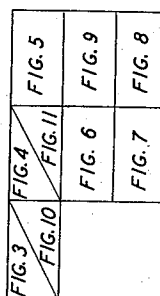
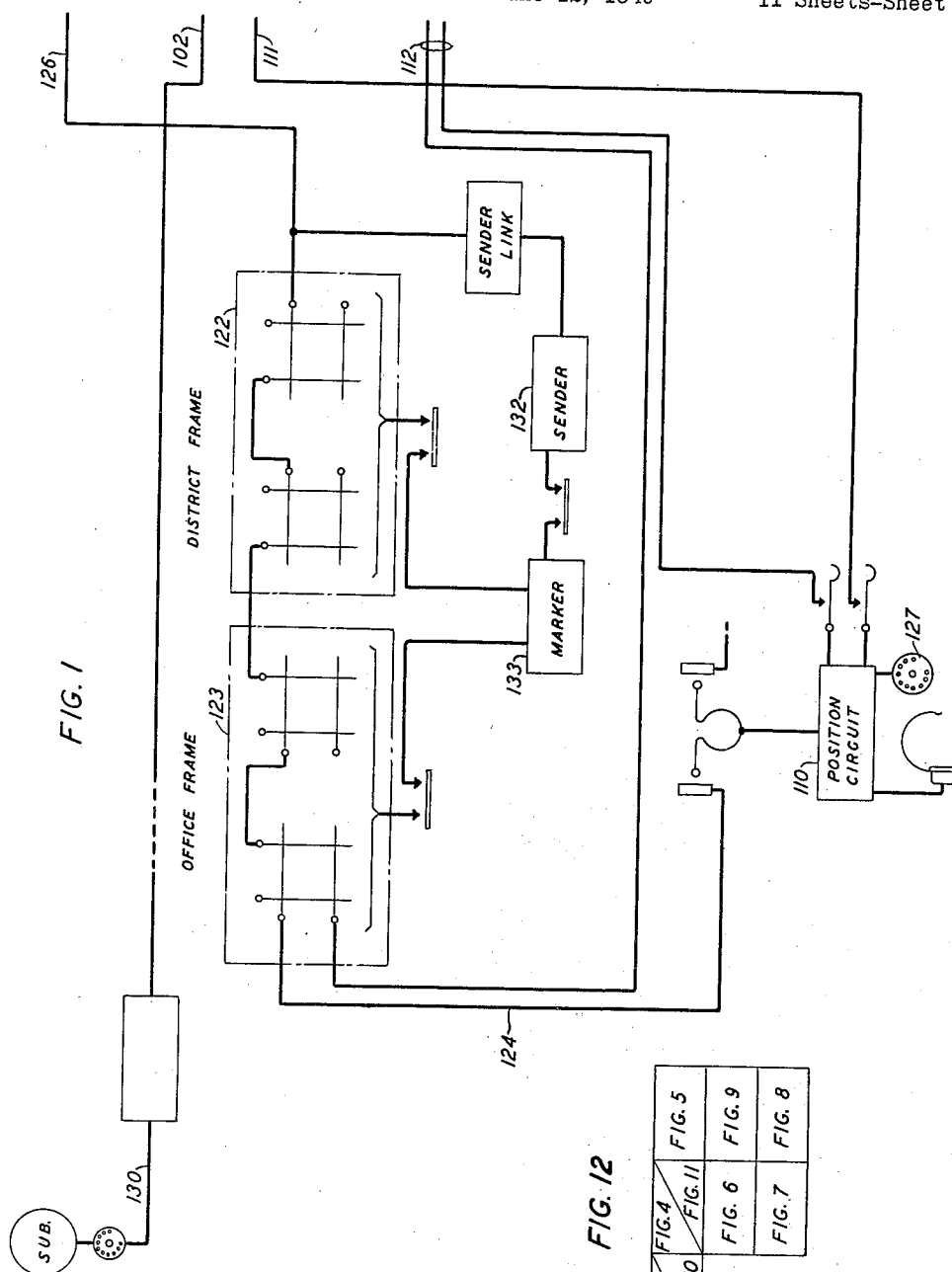
R. E. HERSEY

2,268,397

TELEPHONE SYSTEM

Filed June 12, 1940

11 Sheets-Sheet 1



INVENTOR
R. E. HERSEY

BY

W. T. McKenney
ATTORNEY

Dec. 30, 1941.

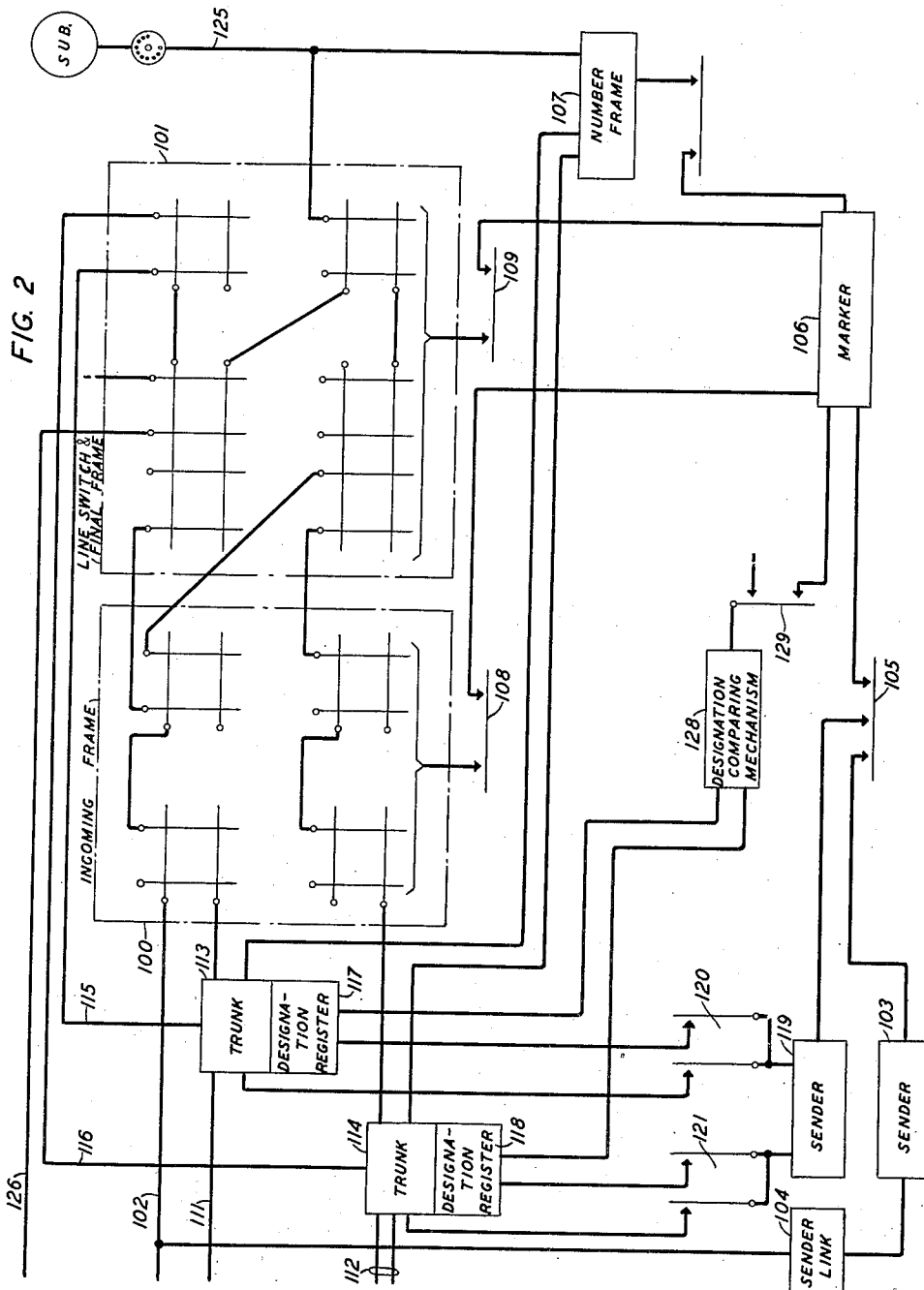
R. E. HERSEY

2,268,397

TELEPHONE SYSTEM

Filed June 12, 1940

11 Sheets-Sheet 2



INVENTOR
R. E. HERSEY
BY *W. P. McKenney*
ATTORNEY

Dec. 30, 1941.

R. E. HERSEY

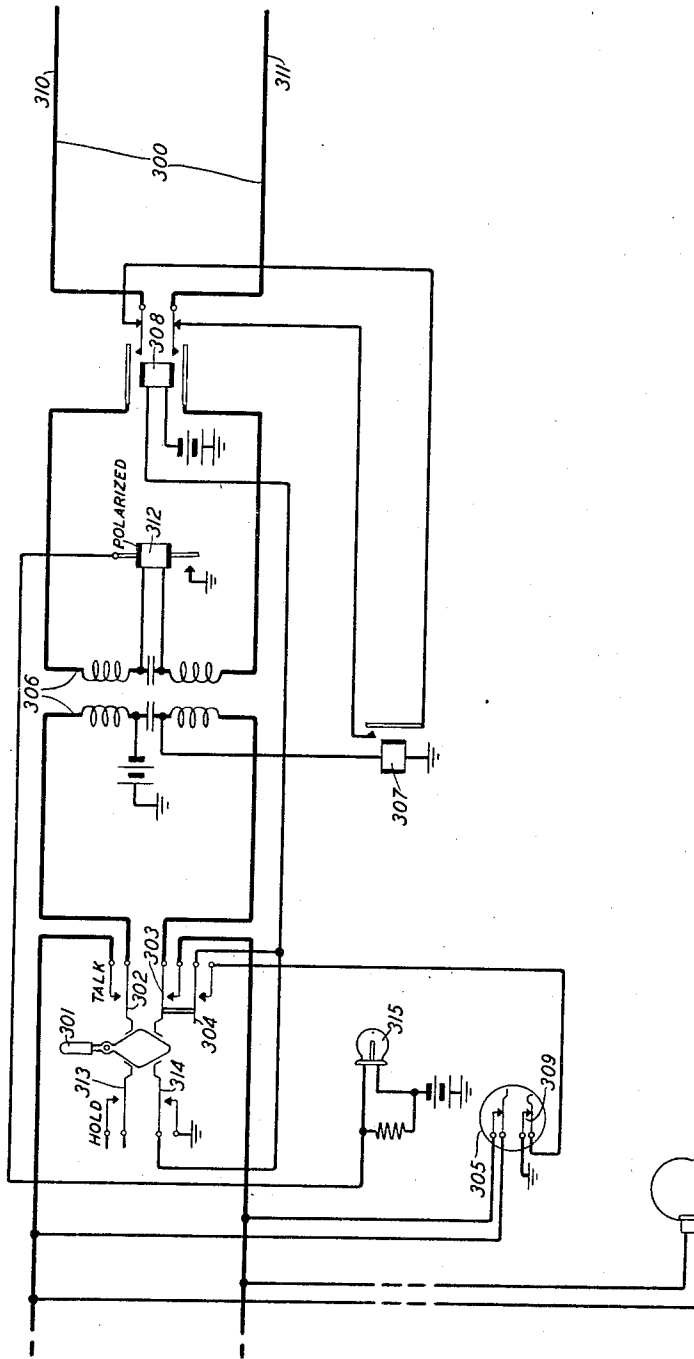
2,268,397

TELEPHONE SYSTEM

Filed June 12, 1940

11 Sheets-Sheet 3

FIG. 3



INVENTOR
R. E. HERSEY
BY *W. J. McKeenly*
ATTORNEY

Dec. 30, 1941.

