

Feb. 6, 1945.

C. W. LUCEK

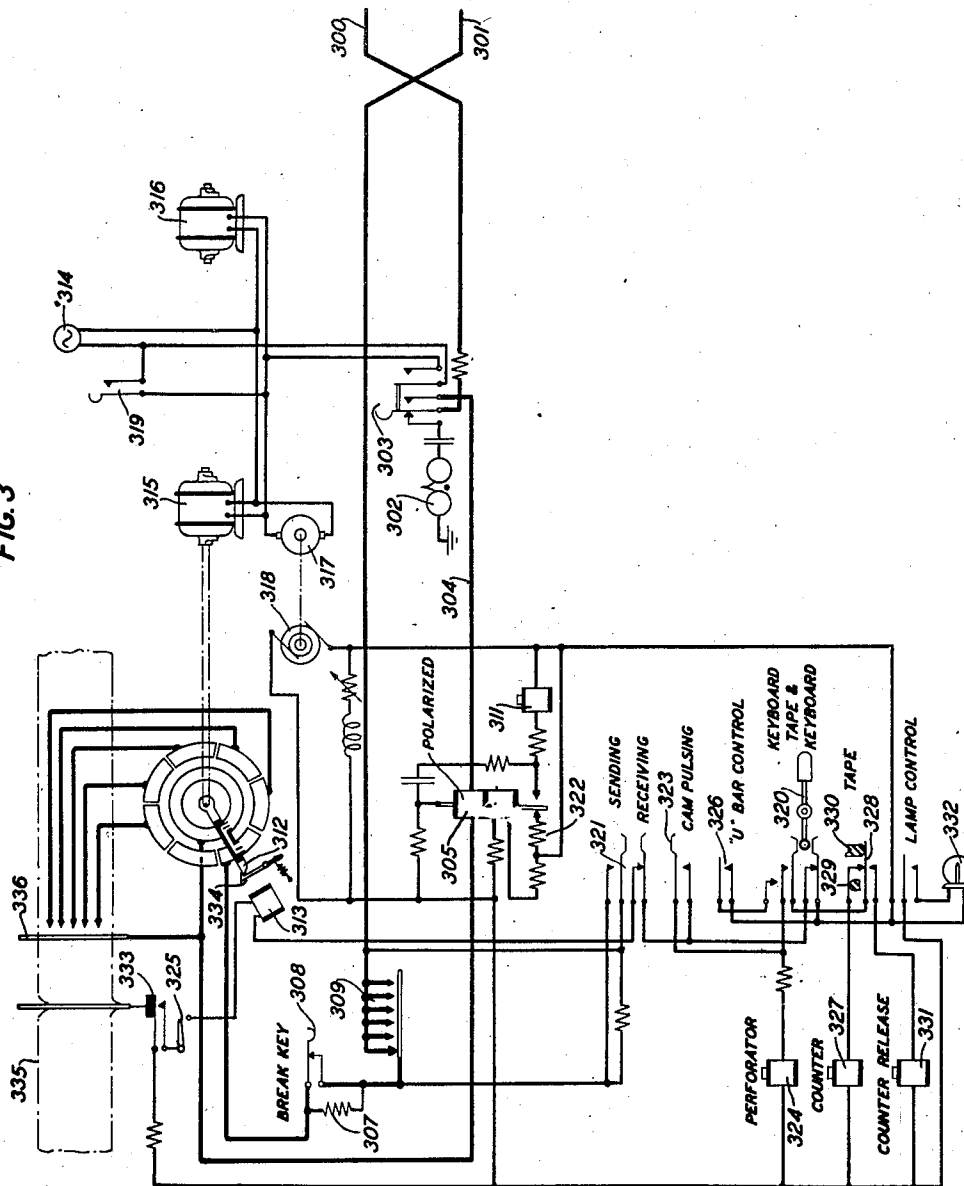
2,368,715

TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 2

FIG. 3



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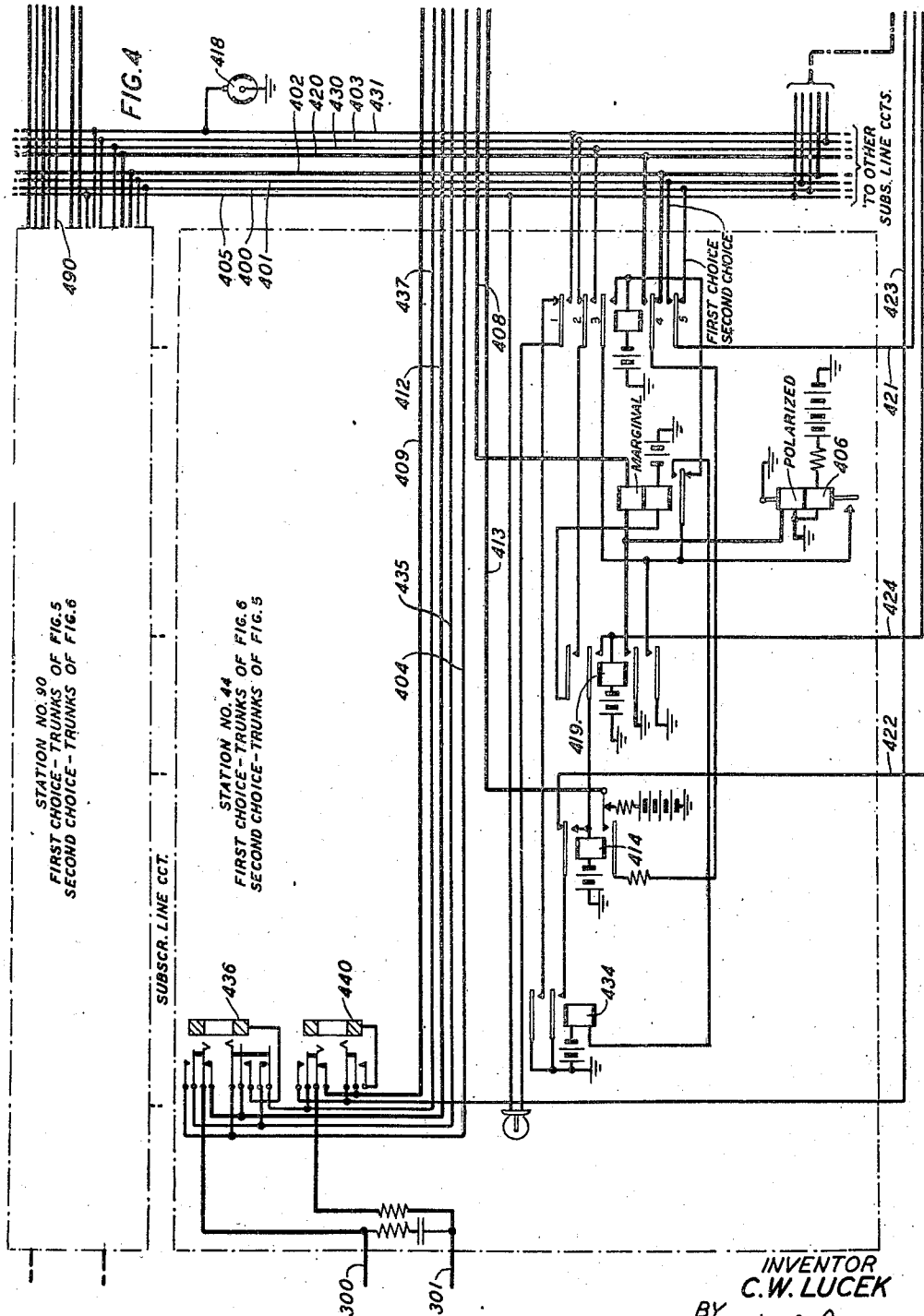
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 3



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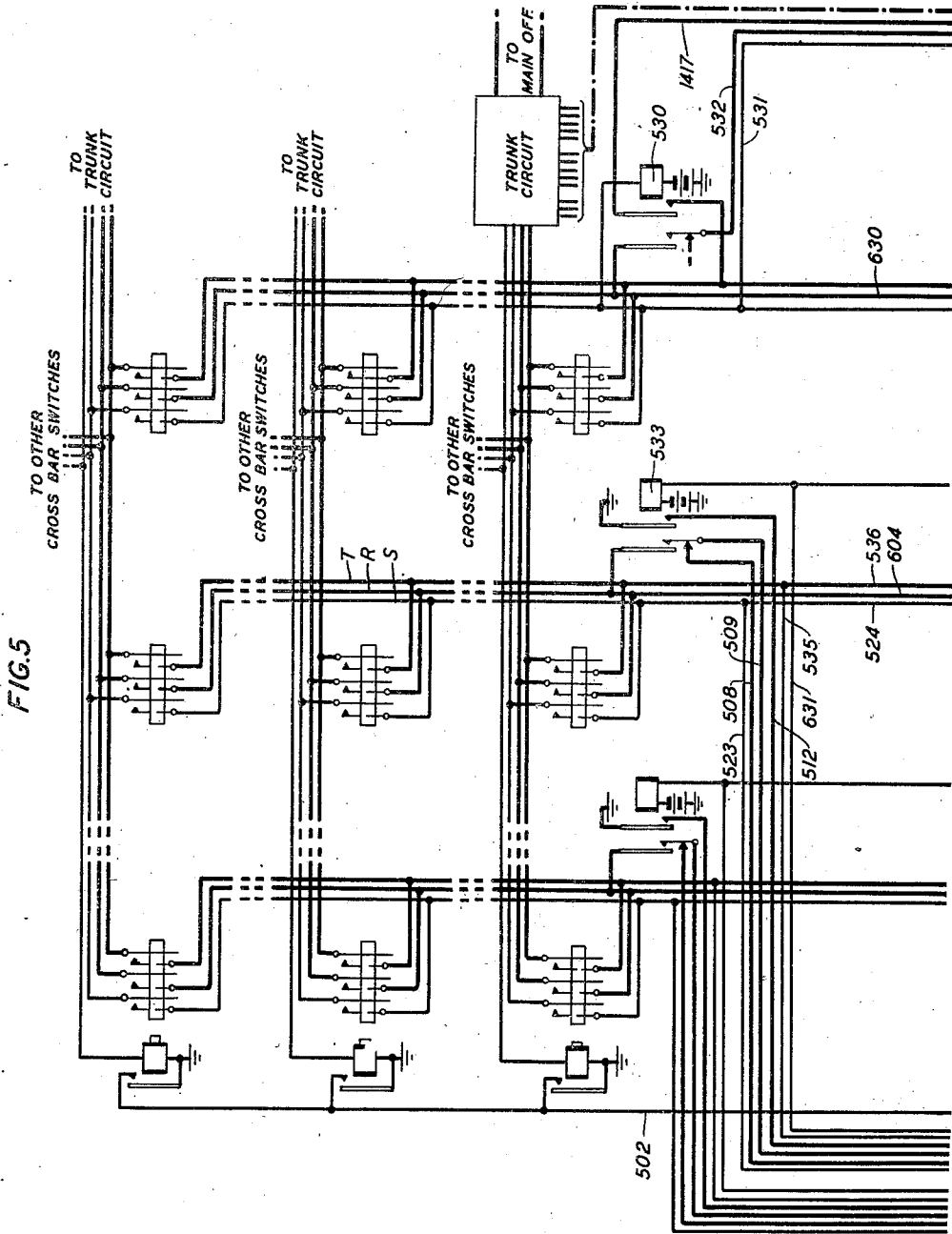
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TELETYPEWRITER EXCHANGE SYSTEM