R. E. HERSEY

2,268,397

TELEPHONE SYSTEM

Filed June 12, 1940

11 Sheets-Sheet 4

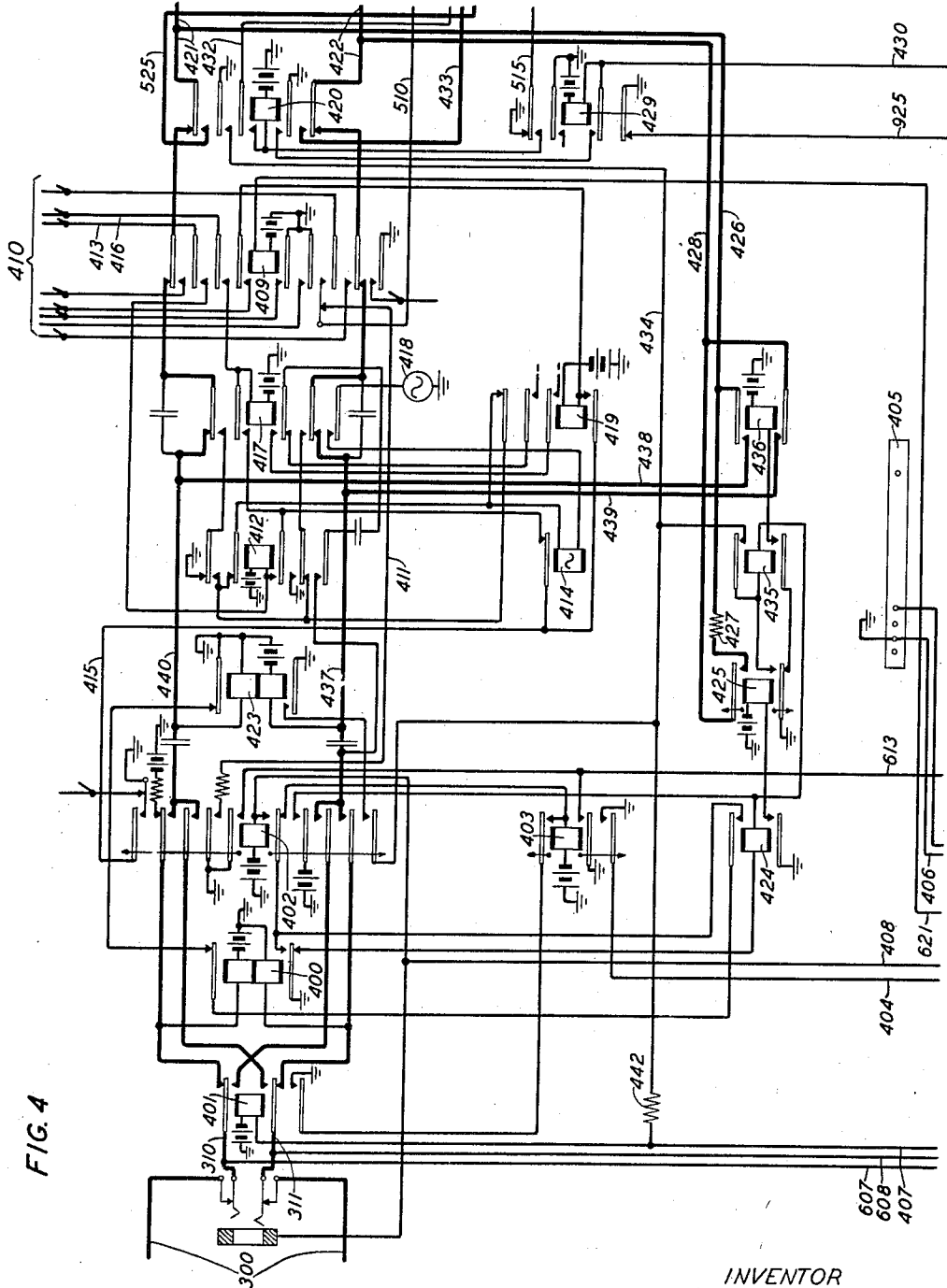


FIG. 4

INVENTOR
R. E. HERSEY
BY
W. R. McKenney
ATTORNEY

Dec. 30, 1941.

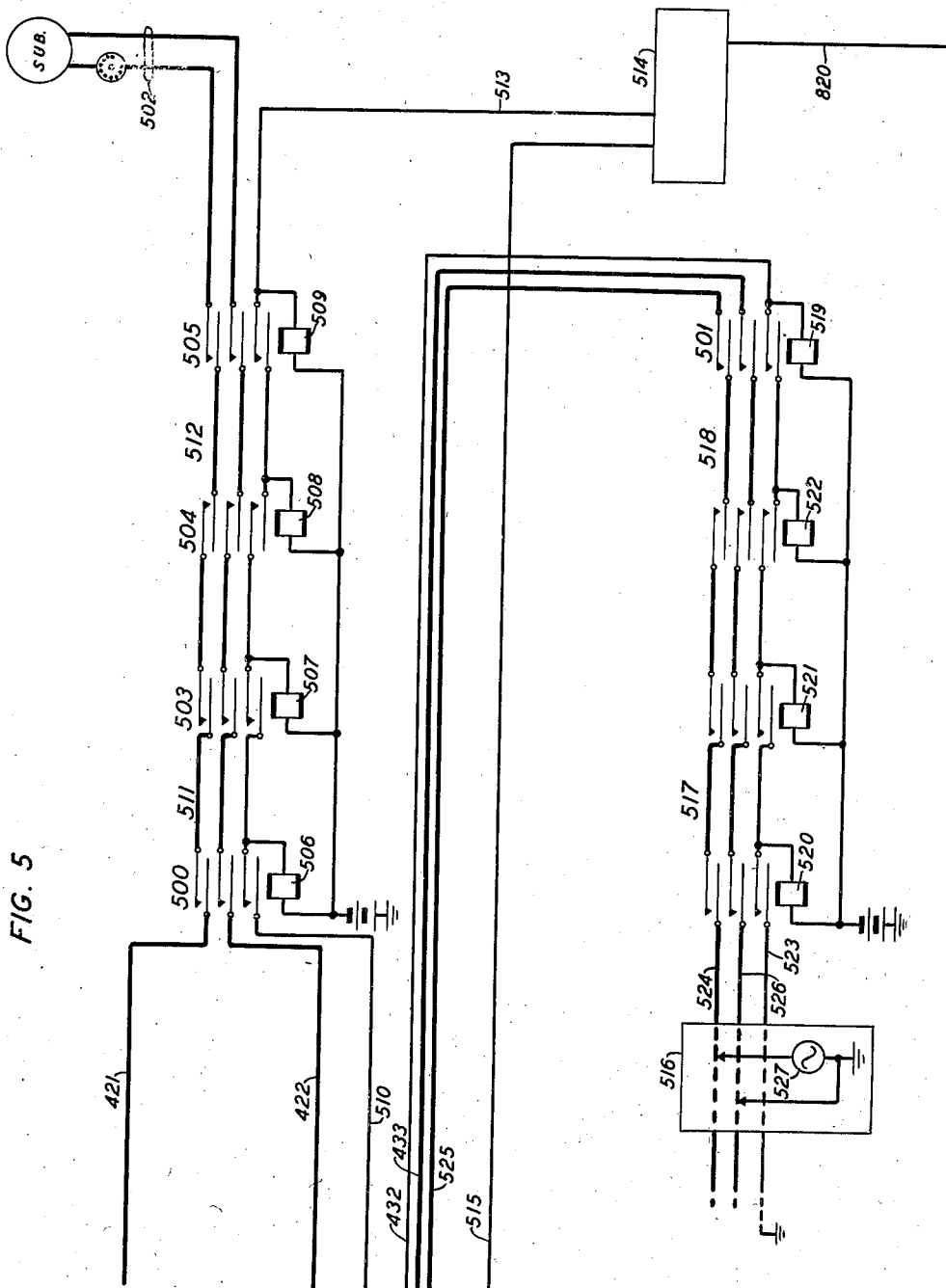
R. E. HERSEY

2,268,397

TELEPHONE SYSTEM

Filed June 12, 1940

11 Sheets-Sheet 5



INVENTOR
R. E. HERSEY
BY *W. R. McNamee*
ATTORNEY

Dec. 30, 1941.

R. E. HERSEY

2,268,397

TELEPHONE SYSTEM

Filed June 12, 1940

11 Sheets-Sheet 6

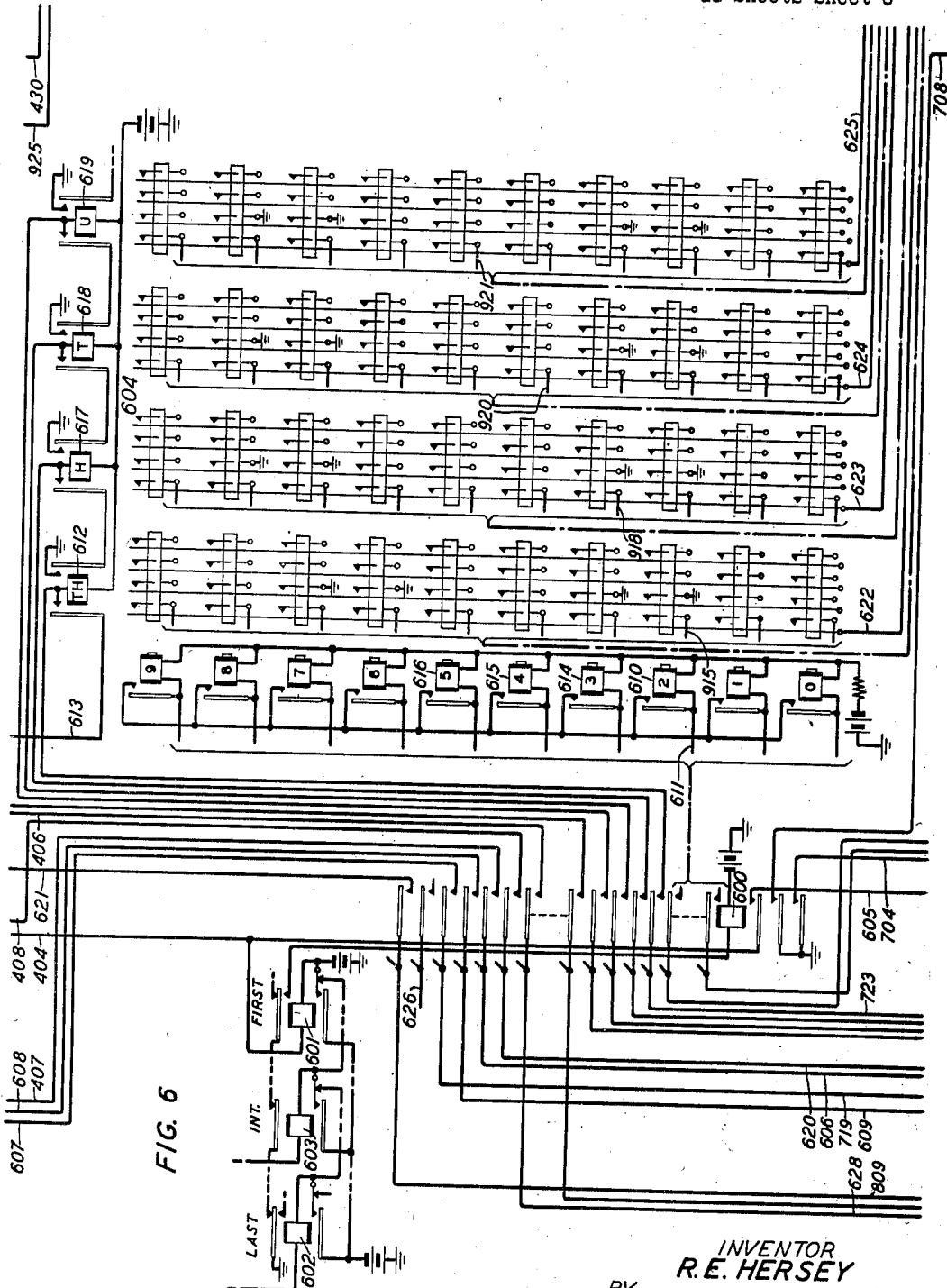


FIG. 6

INVENTOR
R. E. HERSEY
BY *W. R. McKinney*
ATTORNEY

Dec. 30, 1941.

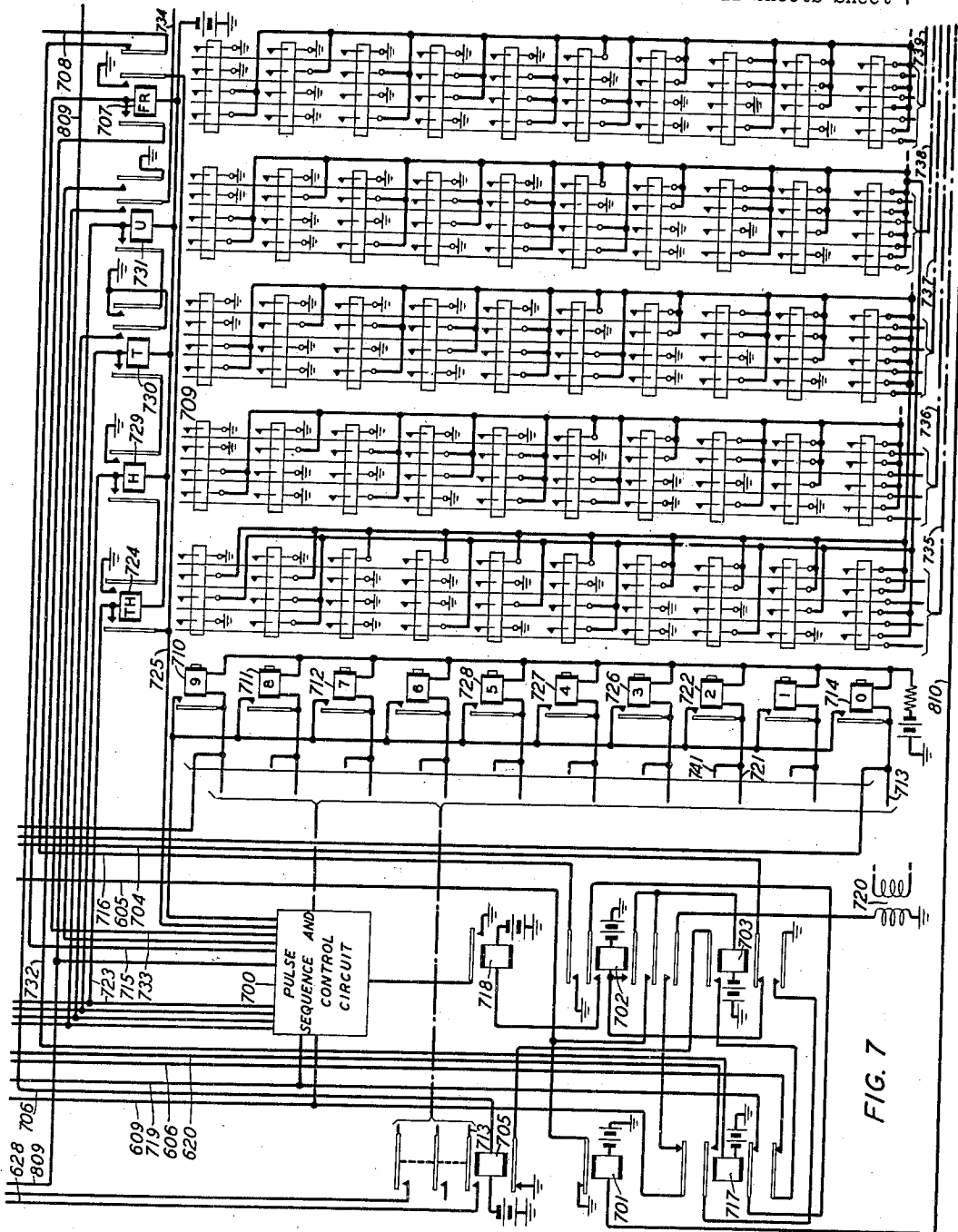
R. E. HERSEY

2,268,397

TELEPHONE SYSTEM

Filed June 12, 1940

11 Sheets-Sheet 7



INVENTOR
R. E. HERSEY
BY
W. R. McKeeney
ATTORNEY

Dec. 30, 1941.

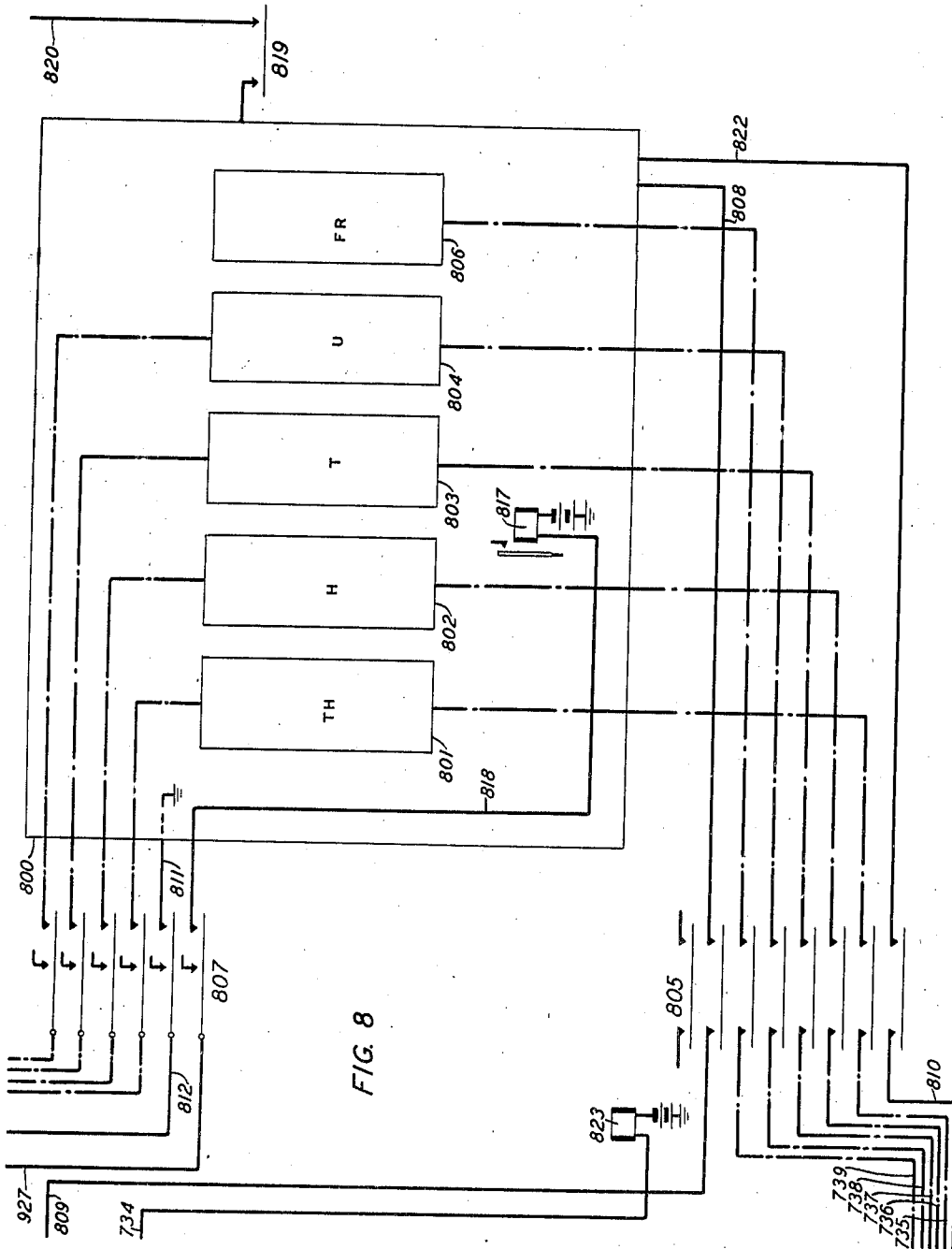
R. E. HERSEY

2,268,397

TELEPHONE SYSTEM

Filed June 12, 1940

11 Sheets-Sheet 8



INVENTOR
R. E. HERSEY
BY *Mr. McKenney*
ATTORNEY

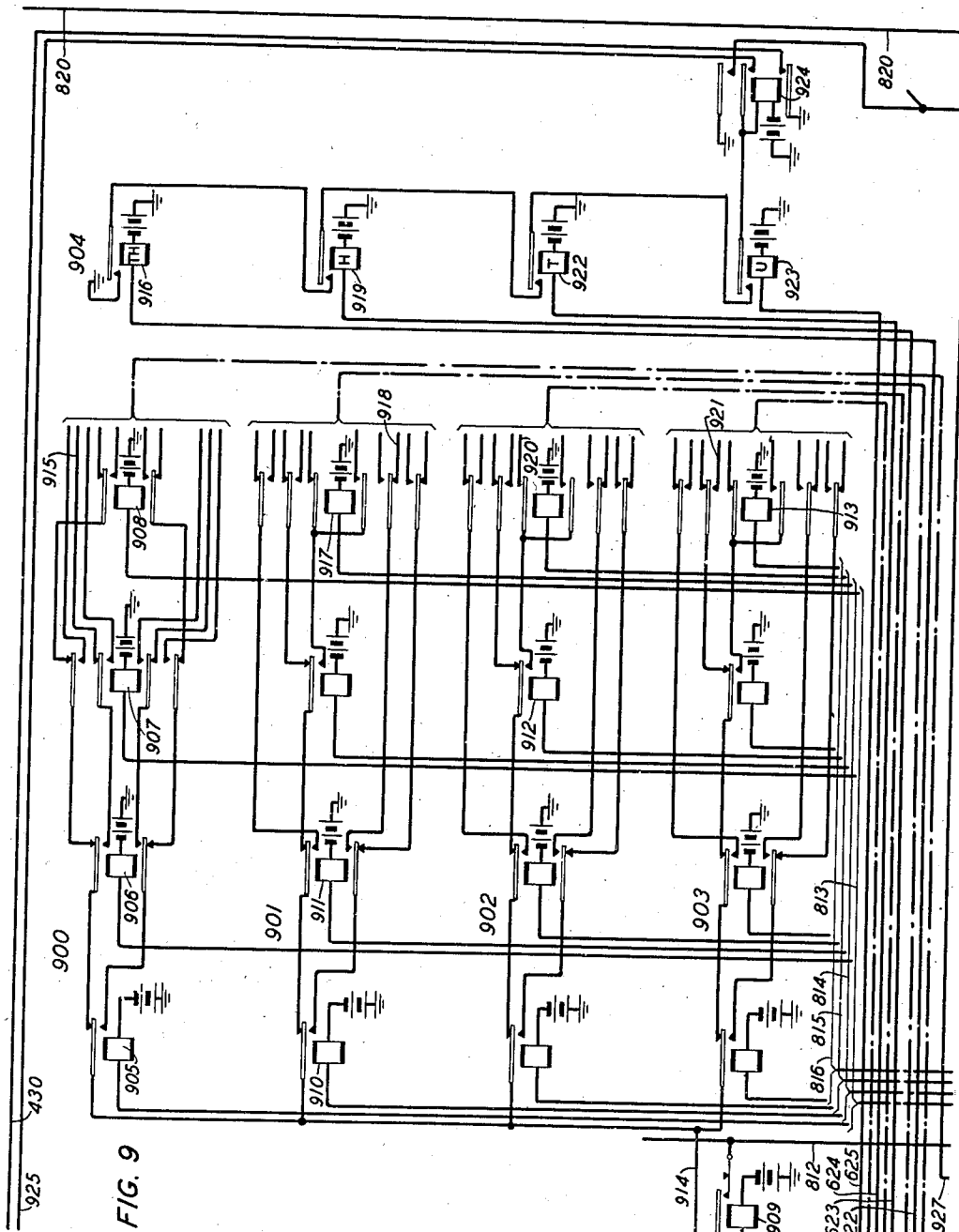
Dec. 30, 1941.

R. E. HERSEY
TELEPHONE SYSTEM

2,268,397

Filed June 12, 1940

11 Sheets-Sheet 9



INVENTOR
R. E. HERSEY
BY *W. R. McKinney*
ATTORNEY

Dec. 30, 1941.

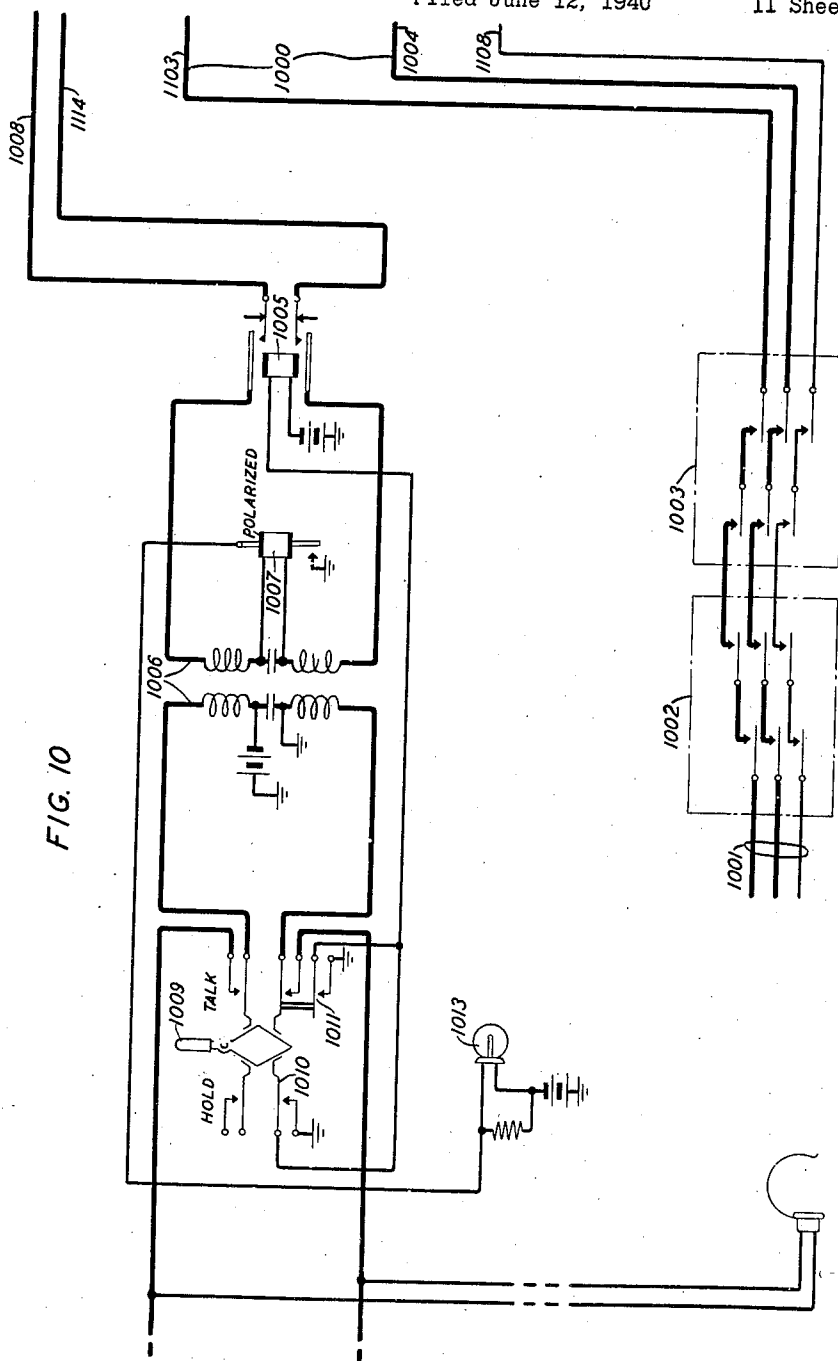
R. E. HERSEY

2,268,397

TELEPHONE SYSTEM

Filed June 12, 1940

11 Sheets-Sheet 10



INVENTOR
R. E. HERSEY
BY
W. R. McKenney
ATTORNEY

Dec. 30, 1941.