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26 Sheets--sheet 4



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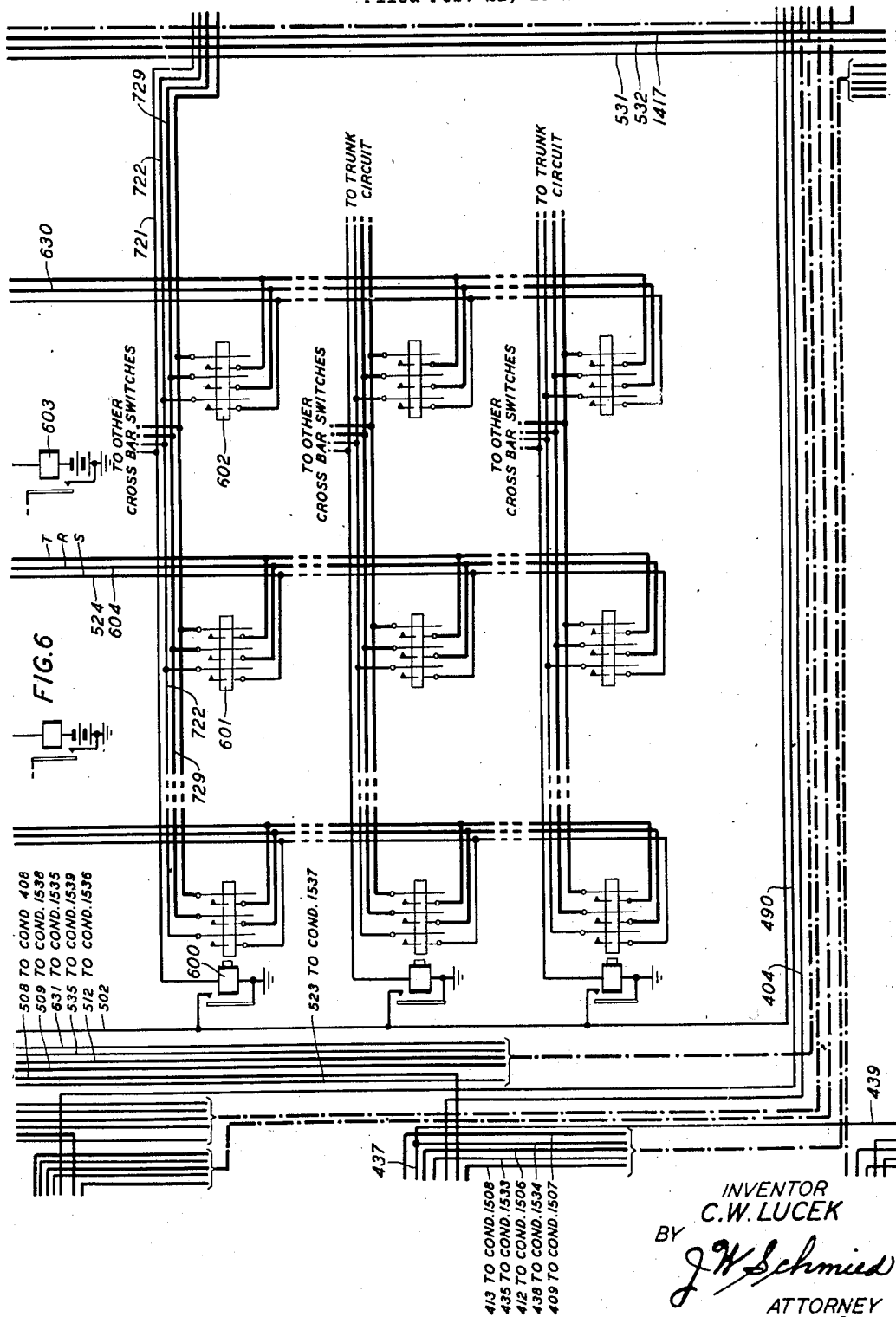
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2,368,715

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Filed Feb. 21, 1942

26 Sheets-Sheet 5



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2,368,715

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Filed Feb. 21, 1942

26 Sheets-Sheet 6

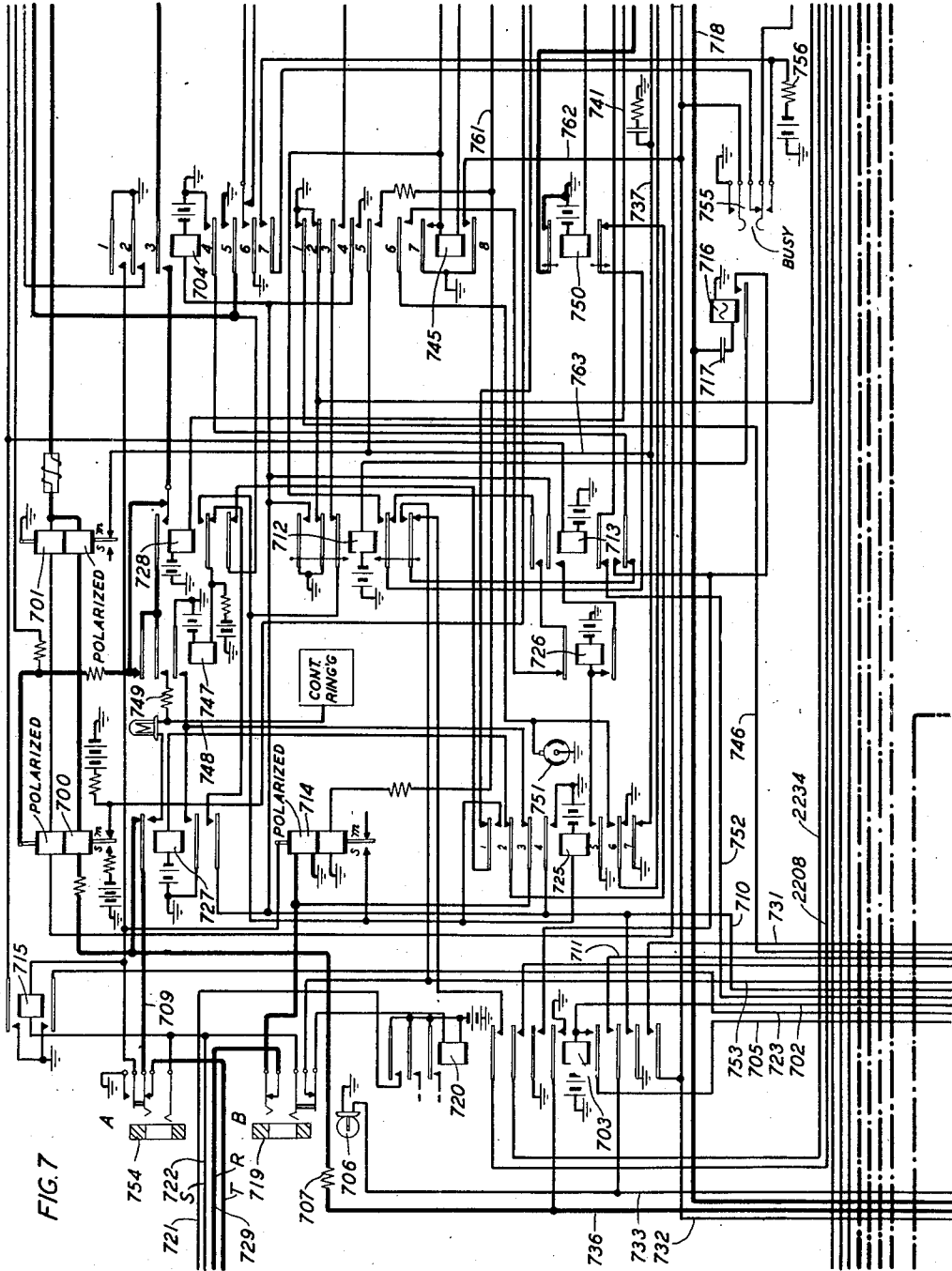


FIG. 7

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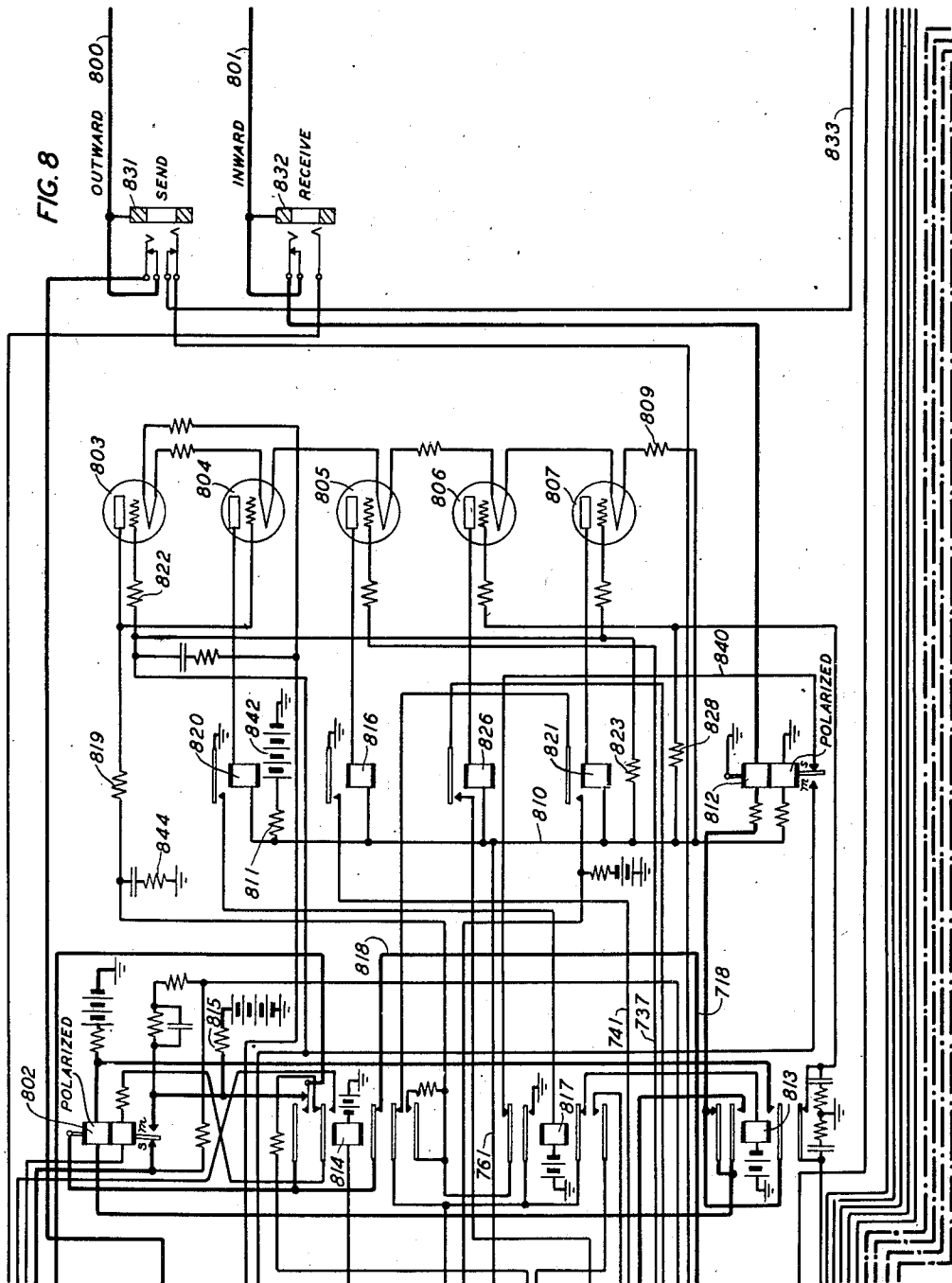
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 7



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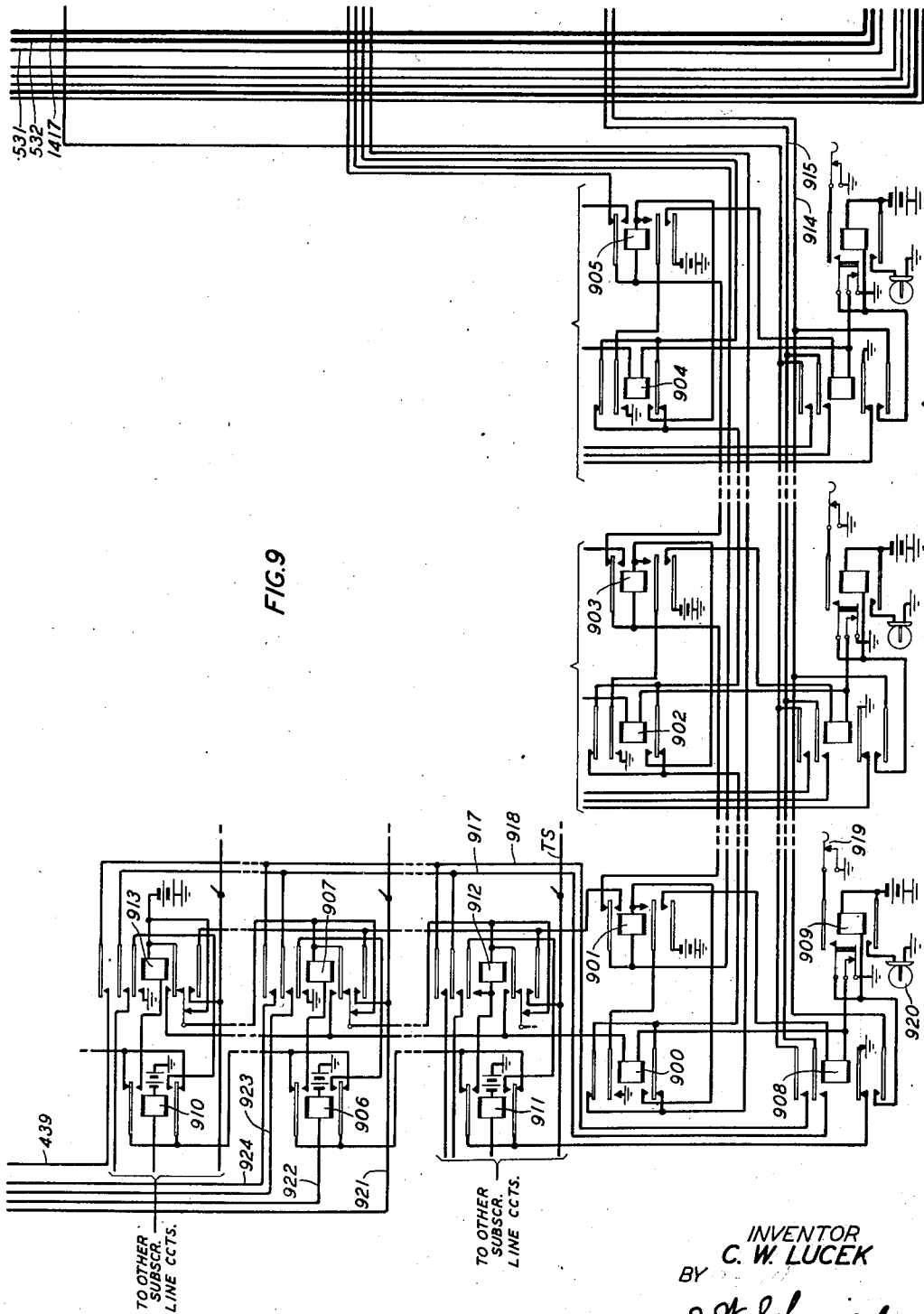
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 8



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2,368,715

TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 9

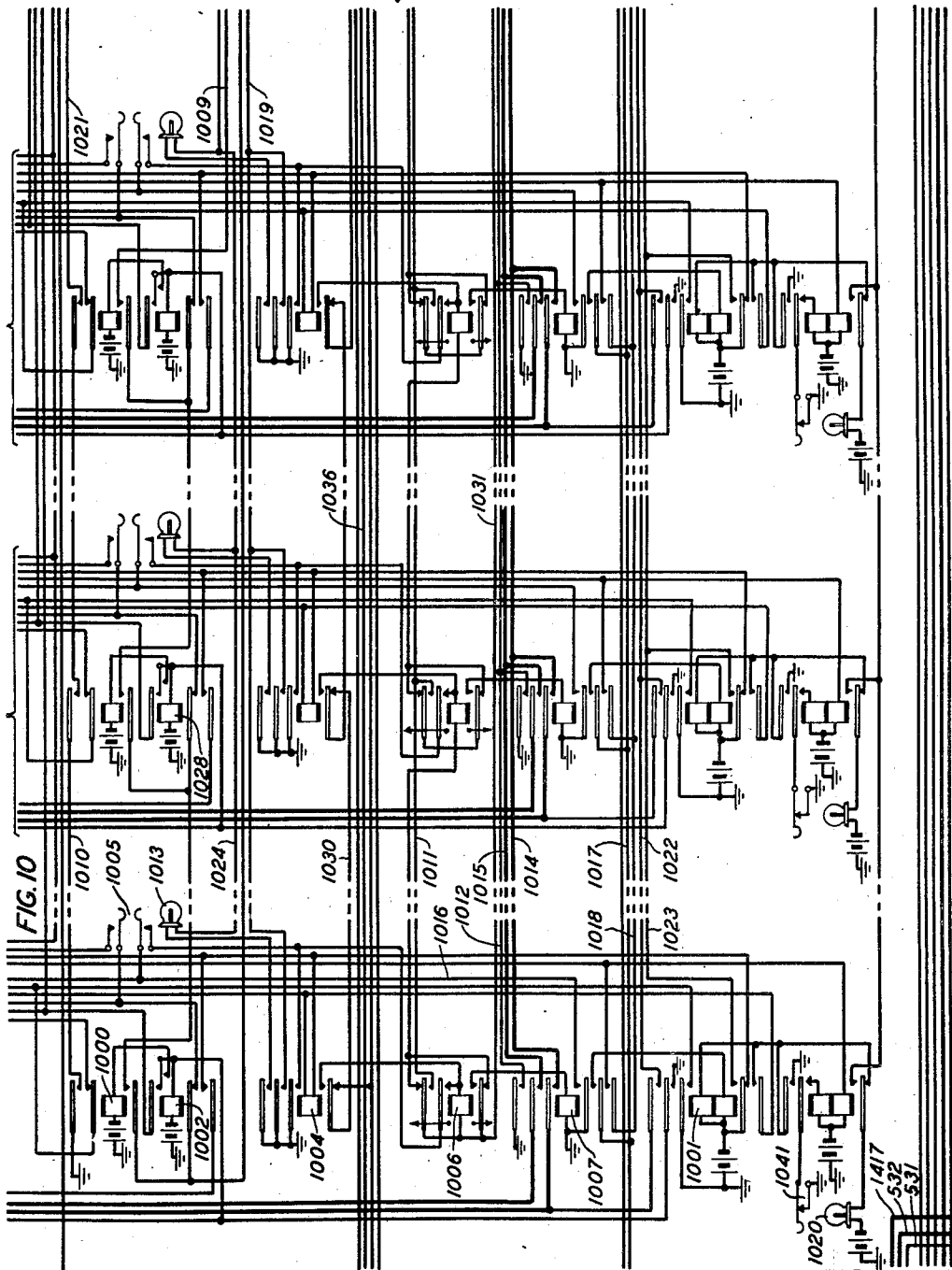


FIG. 10

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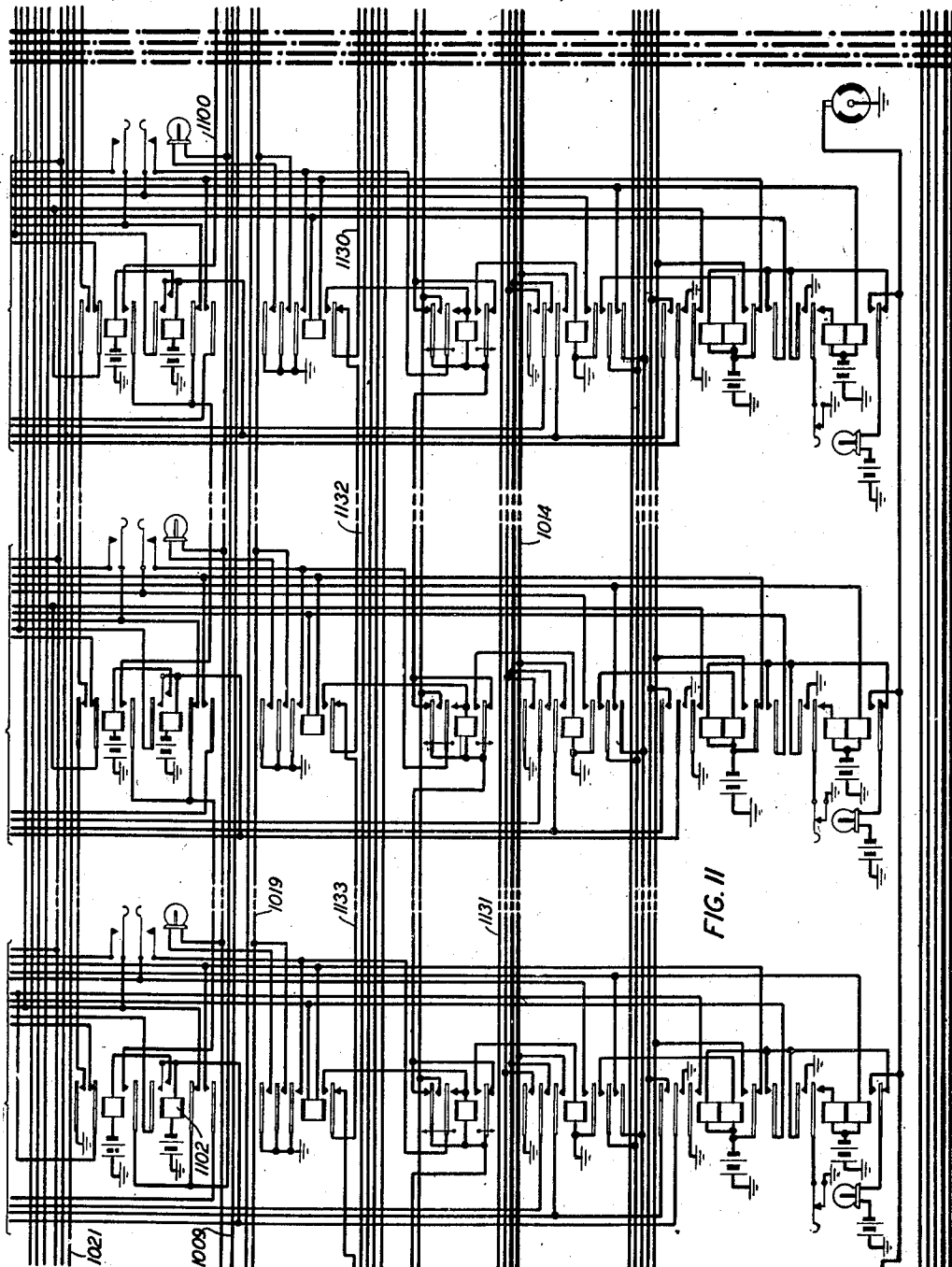
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 10