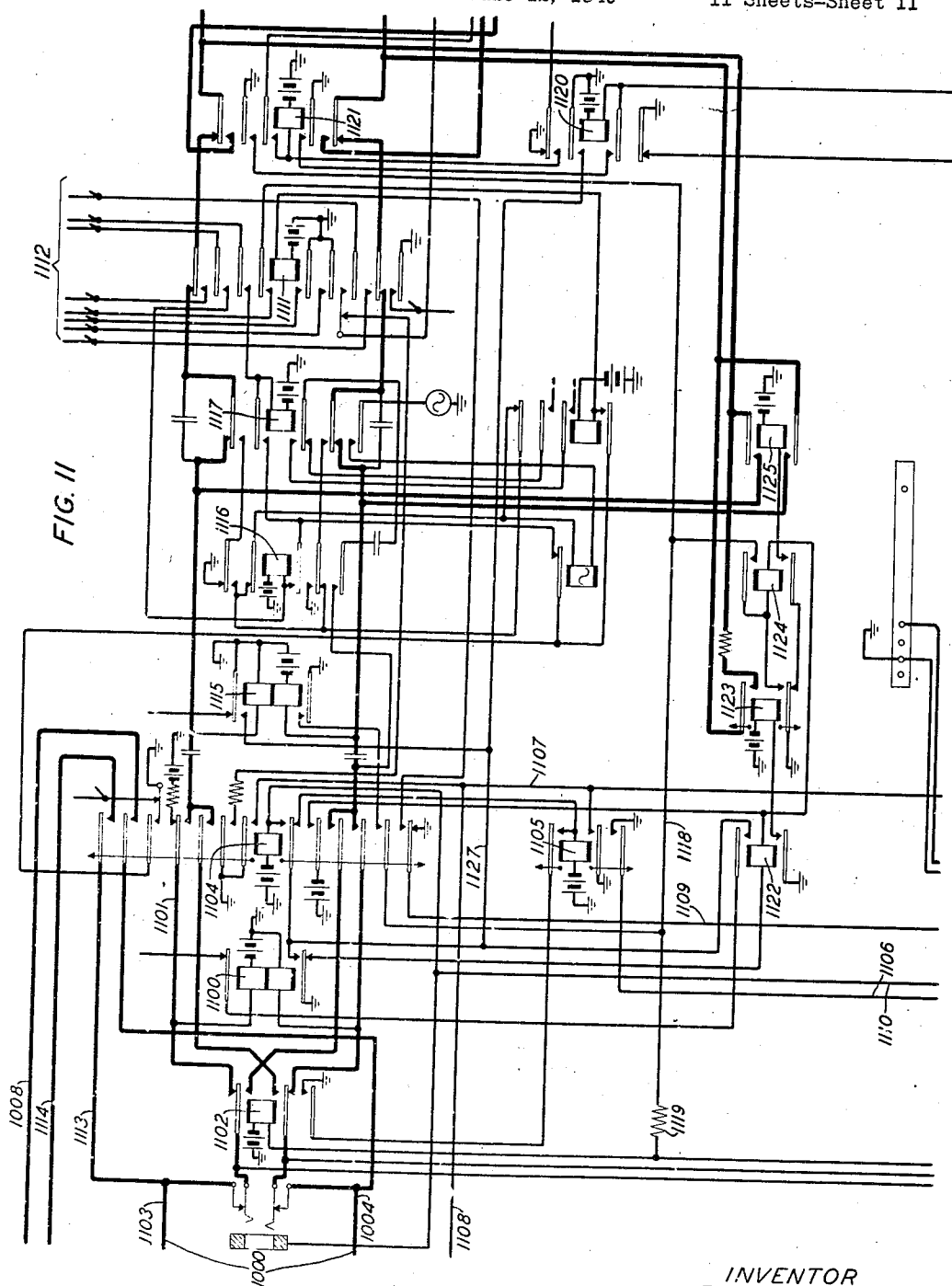
R. E. HERSEY

2,268,397

TELEPHONE SYSTEM

Filed June 12, 1940

11 Sheets-Sheet 11



INVENTOR
R. E. HERSEY
BY *W. E. Hersey*
ATTORNEY

UNITED STATES PATENT OFFICE

2,268,397

TELEPHONE SYSTEM

Ralph E. Hersey, Madison, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application June 12, 1940, Serial No. 340,073

20 Claims. (Cl. 179—27)

This invention relates to telephone systems and particularly to those in which automatic switching mechanism is used for establishing connections.

The objects of the invention are to improve the facilities for intercepting calls made to a particular subscriber's line during his absence; to direct these calls automatically to a predetermined station, such as an operator's position, without requiring any special effort on the part of the calling subscribers; and to make other improvements in systems of this character.

In one form of the system whereby the foregoing objects of the invention are realized one of the service operators in the central office, having been called in the usual manner by a subscriber entitled to this special service and notified that he expects to be absent from his telephone, establishes a connection from her position over a special trunk circuit through the automatic switches to the subscriber's line. To establish this connection the operator transmits the impulses representing the subscriber's designation, and the designation is registered in a register sender and also in a designation register associated with the special trunk used by the operator. The register sender cooperates with a switch-controlling marker to operate incoming and final selector switches, which may be of the cross-bar type, to complete the connection over the special trunk to the subscriber's line. In an alternative form of the system the subscriber unassisted by the operator sets up a connection over another special service trunk between the operator's position and his own line. In either case the connection thus established is maintained during the subscriber's absence, the subscriber's number remains registered on the designation register, and a busy condition is impressed upon the subscriber's line. Thereafter when the marker attempts to complete a call to a busy line, the designation of the busy called line registered in the marker is compared with the designation of the absent subscriber's line, which is registered in the designation register. Hence when the absent subscriber is called, the compared registrations match; whereupon the marker, being notified thereof, cancels the registration it has received pertaining to the called line and extends the calling line automatically to the particular special trunk used for intercepting the calls to said absent subscriber's line. The calling party is now in telephonic connection with the operator, and she takes any message he wishes to leave

and communicates it to the absent subscriber upon his return.

A feature of the invention, therefore, is a system in which the number of a subscriber's line is registered during his absence and his line made busy; in which the numbers of all lines called thereafter and found busy are compared with the registered number; and in which any calling line is automatically routed to an operator as a result of the match that occurs when the calling subscriber attempts to call said absent subscriber's line.

Another feature is a special intercept trunk which the operator uses to set up a conversational connection over the automatic switches to an absent subscriber's line, and which also has an appearance as a called circuit in said switches and is seized automatically to establish a conversational connection between a calling line and the operator whenever the calling subscriber attempts to call said absent subscriber's line.

Another feature is a special trunk which the subscriber, who expects to be absent from his telephone, uses to set up a connection over the automatic switches between the operator's position and his own line, and which also has an appearance as a called circuit in said switches and is seized automatically to establish a connection between a calling line and the operator whenever the calling subscriber attempts to call the absent subscriber's line.

Another feature of the invention is an arrangement in which ringing current is automatically applied to the absent subscriber's line by way of the special trunk connection when a calling line is extended as above explained to the special trunk following the unsuccessful attempt to complete the desired connection to the absent subscriber's line.

A further feature of the invention is an arrangement in which the operator sends a momentary signal over the special trunk circuit to trip the ringing operation and thereby discontinue the application of ringing current to the absent subscriber's line. By arranging the system so that ringing current is always applied to the absent subscriber's line whenever a call is intercepted the subscriber is given an opportunity to answer the call in case he returns to his telephone while the intercepting facilities are still in operation. On the other hand some provision must be made for tripping the ringing operation so that the operator may converse with the calling party in the event the called subscriber has not returned to his telephone. This

is accomplished, as above noted by a special signal transmitted from the operator's position.

The foregoing and other features of the invention will be described more fully in the following detailed specification.

In the drawings accompanying this specification:

Figs. 1 and 2 constitute a general diagram of the system in which the invention is incorporated; Figs. 3 to 11, inclusive, disclose the details of the system; and Fig. 12 is a diagram showing the relative locations of Figs. 3 to 11.

Fig. 3 illustrates the service operator's position and shows the outgoing end of one of the special intercept trunks;

Fig. 4 shows the incoming end of the intercept trunk circuit;

Fig. 5 illustrates the incoming selector switch in which the intercept trunk terminates and a final selector switch for extending the trunk through to the subscriber's line entitled to the special service. This figure also illustrates the incoming and final selector switches for extending a calling line through to the special service trunk.

Fig. 6 shows a register individual to the intercept trunk for registering the telephone number of the absent subscriber. This figure also shows a connector for connecting the intercept trunk and the designation register to a register sender.

Fig. 7 illustrates the register sender;

Fig. 8 illustrates a switch-controlling marker and a marker connector by means of which the sender is connected to an idle marker;

Fig. 9 shows a number comparing circuit for comparing numbers registered in the marker and the number of the absent subscriber; and

Figs. 10 and 11 show one of the special trunks by means of which the subscriber may set up a connection between the operator and his own line.

Although the invention is not so limited, it has been embodied for the purpose of the present disclosure in a system using switches of the cross-bar type for establishing connections and register senders and markers for controlling the operation of these switches. Since the invention is not particularly concerned with all of the detailed circuits and apparatus employed in systems of this type, many of these unessential details have been omitted in the present disclosure. For a full understanding of the operation of these systems reference may be had to Carpenter Patent 2,093,117 of September 14, 1937; Carpenter Patent 2,089,921 of August 10, 1937; Carpenter Patent 2,235,803 of March 18, 1941; and the application by R. E. Hersey, Serial No. 300,928, filed October 24, 1939.

A general understanding of the system may be had from the diagram shown in Figs. 1 and 2. These figures disclose the incoming frames 100 and final frames 101 of cross-bar switches comprising part of the terminating equipment of a local cross-bar office. The regular traffic through these frames to the called subscriber's line is routed over incoming trunk circuits from the local originating unit and from the originating units in the distant offices. One of these incoming trunks, trunk 102, is illustrated. Incoming register senders, such as the sender 103, are associated with the calling incoming trunk by means of the sender link circuits 104 and receive the designations of the called subscribers' lines. These senders are connected through

marker connectors 105 to idle switch-controlling markers, such as the marker 106. The marker receives the designation of the called line from the sender and connects itself to a number frame 107 for the purpose of testing the called subscriber's line and for determining the location of the line in the final switch frames 101. Having determined the location of the incoming trunk and the called line, the marker is connected to the proper incoming and final frames through frame connectors 108 and 109. Following this, the links interconnecting the switches in the frames are tested, an idle path through these frames is selected, and the magnets of the switches are operated to complete the desired connection.

The drawings also illustrate a special service or intercept operator's position 110. This operator's position may be in the same office containing the terminating equipment, or it may be in a distant office. In either case special service trunks 111 and 112 extend from the operator's position to the selectors on the incoming frame 100. These trunks are provided with relays and controlling equipments 113 and 114 at the incoming end, and each trunk also has an appearance, like a subscriber's line, in the final switches on the frame 101. The final switch appearance of trunk 111 is represented by the line 115, and the final switch appearance of the trunk 112 is represented by line 116. Each of the special service trunks is also provided with an individual designation register which serves to maintain a registration of the number of a subscriber's line to which the special trunk is extended for intercept service. For example, the register 117 is provided for the trunk 111, and a similar register 118 is provided for the trunk 112. The trunk 111 is selected by the operator for establishing an intercept connection to the line of a subscriber who has called her and requested the absentee service. The other trunk 112 is under control of the subscriber and may be selected by him under control of his dial to set up the desired intercept connection between the operator and his line.