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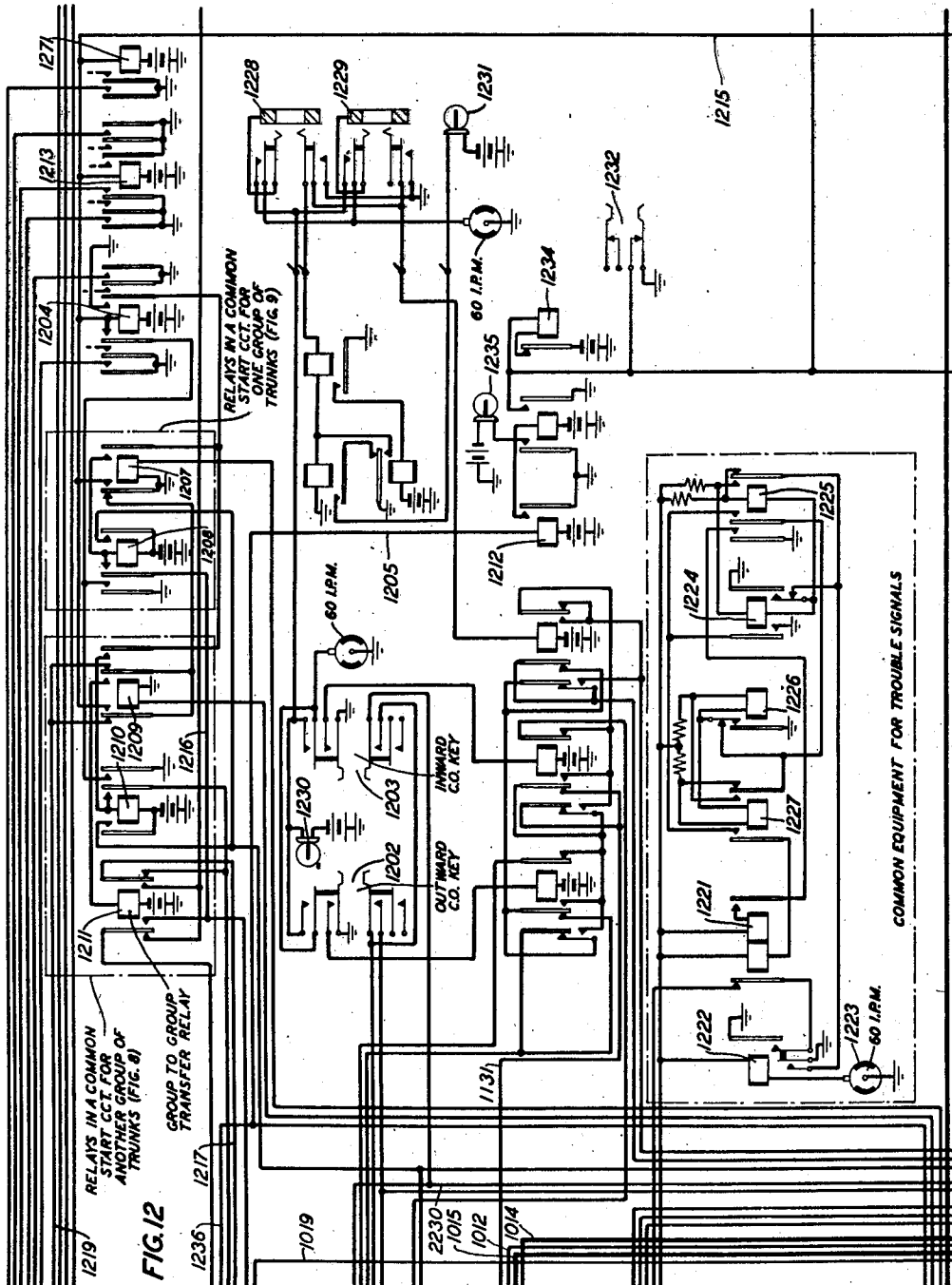
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 11



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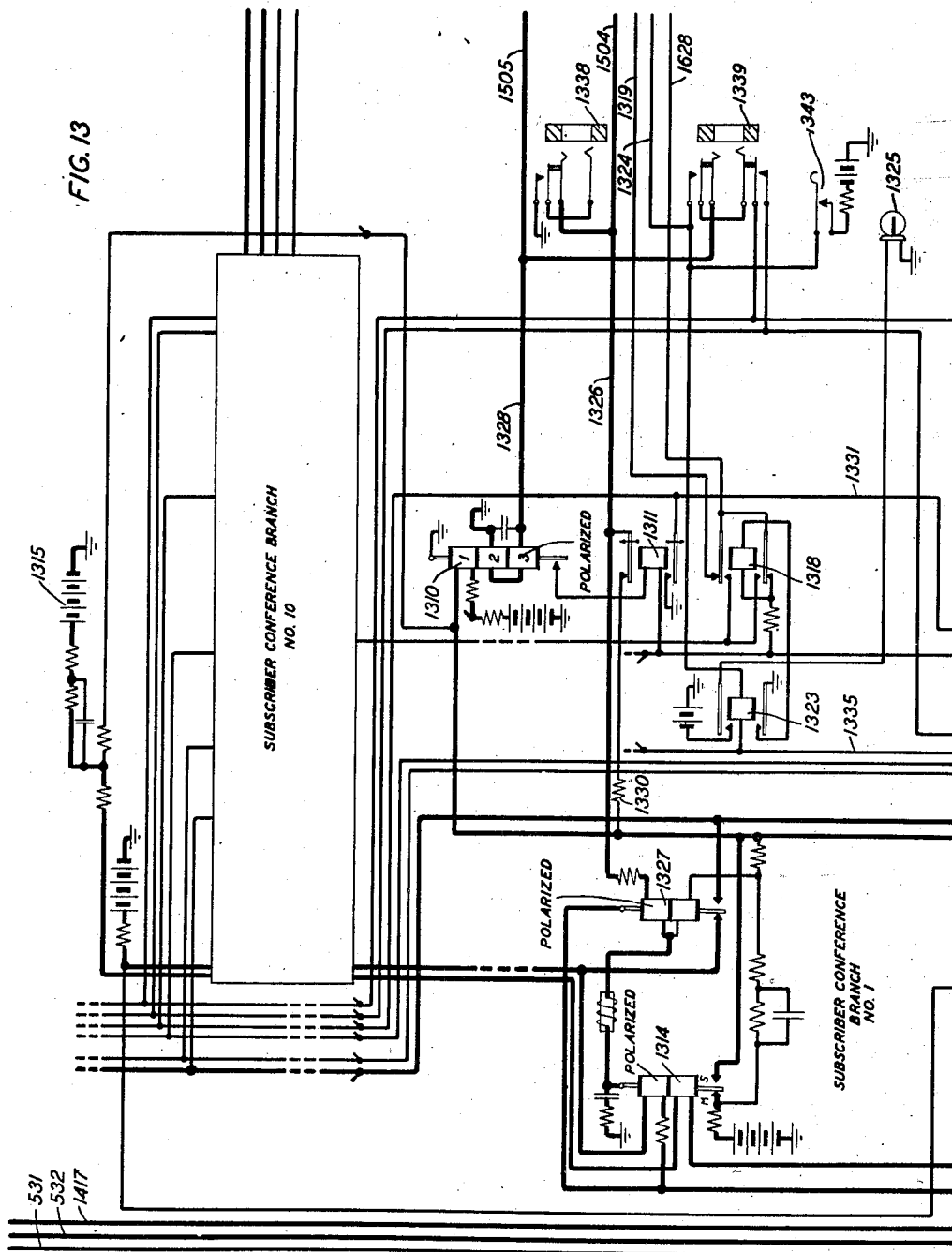
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 12



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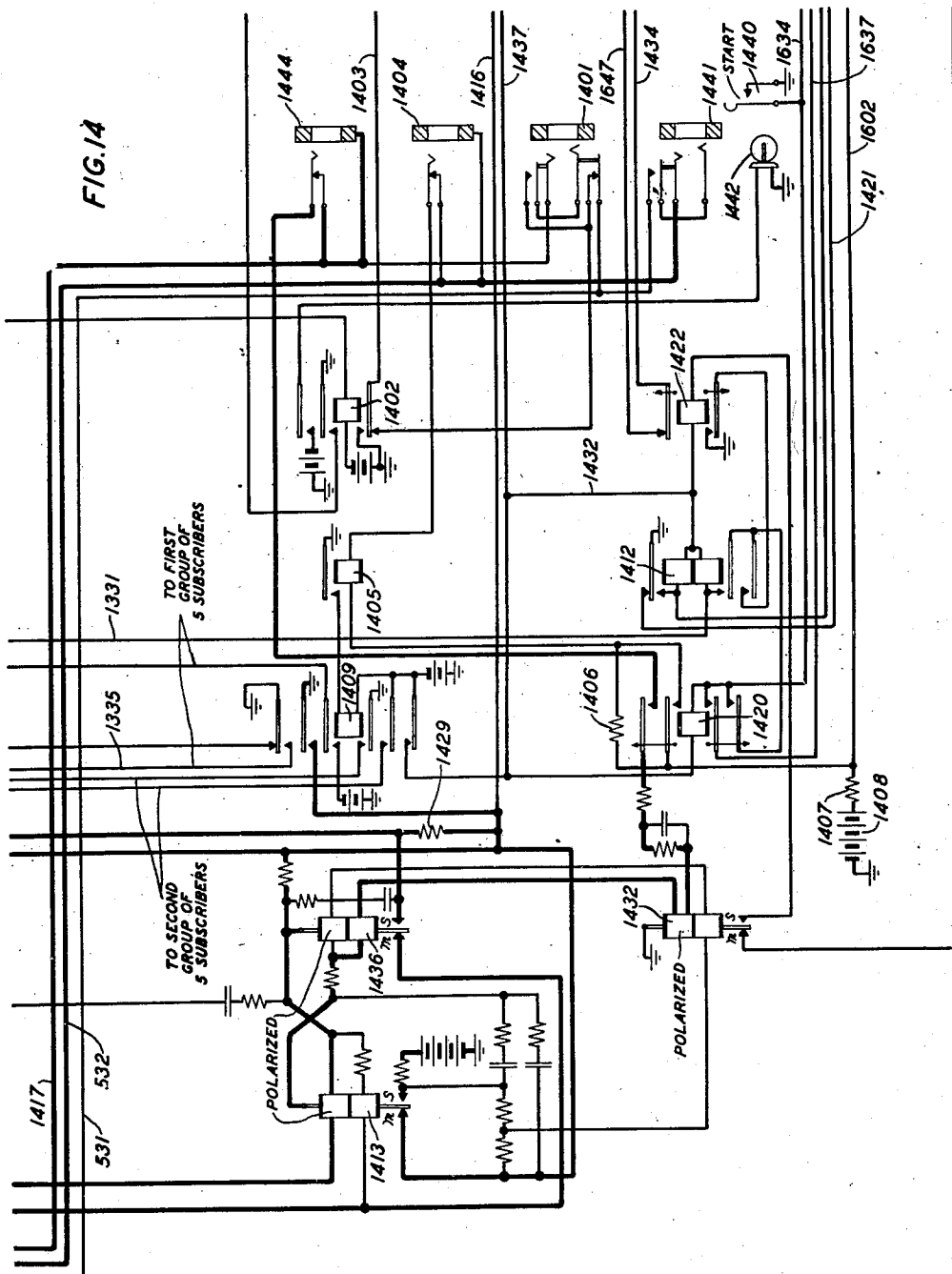
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 13



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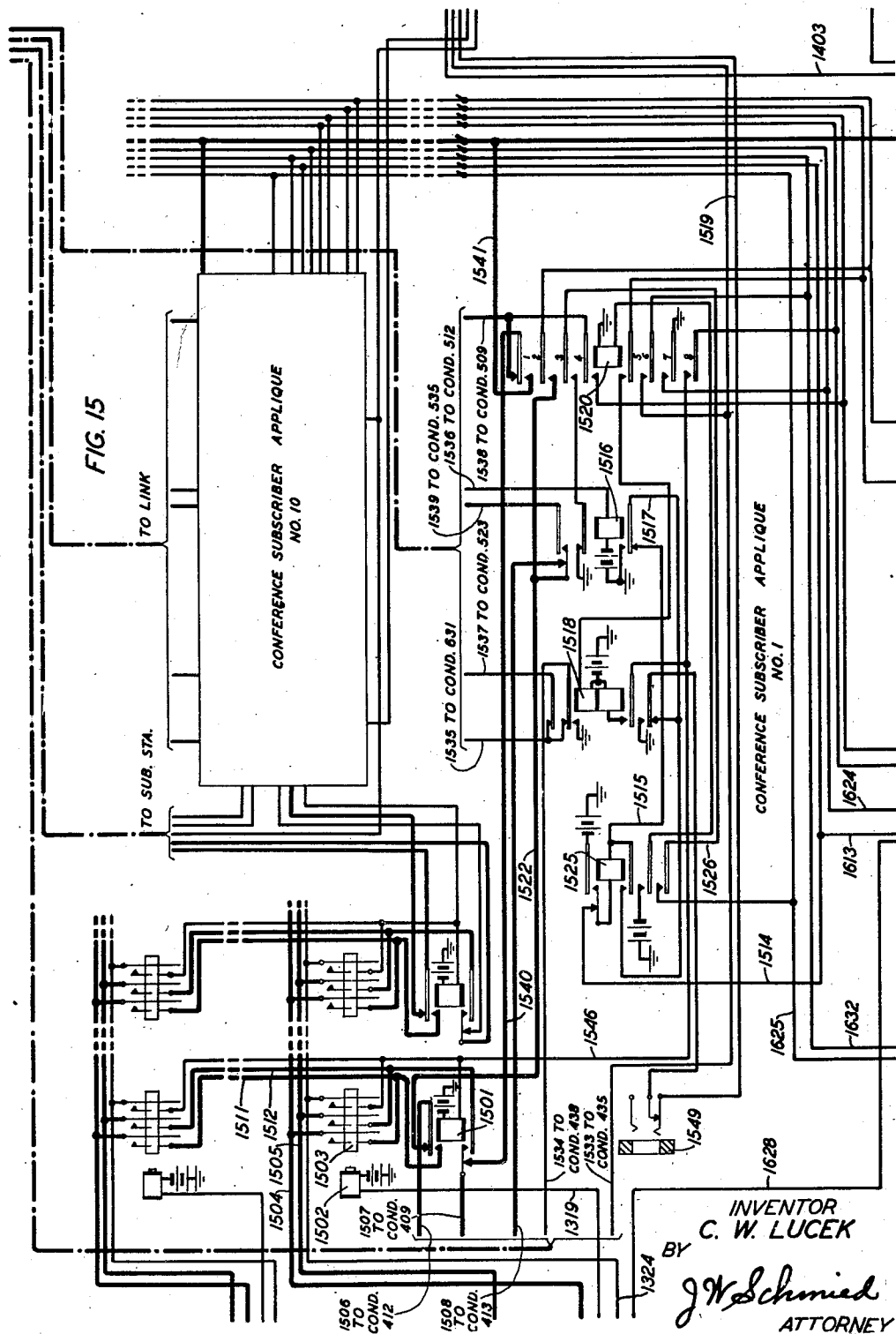
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Filed Feb. 21, 1942

26 Sheets-Sheet 14



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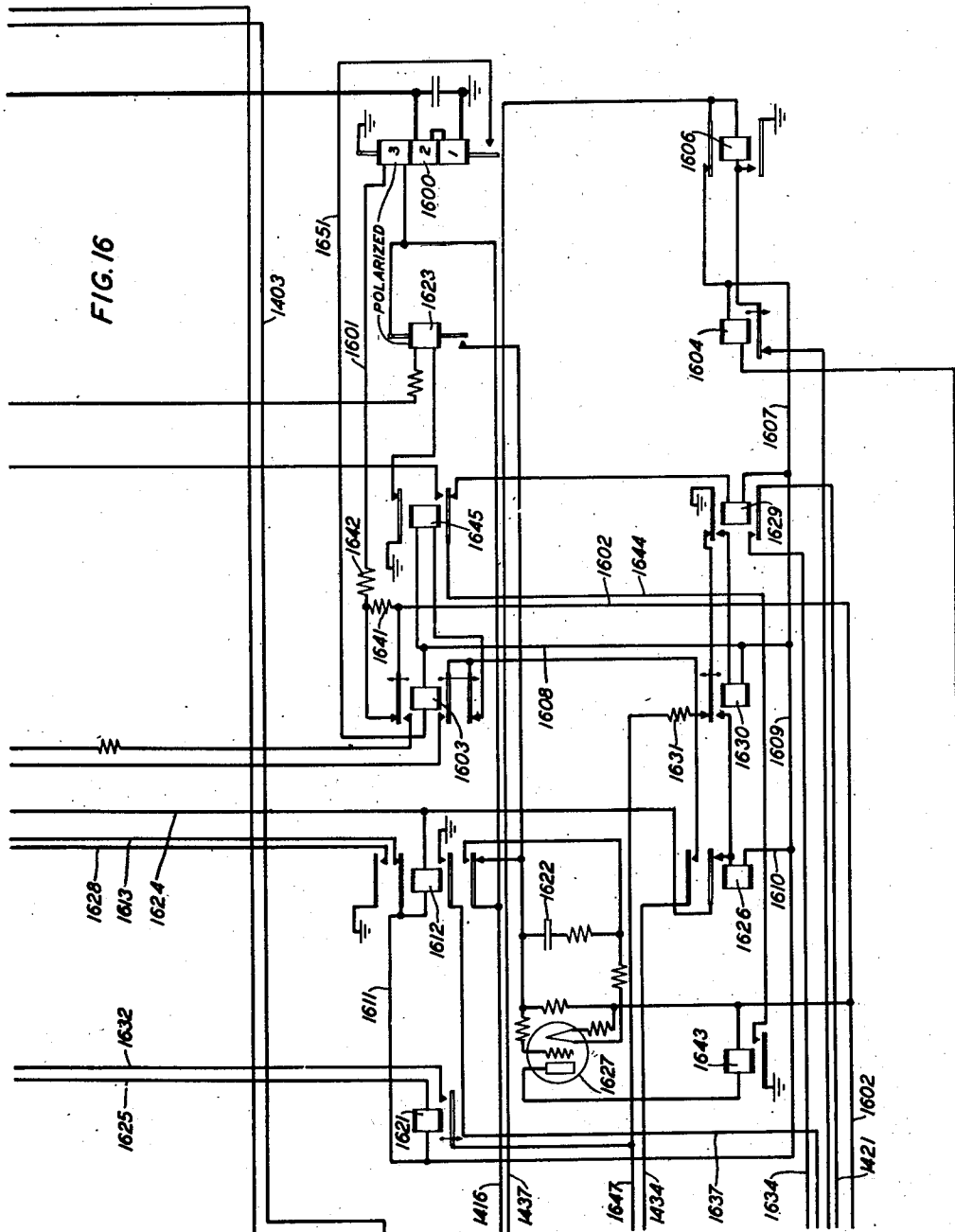
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 15