A special incoming register sender 119 is provided for registering the designation required for extending a connection over one of these special trunks to a subscriber's line. Sender connectors 120 and 121 are provided for connecting the special sender 119 to the intercept trunks and to their associated designation registers. The sender 119 also has access through the marker connectors 105 to the common switch-controlling markers. A designation comparer 122, which is common to the markers, is connectable to any marker and is also associated with the designation registers 117 and 118 for the purpose of comparing the numbers of lines that are called and found busy with the numbers that are registered on the designation registers 117 and 118.

The district and office frames 122 and 123 of the originating office, located in the same office with the frames 100 and 101 of the terminating unit, are also illustrated. Calling subscribers' lines in the office are extended through the switches on the frame 101, which serve as line switches as well as final switches, over district junctors, such as the junctor 126, to the district frame 122. The office frame has access to outgoing trunks to the same and other offices, to special service trunks, such as trunk 112, and also to operators' trunks, such as the trunk 124, to the

service operator's position which may be in the same or another office.

Assume that the subscriber of line 125 wishes to have calls to his line intercepted during his absence. Before leaving his telephone he may call the special service operator in the usual manner by dialing the proper code to set the originating sender 132 and marker 133, which control the district and office switches 122 and 123 to extend his line over the district junctor 126 and over trunk 124 to the operator's position. The operator responds, and the subscriber advises her that he is about to leave his home or office and wishes to have all calls to his line intercepted during his absence. Thereupon the operator seizes an idle one of the special service trunks, such as the trunk 111. Her act of seizing this trunk causes the connector 120 to operate and connect the sender 119 to the trunk 111 through the control mechanism 113 and also to connect the sender 119 to the designation register 117 which is individual to the trunk 111. When the operator receives the dial tone, she manipulates her dial 127 to transmit over the trunk 111 a series of impulses representing the number of the subscriber's line 125. These impulses are registered in the sender 119 in the usual manner, and at the same time they are registered in the designation register 117. The sender 119 seizes an idle marker 106 through the connector 105, and the marker proceeds to control the operation of the incoming and final switches to extend the intercept trunk 111 through to the absent subscriber's line 125. Thereupon the marker 106, the sender 119 and the connector 120 are released. However, the established connections between the operator's position and the subscriber's line 125 and the registration in the designation register 117 are maintained during the subscriber's absence, and the subscriber's line 125 appears busy whenever a marker makes a test thereof during the time the special trunk connection is maintained.

If on the other hand the subscriber wishes to set up the intercept connection himself, he dials a code identifying the group including trunk 112 and also the number of his own line. The sender 132 and marker 133 control the district and office switches 122 and 123 to seize trunk 112, following which the number of the subscriber's line is transferred from sender 132 to the incoming sender 119. The marker 106 then controls the incoming and final switches 100 and 101 to extend the trunk 112 to the subscriber's line 125, omitting the busy test. At the same time the operator is signalled over trunk 112. She informs the subscriber the connection has been set up, and he then hangs up his receiver. The replacement of his receiver releases the connection from his line 125 through switches 101, 122 and 123 to the trunk 112, leaving the established connection between the operator and line 125 by way of the special trunk 112.

Each time during the subscriber's absence that the marker 106 or any of the other markers attempts to set up a connection to another called line and finds it busy, it operates the connector 129 to associate itself with the comparing device 128. The device 128 then proceeds to compare the number of the busy called line, which is still registered in the marker 106, with the number of the absent subscriber's line, which is registered on the designation register 117 or 118 as the case may be and also with all other absent sub-

scribers' numbers which may be registered in other designation registers. The purpose of this comparison is to determine whether the busy called line is the line of an absent subscriber who has requested the intercept service. If, therefore, the subscriber of a calling line 130 attempts to call the absent subscriber's line 125, the comparison shows that the number in the marker 106 is the same as the number registered in the register 117, and the marker is notified of this fact. The marker then proceeds to operate the incoming and final switches to automatically route the calling incoming trunk 102 through these switches over the circuit 115 to the special intercept trunk 111 which was used by the operator to set up the intercept connection to the line 125. When this connection is established from the calling line to the intercept trunk 111, a signal is given the operator, and she responds and converses with the calling subscriber. When the calling subscriber is through conversing with the operator, his connection is released, but the connection between the operator and the absent subscriber's line remains established.

Referring now to Figs. 3 to 9, the outgoing end of one of the intercept trunks 300 is shown terminating at the special service operator's position in the contacts of a key 301, by means of which the operator can associate her telephone and position dial with the trunk and can also hold the trunk while engaged on other calls. The trunk 300 is one that is used by the operator in setting up an intercept connection and corresponds to the trunk 111 in Figs. 1 and 2. The incoming end of the trunk 300 appears in the contacts 500 of an incoming selector switch 511 and also appears in the contacts of the sender-connector relay 600. The incoming end of the intercept trunk is also connected to a set of contacts 501 in one of the switches 518 on the final frame. Moreover, the incoming trunk circuit is provided with a number of relays for applying ringing current, for controlling supervision, and for tripping the ringing operation either under control of the called subscriber or under the control of the service operator.

The register sender shown in Fig. 7 includes the usual controlling and impulse receiving relays and register means for registering the digits of a subscriber's designation received in the form of impulse series. The register comprises a cross-bar switch having vertical rows of contacts for the usual thousands, hundreds, tens and units digits and for the incoming frame identification. Although some of the controlling relays and circuits are shown in detail, many of the relays and circuits that would ordinarily be included in the sender have been omitted and are illustrated in a general way by the rectangle 700.

The designation register shown in Fig. 6 also consists of a cross-bar switch having four vertical rows of contacts, one for each of the four numerals of the subscriber's designation. This register, which is individual to the incoming trunk shown in Fig. 4, is connected to the sender by the connector relay 600 at the same time the incoming trunk is associated with the sender.

The switch-controlling marker 800 includes registers 801, 802, 803 and 804 for registering the thousands, hundreds, tens and units digits, respectively, of the subscriber's number which it receives from the sender by way of the marker connector 805. The marker also contains a frame indication register 806 on which it records

the frame identification of the trunk circuit 300.

The designation comparing circuit, which is shown in Fig. 9, comprises four registers 900, 901, 902 and 903 for the thousands, hundreds, tens and units digits of a subscriber's number. This circuit also includes a group of four relays 904 for each one of the special intercept trunks appearing in the incoming frame. The windings of the relays of the registers 900, 901, 902 and 903 extend through the connector 807 to the marker, and the registers 801, 802, 803 and 804 in the marker serve to operate these relays to duplicate in the comparing circuit the number registered in the marker. The contacts of the register relays in the comparing circuit are wired to the contacts of each of the cross-bar designation registers. Therefore, whenever the number registered in the marker is found to be the same as the number on the designation register associated with a particular intercept trunk, all four of the relays of the group 904 individual to that intercept trunk are operated. The relays of the group 904 when operated serve, as will be explained hereinafter, to notify the marker that the absent subscriber's line has been called.

The operation of the system will now be described in detail. Assume for this purpose that the subscriber of line 502 is about to leave his residence or office and wishes to have all calls to his line intercepted by the operator. Having called and notified the operator of his intentions, the calling subscriber may leave immediately or he may wait to satisfy himself that the operator has successfully established the intercept connection to his line. In any event the operator proceeds to set up the connection by operating the two-way key 301 from its normal position to the position for closing the contact springs 302, 303 and 304. The closure of these contacts associates the operator's dial 305 with the trunk 300, and a circuit is closed from battery through the upper left winding of repeating coil 306, closed contact spring 302 through impulse contacts of the dial 305 thence through the closed spring contacts 303 and the lower left winding of coil 306 and winding of impulse relay 307 to ground. Relay 307 operates and closes a preliminary energizing circuit for relay 400 at distant end of the trunk. At the same time a circuit is closed from battery through the winding of relay 308, contacts 304 and the normally closed contacts 309 associated with the dial 305. Relay 308 operates and disconnects the trunk conductors 310 and 311 from the bridge through the contacts of relay 307 and connects these conductors through the right windings of the repeating coil 306 and the polarized supervisory relay 312. A circuit for relay 400 may now be traced from battery through the upper winding of relay 400, normal contacts of relay 401, conductor 310, contacts of relay 308 through the repeating coil windings and polarized relay 312 through the lower contacts of relay 308, conductor 311, normal contacts of relay 401 to ground through the lower winding of relay 400. Relay 400 remains operated in this circuit; and the direction of the current flow over the trunk is such that polarized relay 312 does not operate.

Relay 400 closes a circuit from ground through its armature and front contact, normal contacts of slow-release relay 402 through the winding of slow-release relay 403 to battery. Relay 403 operates and closes a circuit from ground through its contacts over the start conductor 404 through

the winding of preference relay 601 to battery. Relay 601 operates and opens the battery supply for any other preference relay that may have operated at this time. A circuit is now closed from ground through the back contacts of preference relays 602 and 603, front contact of relay 601 to ground through the winding of relay 600. Relay 600 operates and extends a number of leads from the trunk 300 through to the register sender and also extends the operating conductors for the select and hold magnets of the designation register 604 through to the register sender. The operation of relay 600 closes a holding circuit for relay 601 traceable from battery through the winding of relay 601, contacts of relay 600, conductor 605 to ground at the back contact of the sender release relay 701. Relay 600 also closes circuits for the sender off-normal relay 702 and relay 705. The circuit for relay 702 is traceable from battery through the winding of said relay, normal contacts of relay 703, conductor 704 through contacts of the relay 600 to ground. The circuit for relay 705 may be traced from battery through the winding of said relay, conductor 706, normal contacts of the hold magnet 707, conductor 708 to ground through the contacts of relay 600. Relay 703 also operates in a circuit from battery through its winding, front contacts of relay 702 to the grounded conductor 605. Relay 702 is now held energized in a circuit from battery through its winding and front contacts to the grounded conductor 605.

The identity of the incoming frame in which the trunk 300 appears is now registered on the fourth vertical row of contacts in the register switch 709 of the sender. To this end the relay 705 in operating extends the operating circuits for the ten select magnets 710, 711, 712, etc., through the connector 600 to the terminal block 405 associated with the trunk 300. Assuming that the terminal associated with conductor 406 is grounded, a circuit is completed over this conductor through the contacts of relay 600, conductor 628, contacts of relay 705, conductor 713 through the winding of select magnet 714 to battery. Magnet 714 operates and prepares the contacts in the horizontal row associated therewith. Following the operation of magnet 714 a circuit is closed over the conductor 715 and through the winding of the hold magnet 707 to battery. Magnet 707 operates and closes the cross-point contacts to register the frame identification. Magnet 707 locks in a circuit from battery through its winding and contact, conductor 716 to ground at the front contacts of relay 702. Magnet 707 in operating opens the circuit of relay 705, and this relay releases, opening in turn the circuit of the select magnet 714. The magnet 714 releases, and the cross-point contacts are held closed by the continued energization of the hold magnet 707.

When relay 705 releases following the registration of the frame identification, a circuit is closed for operating relay 401 in the trunk. This circuit may be traced from battery through the winding of relay 401, conductor 407, contacts of relay 600, conductor 606, contacts of relay 717, closed contacts of relay 703 to ground at the back contacts of relay 705. Relay 401 disconnects the windings of relay 400 from the trunk 300, and relay 400 releases. Relay 400 opens the original circuit of relay 403, but this relay is now held in a circuit from battery through its winding and contacts to ground at

the contacts of relay 401. Meanwhile, the pulsing circuit has been completed from the trunk 300 to the impulse relay 718 in the sender. This circuit may be traced from battery through the winding of relay 718, front contacts of relay 702, back contacts of relay 717, conductor 719, contacts of relay 600, conductor 607 to the tip conductor 310 of the trunk and thence as previously traced through the repeating coil windings 306 and returning over the ring conductor 311, conductor 608, contacts of relay 600, conductor 609, contacts of relays 717 and 702 through the secondary winding of the tone coil 720. The direction of current flow over the trunk is the same as before; consequently the polarized relay 312 remains deenergized. At the proper time tone current is applied to the coil 720, and the operator, hearing the tone in her receiver, proceeds to dial the number of the subscriber's line 502.

Assuming the number of line 502 is 2345, the operator transmits with her dial 305 four corresponding series of impulses. As the dial moves away from normal preparatory to the transmission of each series, the off-normal contacts 309 open and relay 308 releases, closing the trunk 300 through the contacts of the pulse relay 307. At each interruption of the circuit of relay 307 the relay releases and opens the circuit of pulse relay 718. The pulse relay 718 operates the pulse and sequence mechanism 700, and at the end of each series of impulses a circuit is closed for operating the proper one of the select magnets of the register switch 709. Since the thousands digit is "2", ground potential is applied to conductor 721 by the impulse circuit 700. Parallel circuits may now be traced for operating the No. 2 select magnet 722 of the sender register 709 and the No. 2 select magnet 610 of the designation register 604. The circuit for magnet 722 extends from battery through the winding of said magnet to the grounded conductor 721; and the circuit for magnet 610 extends from battery through its winding over conductor 611 through contacts of relay 600 thence over conductor 741 to the grounded conductor 721. Thereupon ground potential is applied to conductor 723 and parallel circuits are closed through the thousands hold magnet 724 of register 709 and the thousands hold magnet 612 of register 604. Magnet 724 locks through its own contact to the holding conductor 725; and magnet 612 locks through its own contact over conductor 613 to ground at the closed contacts of relay 403. Following the operation of hold magnets 724 and 612 the select magnets 722 and 610 are released, preparing the switches for registering the next digit. In like manner the hundreds, tens and units digits are received and cause the operation of select magnets 726, 727 and 728, respectively, of switch 709, and select magnets 614, 615 and 616, respectively, of switch 604. The successive operations of these select magnets are followed by the operations of the corresponding hold magnets 729, 730 and 731 of switch 709 and hold magnets 617, 618 and 619 of switch 604. The select magnets are released, and the hold magnets are held over obvious locking circuits.

As soon as the units digit is registered, a circuit is closed from ground through the front contact of the units hold magnet 731, conductor 732 through the winding of relay 717 to battery. This relay operates and closes an operating circuit for slow release relay 402 in the trunk. This circuit may be traced from battery through the winding of relay 402, conductor 408, contact of

relay 600, conductor 620, closed contacts of relay 717 to ground at the front contacts of relay 703. At the same time relay 717 opens the previously traced circuit for relay 401, and the latter relay releases. Relay 400 is again connected to the trunk 300, the direction of current flow over the trunk being the same as before. Hence the polarized supervisory relay 312 at the outgoing end of the trunk remains deenergized. Relay 717 in the sender also opens the impulse circuit, disconnecting the impulse relay 718 from the trunk 300. Relay 402 in the trunk circuit is held in a locking circuit from battery through its winding and front contact to ground at the front contact of relay 400. After an interval slow-release relay 403 releases and opens the energizing circuit of preference relay 601. Relay 601, however, remains locked through the contacts of relay 600 until the sender releases. Relay 403 opens its grounded connection to the conductor 613, but ground is maintained on this conductor by relay 402 to hold the select magnets of the designation register 604.

Following the registration of the number in the sender the start circuit 733 is closed through the front contacts of magnet 731 thence over conductor 734 to the start relay 823 of the marker connector 805, and the marker connector operates to connect the sender to an idle marker 800. Thereupon the number registered in the sender by the closure of the selected cross-points in the vertical rows of contacts of the cross-bar switch 709 is transferred over the groups of conductors 735, 736, 737 and 738 to the thousands, hundreds, tens and units registers 801, 802, 803 and 804 in the marker. Similarly the registration of the frame identification is transferred from the register sender over the group of conductors 739 to the frame register 806 in the marker. The marker proceeds in the usual manner to test the called line 502 and to operate the switch magnets for closing the incoming primary and secondary cross-points 500 and 503 and the final primary and secondary cross-points 504 and 505 to extend the trunk circuit 300 through to the subscriber's line 502. The hold magnets 506 and 507 of the incoming switch and the hold magnets 508 and 509 of the final switch are held to maintain the connection in a circuit over the sleeve conductor 510 through the contacts of relay 409, conductor 411 to ground at the front contacts of relay 402.

During the operations of the marker a circuit is closed over conductor 808 through the connector 805, conductor 809, contacts of relay 600, conductor 621 to operate the relay 409 in the trunk circuit. Relay 409 serves to extend a number of control conductors 410 through to the marker 800. Having successfully established the connection the marker proceeds to release, but before doing so it closes a release circuit for the sender traceable over conductor 822 through connector 805, conductor 810 through the winding of relay 701 to battery. Relay 701 operates and causes the release of the sender including the operated hold magnets of the register 709. Relay 701 also removes ground potential from conductor 605, and relays 600 and 601 release, disconnecting the sender from the trunk. The register 604, however, remains in its operated condition, the hold magnets being held by the grounded conductor 613.

While the trunk 300 is connected to the marker by way of conductors 410, the proper control relays in the trunk are operated to control the

application of ringing current to the called line. Assume, for example, that it is desired to apply ringing current to the tip conductor of the subscriber's line 502. This being the case, the marker causes the operation of relay 412 over a circuit from battery through the winding of said relay, contacts of relay 409, the latter relay being operated while the trunk is connected to the marker, thence over conductor 413 to ground in the marker. Relay 412 operates and locks in a circuit from battery through its winding and front contact, back contact of the tripping relay 414, conductor 415 to ground at the front contact of relay 402. At the same time the marker closes a circuit from battery over conductor 416 through the contacts of relay 409 and the winding 417 to battery. Relay 417 also operates and locks through its winding and contact and the back contact of relay 414 to the grounded conductor 415. When thereafter the marker, having completed the connection through to the called line 502 as above described, releases the relay 409 and disconnects itself from the trunk, ringing current is applied through the incoming and final selectors 511 and 512 to the line 502. The ringing circuit may be traced from the source 418, front contact of relay 417, winding of the tripping relay 414, normal contact of relay 419, front contacts of relay 412, front contacts of relay 417, normal contacts of relays 409 and 420, tip conductor 521 thence through the switches 511 and 512 over the loop of the line 502 and returning through the switches to the ring conductor 422, normal contacts of relays 420 and 409, front contacts of relays 417 and 412 to ground.

If the subscriber of line 502 is waiting to verify the establishment of the intercepted connection before he leaves his telephone, he now replies by removing the receiver from the switch-hook. The closure of the subscriber's loop operates the ringing trip relay 414 in the well-known manner, and this relay causes the release of relays 412 and 417. Relay 417 disconnects the ringing source and closes the called subscriber's line through to the windings of the supervisory relay 423. Relay 423 operates and closes a circuit from ground through its front contact, front contacts of relay 402, conductor 434, resistance 442, through the winding of relay 401 and battery. Relay 401 operates and reverses the connections of relay 400 to the tip and ring conductors of trunk 300 extending toward the operator's position. Relay 400 remains energized, and the reversal of current over the line causes relay 312 to operate. In the meantime the operator, having completed the dialing operation, throws the key 301 to the hold position, opening the contact springs 302 and 303 and closing springs 313 and 314. Relay 308 is now held in a circuit closed to ground at the spring 314. When, therefore, the called subscriber answers and current is reversed to release the relay 312 as described, the signal lamp 315 is lighted in a circuit closed from battery through the lamp to ground at the closed contact of relay 312. The operator, seeing the light 315, knows that the subscriber has answered. She then throws the key 301 back to the talking position, closing springs 302 and 303 and connecting her telephone set to the trunk. She then speaks to the subscriber and notifies him that the intercept condition has been established for receiving calls to his line during his absence. Thereupon the subscriber replaces his receiver and leaves his

telephone. Replacement of the receiver opens the loop and causes the release of relay 423. Relay 423 releases relay 401, and the current flow over the trunk is restored to its former direction. Relay 312 again releases and opens the circuit for lighting the lamp 315. The key is now restored to the holding position where it is left until a call to the absent subscriber's line is intercepted.

Should the subscriber of line 502 leave his telephone immediately without waiting for the operator to set up the intercept connection, it then becomes necessary for the operator to discontinue the ringing of his line. If, therefore, he does not answer his bell, the operator momentarily throws the key 301 to the neutral position and then returns it to the hold position. In the neutral position of the key both relay 307 and 308 release; therefore, the circuit of relay 400 is opened. Relay 400 releases and closes a circuit from ground through its back contact, winding of relay 424 to battery at the front contact of relay 402. Relay 424 operates and closes a new locking circuit for slow-release relay 402 to replace the holding circuit just opened by the release of relay 400. The new locking circuit may be traced from battery through the winding and front contact of relay 402, front contact of relay 424, back contact of relay 400 to ground at the back contact of relay 423. Relay 424 also closes an obvious operating circuit for slow-release relay 425. Relay 425 closes a bridge across the trunk circuit to trip the ringing operation. This bridge may be traced from the tip conductor 421, conductor 426, resistance 427, contacts of relay 425, conductor 428 to the ring conductor 422. This bridge causes the operation of the tripping relay 414, and relays 412 and 417 are released to discontinue the ringing operation as above described. In the meanwhile, the operator has restored the key 301 to the hold position and relay 308 reoperates to close the trunk circuit through the winding of relay 312. Relay 400 thereupon reoperates, reclosing the hold circuit of relay 402 and opening the circuit of relay 424. Relay 424 releases and in turn causes the release of relay 425.

During the subscriber's absence the numbers of all lines that are called and found busy are compared with the registered number of the absent subscriber in order that all calls intended for his line may be intercepted and extended to the service operator. The comparison is made by the comparing mechanism shown in Fig. 9 which is common to the markers. Each time a marker, such as the marker 800, receives and registers the number of a called line and finds the line busy on making a test thereof, it seizes the comparing mechanism and connects itself thereto through the connector 807. Thereupon the number of the busy called line is transferred from the marker to the registers 900, 901, 902 and 903 of the comparing mechanism. The comparing mechanism then determines whether the number it has received from the marker is the same as the number registered on the designation register 604 pertaining to the absent subscriber's line. If the compared numbers are not identical, the usual busy tone is returned to the calling subscriber; however, if they are identical, the marker proceeds to extend the calling line to the operator's position. When, therefore, a calling line is extended to an incoming trunk circuit 516 on a call intended for the absent subscriber's line 502, the number "2345" is registered on the registers 801, 802, 803 and 804 in

the marker. The marker, having tested the sleeve conductor 513 of the line, appearing in the number frame 514 and having found the line busy, seizes the comparing mechanism and applies ground potential over conductor 811 through the connector 807, conductor 812, causing the operation of certain relays (not shown) in the comparing circuit and resulting finally in the operation of relay 909. The thousands digit "2" is now transferred from the register 801 through the connector 807 and conductors 813 causing the operation of relay 906, the remaining relays 905, 907 and 908 remaining deenergized. In like manner the hundreds, tens and units digits "345" are transferred over conductor groups 814, 815 and 816 causing the operation of relays 910 and 911 of the hundreds register 901, relay 912 of the tens register 902, and relay 913 of the units register 903, the other register relays remaining deenergized.

Circuits are now extended through the contacts of the registers 900, 901, 902 and 903 to the corresponding rows of contacts in the cross-bar designation register 604 to determine whether the operated relays match with the operated cross-point contacts in the switch. The matching circuit for the thousands register may be traced from the grounded conductor 812, through the contacts of relay 909, conductor 914, back contacts of relay 905, front contacts of relay 906, back contacts of relay 907, conductor 915, through the cross-point contacts which were closed by the conjoint operation of select magnet 610 and hold magnet 612 when the thousands digit 2 was registered, and which are maintained closed by the continued energization of the hold magnet 612, thence over conductor 622 through the winding of relay 916 to battery. The matching circuit for the hundreds digit may be traced from the grounded conductor 914 through the front contacts of register relays 910 and 911, back contacts of relay 917, conductor 918 through the closed cross-point contacts in the vertical row controlled by the hold magnet 617 and returning over conductor 623 through the winding of relay 919 to battery. In like manner the matching circuits for the tens and units digits are traceable from grounded conductor 914 through the contacts of the tens register 902 to conductor 920 and through the contacts of the units register 903 to the conductor 921. Conductors 920 and 921 are further traceable through the closed cross-point contacts in the tens and units rows of the switch 604 and returning over conductors 624 and 625, respectively, through the windings of relays 922 and 923, respectively, to battery. Thus all of the relays of the group 904 are operated indicating a match between the registered numbers. For a more complete disclosure and description of the number comparing circuit and its cooperative relation with the marker, reference is made to the copending application by R. E. Hersey, Serial No. 300,928, filed October 24, 1939.