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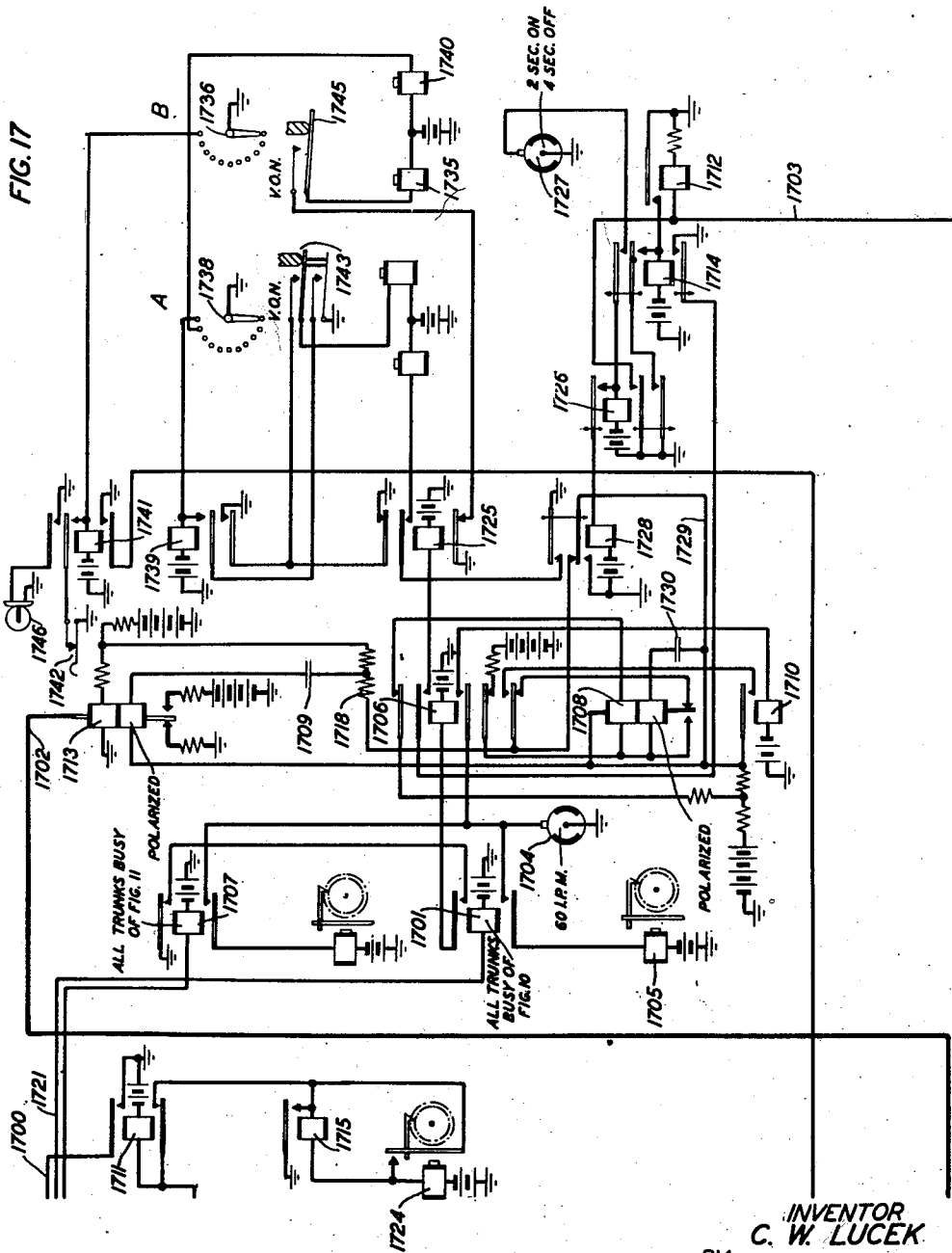
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 16



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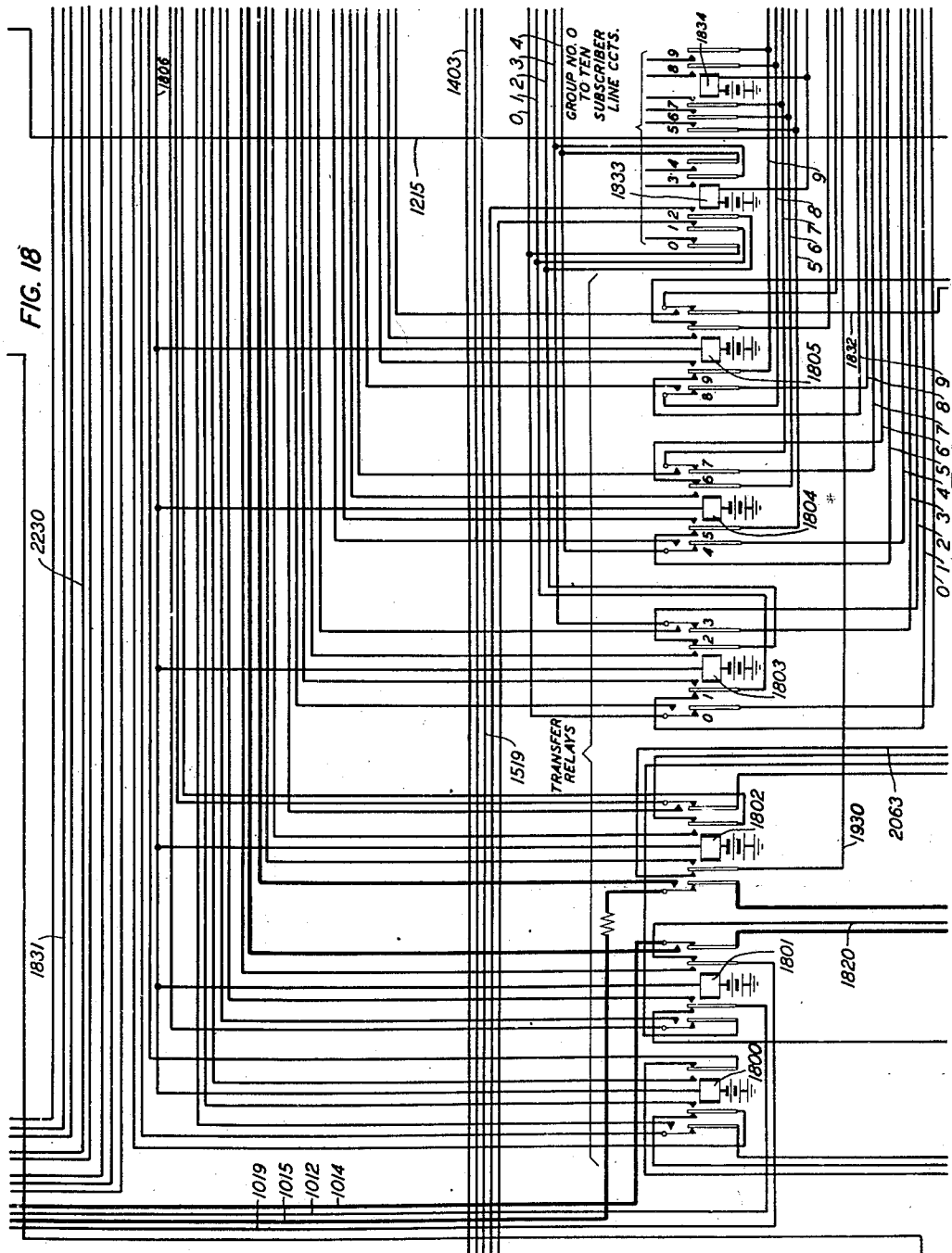
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 17



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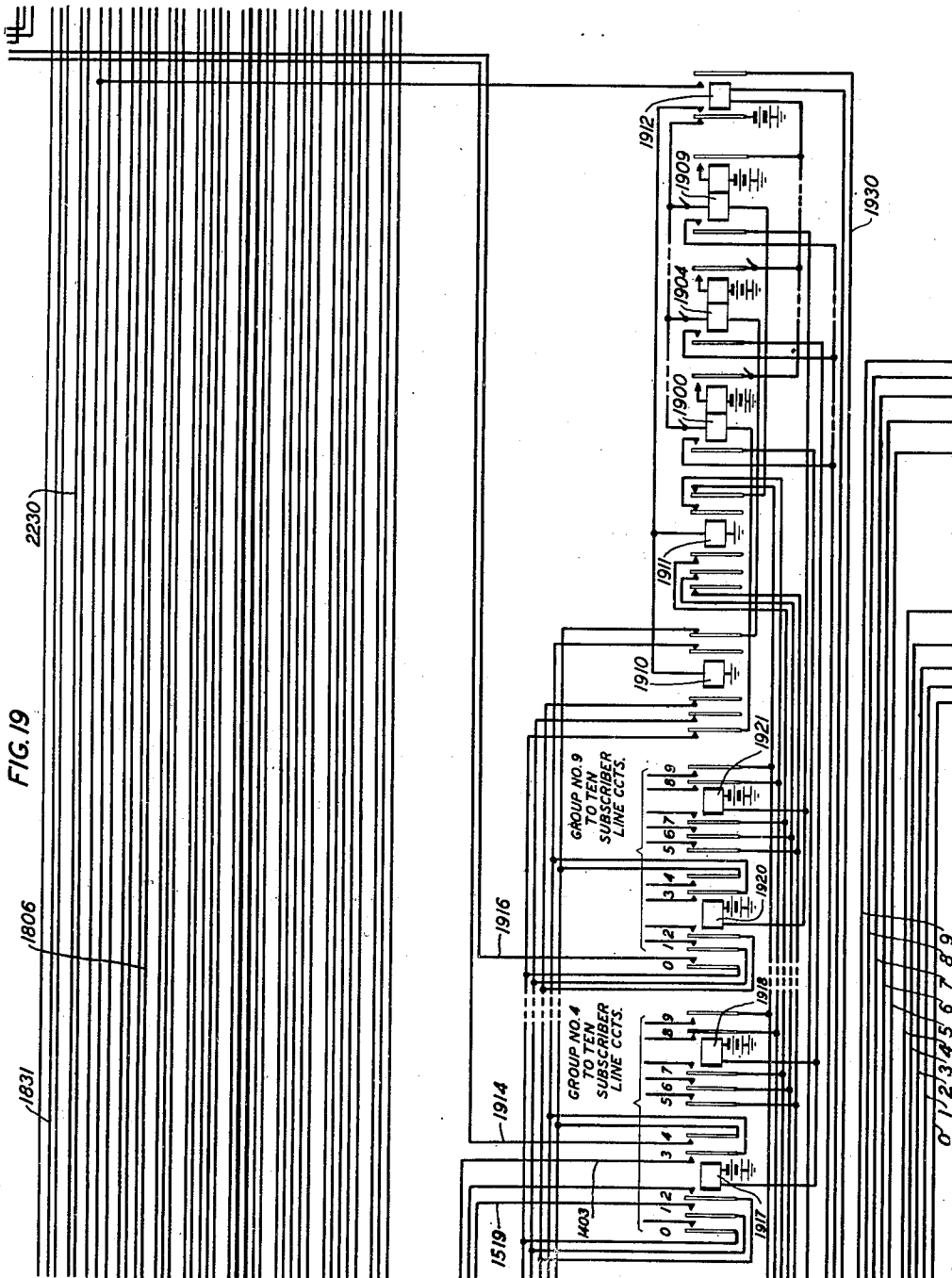
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 18