With all of the relays of the group 904 operated a circuit is closed as follows for the relay 924: Battery through the winding of said relay, front contacts of relays 923, 922, 919 and 916 to ground. Relay 924 locks in a circuit from battery through its winding and contact, conductor 925, ground at the back contact of relay 429. Relay 924 also closes an operating circuit for relay 429 traceable from battery through the winding of relay 429, conductor 430 to ground at the front contact of relay 924. Relay 429 op-

erates and opens the temporary locking circuit of relay 924, but the latter is held over its original operating circuit under control of the marker. The marker 800 is now notified that the absent subscriber's line has been called and that the calling line should be automatically routed to the service operator's trunk 300. The notifying signal is sent to the marker by the relay 924, which operated as a result of the matched designations. The signal circuit may be traced from ground through the front contacts of relay 924, conductor 927 through connector 807, conductor 818 through the winding of a route relay 817 in the marker. In the well-known manner the operation of the route relay in the marker causes the marker to associate itself through a connector 819 and over a group of test conductors 820 with the number frame 514 containing the group of intercept trunks extending from the service operator's position. Having connected itself to the number frame, the marker proceeds to test the group of intercept trunks in the same manner that a marker ordinarily tests a private branch exchange group. Normally each one of these intercept trunks appears busy at the number frame 514. For example, the test conductor 515 of the intercept trunk 300 is normally grounded at the back contact of relay 429, so that the trunk will appear busy to a marker testing the group at the number frame 514. Since, however, a call is about to be intercepted by this trunk, ground potential is removed from the test conductor 515 by relay 429 which has just operated as above described. Therefore, when the marker tests the group containing the intercept trunk 300, it will find this trunk idle and all others busy. Consequently the marker selects this trunk and also selects an idle set of links for extending the incoming trunk 516, to which the calling line has already been extended, through the incoming and final switches 517 and 518 to the intercept trunk 300. Having tested the conductor 515 and found it idle, the marker 800 applies ground potential over conductor 820 to conductor 515, resulting in the operation of relay 420 over a circuit traceable from battery through the winding of said relay, front contacts of relay 429 to the grounded conductor 515. Relay 420 closes a circuit for holding relay 429, traceable from battery through the winding and front contacts of relay 429 to ground at the front contact of relay 420. Relay 420 also extends the grounded conductor 515 through its front contacts thence over conductor 432 through the winding of the hold magnet 519 to battery. Magnet 519 closes and holds the contacts 501 of the final secondary switch, and in the well-known manner, the marker also operates the hold magnets 520, 521 and 522 to close the remaining cross-points in the switches 517 and 518.

The marker releases, and the connection through the incoming and final switches 517 and 518 is maintained by the hold magnets 520, 521, 522 and 519 which are held in holding circuits extending through the closed contacts of the switches to ground applied on the holding conductor 523 of the incoming trunk 516. Relay 420 is also held in a circuit from battery through its winding and front contact, conductor 432 thence through the closed contacts of switches 518 and 517 to the grounded conductor 523. Ringing current is also applied to the subscriber's line 502 from the incoming trunk 516. The ringing circuit extends from the source 527, over the tip

conductor 524, through the contacts of switches 517 and 518, conductor 525, through front contacts of relay 420, thence over tip conductor 421, through the switches 511 and 512 over the loop of the line 520, returning through switches 512 and 511, conductor 422, front contacts of relay 420, conductor 433 through the switches 518 and 517 to ring conductor 526. Since the called subscriber is absent and does not answer his telephone, it is necessary to signal the operator in order that she may trip the ringing operation. At the time the calling line is being extended to the intercept trunk, a circuit is closed from ground through the front contacts of relay 420, conductor 434, through the winding of relay 401 to battery. Relay 401 operates and reverses the connection of the windings of relay 400 to the trunk 300. This reversal causes the operation of relay 312 at the originating end of the trunk, and this relay closes an obvious circuit for lighting the lamp 315. The operator, seeing the lamp lighted, throws the key 301 to the talking position and challenges. Receiving no reply she knows that a call is being intercepted and that she should trip the ringing operation. To do this she throws the key momentarily to the mid-position to open the trunk circuit 300. Relay 400 releases and operates relay 424 as above described. Relay 424 holds relay 402 and operates slow-release relay 425. Relay 425 closes a bridge for tripping the ringing operation. The tripping circuit may be traced from the ringing source in the incoming trunk 516 thence over conductor 524 through the switches 517 and 518, conductor 525, front contacts of relay 420, conductor 426, resistance 427, contacts of relay 425, conductor 428, contacts of relay 420, conductor 433 thence through the switches 518 and 517 to the ring conductor 526 of the incoming trunk circuit. Relay 425 also closes a circuit from ground through its front contact, winding of relay 435 to battery through the front contact of relay 402. Relay 435 locks in a circuit from battery through the front contacts of relay 402, winding and front contact of relay 435 to ground at the contacts of relay 420. After a moment the operator throws the key 301 from the mid-position to the talking position, and relay 308 operates to reclose the trunk 300 through the winding of polarized relay 312. Thereupon relay 400 reoperates and releases relay 424. After an interval relay 425 releases and a circuit is closed from ground to the back contact of said relay, front contact of relay 435, winding of relay 436 to battery. Relay 436 operates and completes the talking circuit between the operator's position and the calling subscriber's line. Talking current is supplied toward the originating end of the trunk 300 through the windings of relay 400. The talking circuit from the incoming end of the trunk 300 toward the calling subscriber's line may be traced from battery through the lower winding of relay 423, conductor 437, conductor 439, front contacts of relay 436, conductor 426, front contacts of relay 420, conductor 433 and thence through the switches 518 and 517 to the ring conductor 526 of the incoming trunk 516 to which the calling subscriber's line is connected. The return part of this circuit may be traced from the tip conductor 524 of the incoming trunk 516 through the switches 517 and 518, conductor 525, front contacts of relay 420, conductor 426, front contacts of relay 436, conductor 438, conductor 440, through the upper winding of relay 423 to ground. The conductors 524 and 526 of the incoming trunk 516 may also

extend through the windings of a battery supply relay similar to the relay 423 of the intercept trunk 300. The windings of the relay in trunk 516 may be connected in either direction. If they are connected in the same direction as the windings of relay 423, no current flows and neither the relay 423 nor the relay in the incoming trunk 516 will operate. The operator now speaks to the calling subscriber, advises him that the called party is absent, and offers to take any message that the calling subscriber may wish to leave for subsequent communication to the absent subscriber.

After the operator and the calling subscriber have finished their conversation the calling subscriber replaces his receiver and releases the connection he has established from his line through the switches 517 and 518. The release of this connection removes ground potential from conductor 432, and relay 420 releases to open the tip and ring conductors of the trunk 300 which appear in the cross-point contacts 501 of the final switch 518. Relay 420 in turn releases relay 429, which restores the normal busy potential to the conductor 515 of the intercept trunk 300. Relay 420 also releases relays 435 and 401 and relay 435 releases relay 436. Relay 401 reverses the direction of the current over the trunk 300, and relay 312 releases. The operator restores her key to the hold position and notes that the lamp 315 is dark, indicating that the calling subscriber has replaced his receiver. The equipment is now in the same condition that existed prior to the call to the absent subscriber's line; that is to say, the intercept trunk 300 remains connected to the absent subscriber's line through the switches 511 and 512, and the absent subscriber's number remains registered on the designation register 604 in readiness for intercepting the next call made to the line 502.

Should the absent subscriber return while his bell is being rung on a call that is about to be intercepted he may answer in the usual manner by removing his receiver. The removal of his receiver trips the ringing mechanism in the calling incoming trunk 516, the tripping circuit being traceable from conductor 524, through switches 517 and 518, conductor 525, front contacts of relay 420, conductor 421, switches 511 and 512, over the closed loop of the line 502 and returning through switches 512 and 511, conductor 422, front contacts of relay 420, conductor 433 through the switches 518 and 517 to conductor 526. The called subscriber may now speak to the calling party. In the meantime the operator, having observed the lighted lamp 315, throws the key 301 to the intermediate position, causing the release of relay 400 and the operation of relays 424, 425 and 435 as above described. Relay 435 locks in a circuit from battery through the front contacts of relay 402, winding and front contacts of relay 435 to ground at the front contact of relay 420. When the operator subsequently moves the key to the talking position, relay 400 reoperates, and relays 424 and 425 release and relay 436 operates to extend the talking connection from the trunk 300 to a called subscriber's line 502. The operator now challenges and discovers that the absent subscriber has returned to his telephone and has answered the calling party. While the trunk 300 is extended through relay 435 to the established connection between the calling and called parties, supervisory relay 423 is operated in a circuit including the loop of the called line 502, and the

same is true of the corresponding supervisory relay in the incoming trunk 516. After learning that the called party has answered, the operator throws the key 301 to the hold position and the energizing circuit of relay 400 is maintained, and relay 402 is held by relay 400. As soon as the supervisory relay 423 is operated, relay 401 is operated, and relay 312 is operated at the originating end of a trunk to light the supervisory lamp 316 as a signal to the operator that the called subscriber has his receiver off the switchhook.

When the calling subscriber replaces his receiver, the connection to the called party's line 502 is released, and relays 420 and 429 are deenergized. If the called subscriber 502 still has his receiver off the switchhook the circuit of relay 423 is reclosed and relay 435 is now held in a circuit from battery through the front contact of relay 402, winding and front contact of relay 435, conductor 434, front contact of relay 402 to ground at the front contact of relay 423. When the subscriber of line 502 finally restores his receiver, relay 423 releases, and relays 435 and 436 release. The release of relay 423 opens the circuit of relay 401 and relay 312 releases to extinguish the lamp 315.

Should the absent subscriber return and wish to discontinue the intercept service, he may do so by merely removing his receiver from the switchhook. The removal of the receiver closes the circuit of relay 423, and this relay in turn closes the circuit for relay 401. Relay 401 reverses the current direction, and the lamp 315 is lighted at the operator's position. The operator responds by throwing the key 301 immediately to the talking position. Relay 400 remains energized and holds the relay 402 operated, and the operator now speaks to the subscriber over the intercept trunk connection. He informs her that he does not wish the service any longer, and she instructs him to hold his receiver off the switchhook for a moment, in order that she may release the connection. While the subscriber is holding his receiver off the switchhook and relay 423 is energized, she throws the key 301 to the intermediate position and leaves it there. Relay 400 immediately releases, and after an interval the slow-release relay 402 releases, since relay 423 is now operated. Relay 402 removes ground potential from conductor 411, and the incoming and final switches 511 and 512 are restored to normal. Relay 402 also removes ground potential from conductor 613, allowing the hold magnets 612, 617, 618 and 619 to release and restore the designation register 604 to its normal condition. The subscriber of line 502 now replaces his receiver on the switchhook, and his line is available for incoming and outgoing calls as usual.

A description will now be given of the operations involved when the subscriber establishes the intercept connection to his own line without the assistance of the operator. In this case the special intercept trunk 1000 shown in Figs. 10 and 11 is used; accordingly, these figures should be substituted for Figs. 3 and 4 in the drawings.

When the subscriber of line 502 wishes to set up the intercept connection, he removes his receiver, resulting in the automatic extension of his line through the line switches to a district junctor 1001 terminating in the district frame 1002. An originating sender is associated with the subscriber's line, and he dials a code designation representing the group of intercept trunks, including the trunk 1000, following which he

dials the numerical designation of his own line. The originating sender and marker control the operation of the district and office switches 1002 and 1003 to seize the idle intercept trunk 1000. A circuit is now closed from battery through the upper winding of relay 1100 thence over conductor 1101 through the contacts of relay 1102, conductor 1103 through the office and district selectors 1003 and 1002, thence through the supervisory relay (not shown) in the district junctor 1001 and returning through the district and office switches 1002 and 1003, over conductor 1004, contacts of relay 1102, through the lower winding of relay 1100 to ground. Relay 1100 closes a circuit from ground through its front contact, normal contact of relay 1104 through the winding of slow-release relay 1105 to battery. Relay 1105 closes a circuit from ground over conductor 1106 and 404 to operate the relay 601 in the manner previously described for the purpose of connecting the intercept trunk 1000 to the idle register sender of Fig. 7. Relay 1105 also closes a circuit from ground over conductor 1107 and thence over the sleeve conductor 1108 to guard the trunk 1000 against seizure by other office selector switches 1003.

As soon as the incoming sender of Fig. 7 is associated with the trunk 1000, the numerical designation is transferred in the well-known manner from the originating sender to the incoming sender. If the transfer of the designation is made by the usual revertive impulse method the pulse and sequence circuit 700 of the incoming sender may be arranged to transmit these revertive impulses back over the established connection to satisfy the registrations in the originating sender. As these numerical designations are received in the terminating sender they cause the operation of the cross-bar registers 709 and 604 in the manner already described. Thus the number of the subscriber's own line 502, which he has dialed into the originating sender, is registered in the terminating sender of Fig. 7 and also on the register mechanism 604 individual to the special service trunk 1000.

Since the connection being established is one that reverts to the calling line, which is, therefore, in a busy condition, it is necessary to apprise the sender and marker of this fact in order that the usual busy test may be omitted. This class information is sent to the sender by means of a circuit traceable from ground through the back contact of relay 1104, conductor 1109 thence over conductor 621 through contacts of the relay 600, conductor 809 to the sender control circuit 700 where appropriate relays may be operated to record the information.

After the numerical designation has been registered in the sender and in the register mechanism 604, an idle marker is associated with the sender in the manner described, and the numerical registration is transferred to the marker together with the necessary class information for notifying the marker that the called line is one that should be seized without regard to its busy condition and that the usual ringing operation may be omitted. The marker sets up the connection in a manner previously described, causing the operation of switches 511 and 512 to extend the intercept trunk 1000 through to the subscriber's line 502. When the sender reaches the stage at which relay 717 is operated, relay 1102, which was previously operated in the

manner hereinbefore described, releases. Relay 1102 reconnects the relay 1100 to the tip and ring conductors of the trunk 1000, and relay 1100 reoperates. Relay 1117 also closes the previously traced circuit from ground through the contacts of relay 703, contacts of relay 717, conductor 620, contacts of relay 600, conductor 403 thence over conductor 1119 through the winding of slow-release relay 1104 to battery. Relay 1104 operates and locks through its front contact to ground at the front contact of relay 1102. Relay 1104 removes ground potential from conductor 1109 and extends this conductor through to the winding of relay 1111 in order that this latter relay may be operated in the manner above described to extend the control conductors 1112 through to the marker. Relay 1105 releases following the operation of relay 1104, and relay 600 releases to disconnect the sender from the trunk 1000. The registers 604, however, are held in their operated condition by the hold conductors 613 and 1107, the latter of which is grounded at the contacts of relay 1104.

When relay 1104 operates as above explained, a circuit is completed from battery through the upper winding of relay 1100, conductor 1101, back contact of relay 1102, conductor 1113, closed contact of relay 1104, conductor 1114 through the closed contact of relay 1005 through the windings of repeating coil 1006 and polarized supervisory relay 1007, contacts of relay 1005, conductor 1008 through the contacts of relay 1104, contacts of relay 1102 to ground through the lower winding of relay 1100. Relay 1005 is operated at this time since the operator's key 1009 is normally standing in the hold position, closing the circuit of relay 1005 through the contacts 1010. Thus the supervisory relay in the district junctor 1001 and the supervisory relay 1007 at the operator's position are connected in parallel through the windings of relay 1100. The direction of current flow through the winding of the polarized supervisory relay 1007 is such that the relay does not operate. As soon, however, as the trunk 1000 is completed through to the calling line 502 in the manner above described, the supervisory relay 1115 operates in series with the subscriber's line 502. The circuit for the supervisory relay is closed at this time since the ringing control relays 1116 and 1117 are deenergized, the marker having omitted to prepare the trunk for ringing. Relay 1115 in operating closes a circuit from ground through its front contact, front contact of relay 1104, conductor 1118, resistance 1119 to the winding of relay 1102 to battery. Relay 1102 reverses the connections of relay 1100, causing the polarized relay 1107 to operate. Relay 1107 closes an obvious circuit for lighting the lamp 315 at the operator's position.

Noting the lighted lamp 1013, the operator throws the key 1009 to the neutral position and then to the talking position where a second holding circuit is closed through the contacts 1011 for holding the relay 1105. While the key is in the neutral position and relay 1100 is released, relay 1104 is held in a circuit closed at the front contact of supervisory relay 1115. The operator's telephone is now connected to the repeating coil 1006 and the operator speaks to the calling subscriber and advises him that the intercepted connection which he desires has been established between her position and his line. Thereupon the calling subscriber replaces his receiver on

the switchhook causing the release of the line switch and the district and office selector switches 1002 and 1003. The replacing of his receiver on the switchhook also releases the supervisory relay 1115, which in turn causes the release of relay 1102 to reverse the connections of the relay 1100 to the trunk 1000. The direction of current flow over the trunk 1000 is now such that the polarized relay 1007 releases, and the lamp 1013 is extinguished as a signal to the operator that the subscriber has replaced his receiver. The operator now restores the key to the hold position.

Thereafter whenever a call is intercepted during the subscriber's absence relays 1120 and 1121 are operated as previously described and relay 1102 is operated to reverse the direction of current flow, causing the illumination of the lamp 1013 at the operator's position. The operator trips the ringing current by throwing her key 1009 to the intermediate position where relay 1100 releases to cause the operation of relays 1122 and 1123. While relay 1100 is released the relay 1104 is held in a circuit closed over conductor 1127 to ground at the front contact of relay 1120. Relays 1124 and 1125 are also operated as previously described to complete the talking circuit between the calling subscriber and the operator's position.

When the absent subscriber returns and wishes to have the intercept service discontinued, he removes his receiver from the switchhook to cause the operation of supervisory relay 1115. Relay 1115 operates relay 1102 and current is reversed over the trunk to cause the lamp 1013 to light. The operator answers and is advised by the subscriber that he wishes the intercept connection to be released. The operator then throws her key 1009 in the intermediate position, causing the release of relay 1100 and the subsequent release of relay 1104 as soon as the subscriber replaces his receiver to release relay 1115. Relay 1104 causes the release of the connection in the manner hereinbefore described.

What is claimed is:

1. In a telephone system, a subscriber's line, a designation register for establishing and maintaining a registration of the designation of said line during the subscriber's absence, a calling line, a station, and means controlled by said register when the calling party attempts to establish a connection with said absent subscriber's line for automatically extending the calling line to said station.

2. In a telephone system, a subscriber's line, a variably-operable register for establishing and maintaining a registration of the number of said line, means for rendering said line busy while said registration is maintained on said register, a calling line, a telephone station, and means controlled by said register and effective when the calling party attempts to establish a connection to said busy line for automatically extending said calling line to said telephone station.

3. In a telephone system, a line, an operator's position, automatic switches controlled by the operator for setting up a connection to said line, a register for registering the number of said line during the time said connection is established, and means under control of said register for routing to said operator's position all calls directed to said line while the number thereof is registered on said register.

4. In a telephone system, a subscriber's line,

an operator's position, automatic switches, a variably-operable register, means controlled by said operator for operating said switches to set up a connection to said line and for setting said register in accordance with the designation of said line, and means controlled by said register while said designation is registered thereon for routing to said operator all calls directed to said subscriber's line.

5. In a telephone system, a subscriber's line, an operator's position, automatic switches, a variably-operable register, means controlled by said operator for operating said switches to set up and maintain a talking connection between the operator's position and said line during the subscriber's absence from his telephone, means also operated in the establishment of said connection for setting said register in accordance with the designation of said line, and means controlled by said register while said designation is registered thereon for routing to said operator's position all calls directed to said subscriber's line.

6. In a telephone system, a line, an operator's position, automatic switches, means at said position for sending the designation of said line to cause the operation of said switches for setting up a connection to said line, a variably-operable register also responsive to register the designation sent from said position, and means controlled by said register in accordance with the designation registered thereon for routing to said operator's position calls directed to said line.

7. In a telephone system, subscriber's lines, register means for registering the designation of a particular one of said lines, automatic switches, switch-controlling registers responsive to calling subscribers' lines for registering the designations of called lines and for controlling said switches to establish the desired connections, means for comparing the called line designations registered on said switch-controlling registers with the registered designation of said particular line, a special station, and means dependent on the results of the comparison of said designations for automatically extending the calling lines to said special station.

8. In a telephone system, subscribers' lines, register means for registering the designation of a particular one of said lines, a register mechanism, means controlled over calling lines for setting said mechanism in accordance with the designations of called lines, automatic switches controlled by said register mechanism to establish the connections to the called lines, means for comparing the designations registered in said register mechanism with the registered designations of said particular line, a special station, and means effective when the designation in said register mechanism corresponds to that of said particular line for automatically extending the calling line to said special station.

9. In a telephone system, subscribers' lines, an operator's position, means for extending and maintaining a connection between the operator's position and a particular one of said lines while the subscriber is absent, means for registering the designation of said particular line, a register mechanism, means controlled by calling lines for setting said mechanism in accordance with designations of called lines, automatic switches controlled by said register mechanism for establishing the connections to said called lines, means effective each time a called line is found busy for comparing the designation registered in said

register mechanism with the registration on said first-mentioned register, and means controlled in accordance with the result of said comparison for automatically extending the calling line to said operator's position.

10. In a telephone system, a line, an operator's position, automatic switches controlled by the subscriber of said line for setting up a connection between the operator's position and said line, and means for routing to said operator's position all calls directed to said line during the time said connection is established between said position and line.

11. In a telephone system, a subscriber's line, an operator's position, automatic switches, means for transmitting designation signals over said line to control the selective operation of said switches to establish a connection between the operator's position and said line, register means controlled by the designation signals transmitted over said line for registering the designation of said line, and means under the control of said register means for routing to the operator's position all calls directed to said line while the designation thereof is registered on said register means.

12. In a telephone system, a subscriber's line, an operator's position, automatic switches, means responsive to the initiation of a call by the subscriber of said line for extending said line to said automatic switches, means for transmitting designation impulses over the subscriber's line to cause the operation of said switches to establish a connection between the operator's position and said line, means for maintaining said connection between the operator's position and the subscriber's line after the subscriber has restored his substation to its normal condition, and means for routing to the operator's position all calls directed to the subscriber's line while said connection is being maintained.

13. In a telephone system, a subscriber's line, an operator's position, a trunk appearing in said position, means controlled by the subscriber of said line for extending a connection from said line to said trunk and for extending a connection from said trunk back to said line, and means effective while said trunk is connected to said line for routing over said trunk to the operator's position all calls directed to said subscriber's line.

14. In a telephone system, a subscriber's line, an operator's position, a trunk appearing in said position, means controlled by the subscriber of said line for extending a connection from said line to said trunk and for extending a connection from said trunk back to said line, means controlled by the subscriber for releasing the connection from his line to said trunk without releasing the connection from said trunk to said line, and means effective while said trunk is connected to said line for routing to the operator's position calls directed to said line.

15. In a telephone system, automatic switches, subscribers' lines appearing in said switches, an operator's position, a trunk extending from said position and appearing in said switches, means controlled by the operator for setting up a connection over said trunk and through said switches to a particular one of said lines, register means for registering the designation of said particular line while said connection is maintained, means controlled by calling lines for establishing connections through said switches to called lines, and means controlled by said register when a calling party directs a call to said particular line for

automatically extending the calling line through said switches and over said trunk to the operator's position.

16. In a telephone system, group selectors, final selectors, subscribers' lines appearing in said final selectors, an operator's position, a trunk extending from said position and appearing in said group selectors and also appearing in said final selectors, means controlled by the operator for setting up a connection over said trunk and through said group and final selectors to a particular one of said lines, register means for registering the number of said particular line while said connection is maintained, means controlled by calling lines for establishing connections through said switches to called lines, and means controlled by said register when a calling party directs a call to said particular line for automatically extending the calling line through said group and final selectors and over said trunk to the operator's position.

17. In a telephone system, subscribers' lines, an operator's position, a trunk, means controlled by the operator for setting up a connection from her position over said trunk to a particular one of said lines, means for establishing a connection from a calling line to a called line, signaling means for applying ringing current to the called line, means effective when the calling subscriber attempts to call said particular line for automatically extending the calling line over said trunk to the operator's position, and circuit means for connecting said signaling means over said trunk to said particular line.

18. In a telephone system, subscribers' lines, an operator's position, a trunk, means controlled by the operator for setting up a connection from her position over said trunk to a particular one of said lines, means for establishing a connection from a calling line to a called line, signaling means for applying ringing current to the called line, and means effective when the calling sub-

scriber attempts to call said particular line for automatically extending the calling line over said trunk both to said particular line and to the operator's position and for applying current from said signaling means over said trunk to said particular line.

19. In a telephone system, subscribers' lines, an operator's position, a trunk, means controlled by the operator for setting up a connection from her position over said trunk to a particular one of said lines, means for establishing a connection from a calling line to a called line, signaling means for applying ringing current to the called line, means effective when the calling subscriber attempts to call said particular line for automatically extending the calling line over said trunk to the operator's position, circuit means for connecting said signaling means over said trunk to said particular line, and means controlled over said trunk by the operator for disconnecting said signaling means from said particular line.

20. In a telephone system, subscribers' lines, an operator's position, a trunk, means controlled by the operator for setting up a connection from her position over said trunk to a particular one of said lines, means for establishing a connection from a calling line to a called line, signaling means for applying ringing current to the called line, means effective when the calling subscriber attempts to call said particular line for automatically extending the calling line over said trunk both to said particular line and to the operator's position and for applying current from said signaling means over said trunk to said particular line, means for sending a signal over said trunk to notify the operator that a calling line has been extended to said trunk, and means controlled over said trunk by the operator for disconnecting said signaling means from said trunk.

RALPH E. HERSEY.