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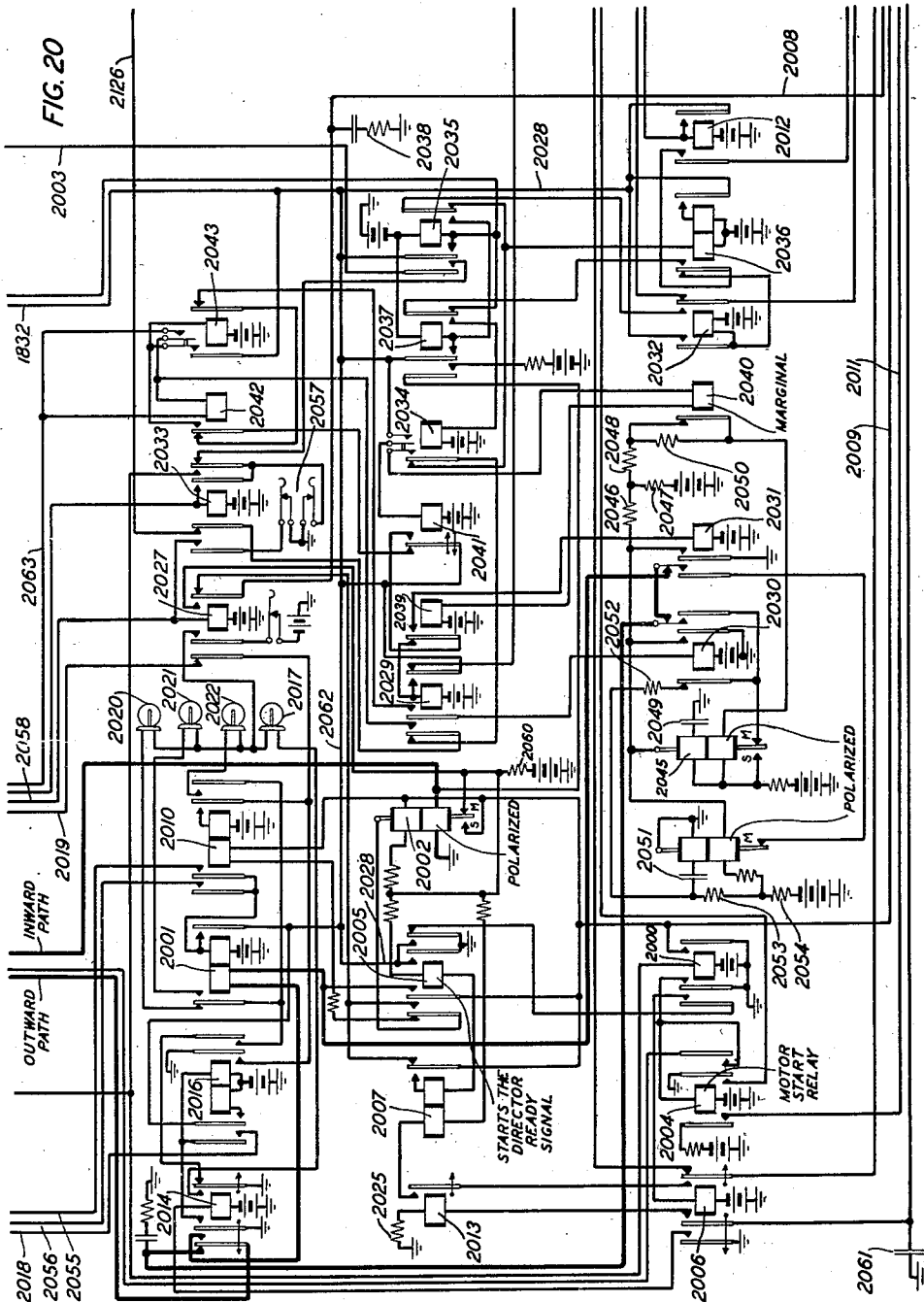
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 19



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2,368,715

TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 20

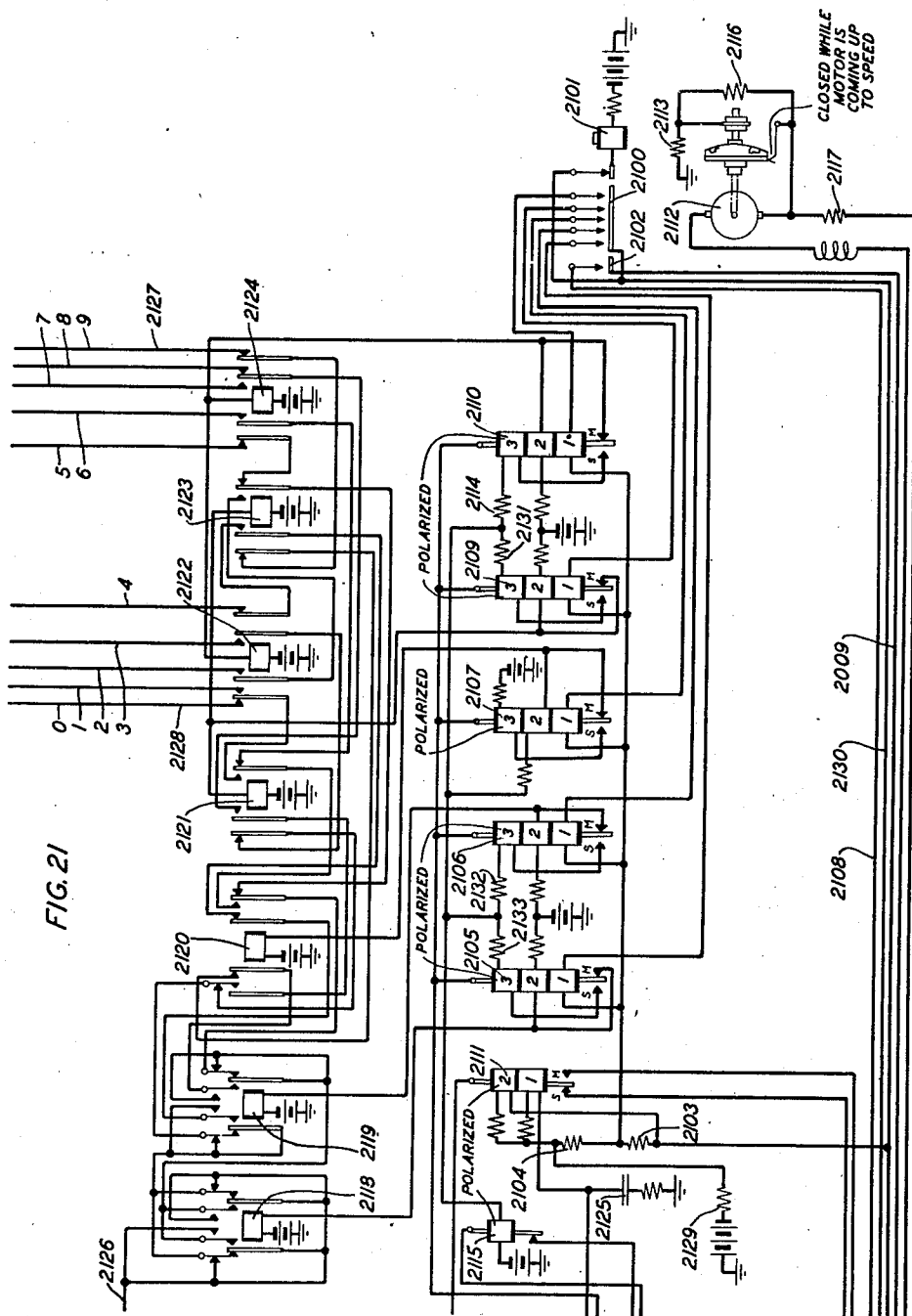


FIG. 21

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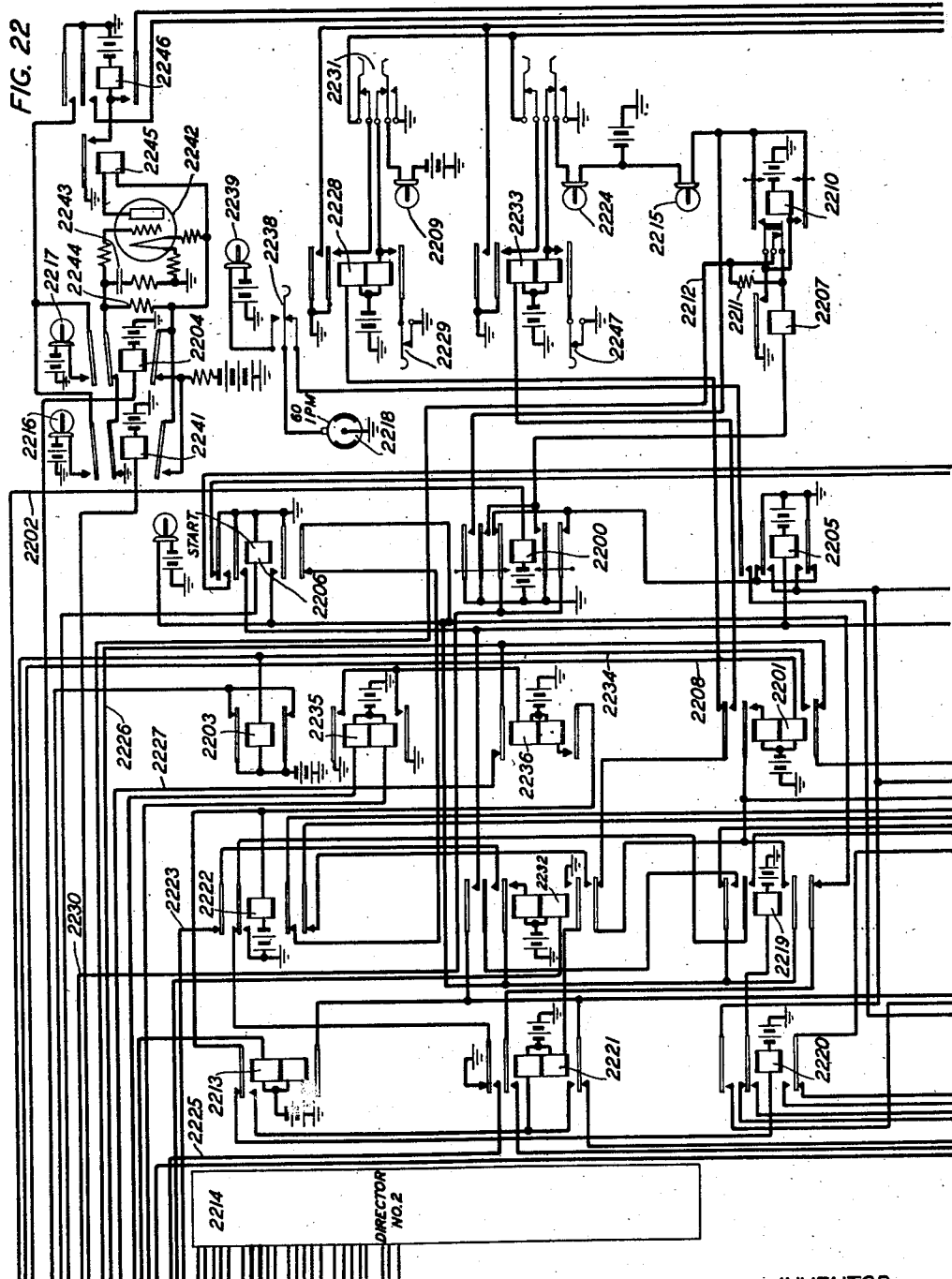
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 21



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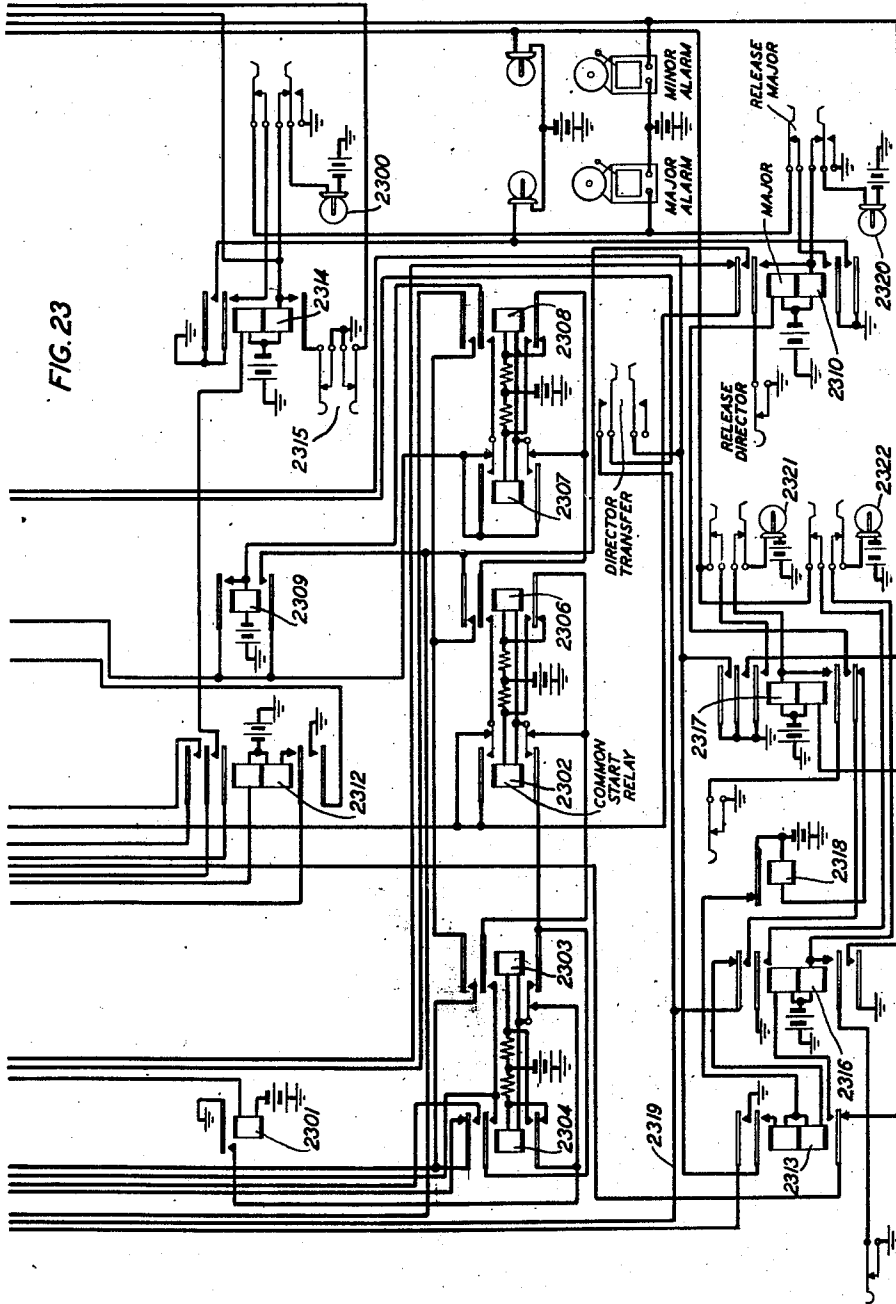
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 22



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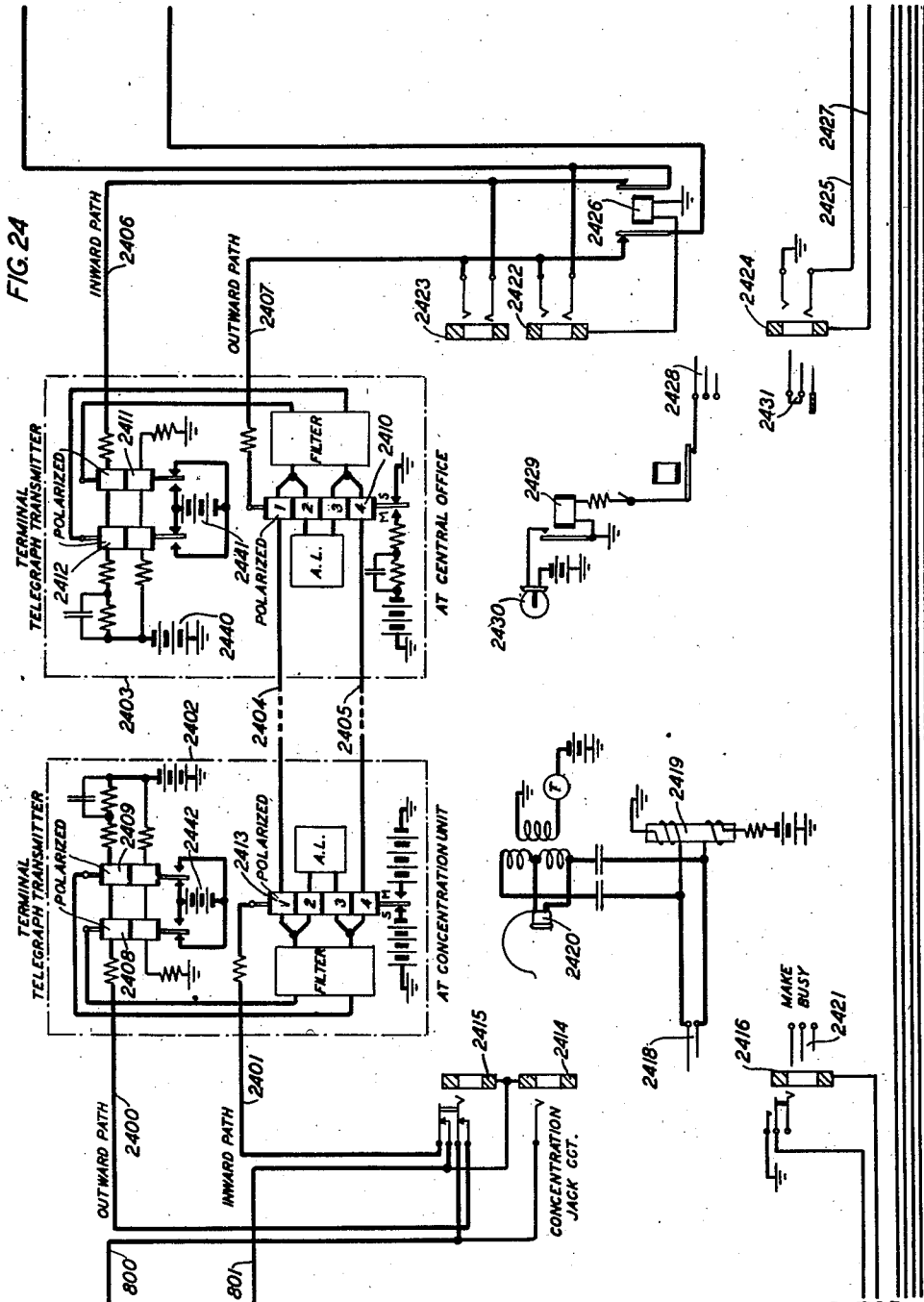
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 23



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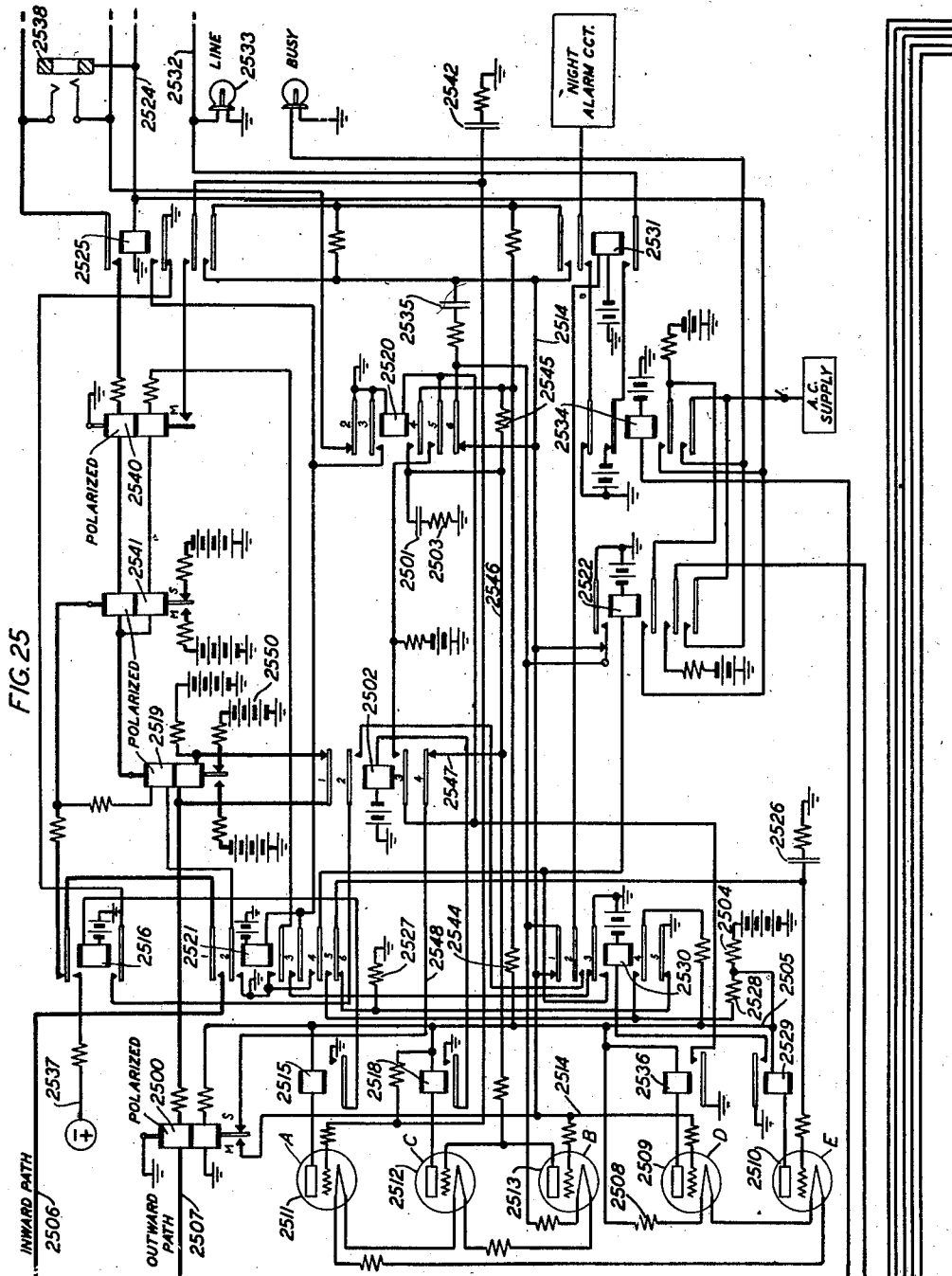
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 24



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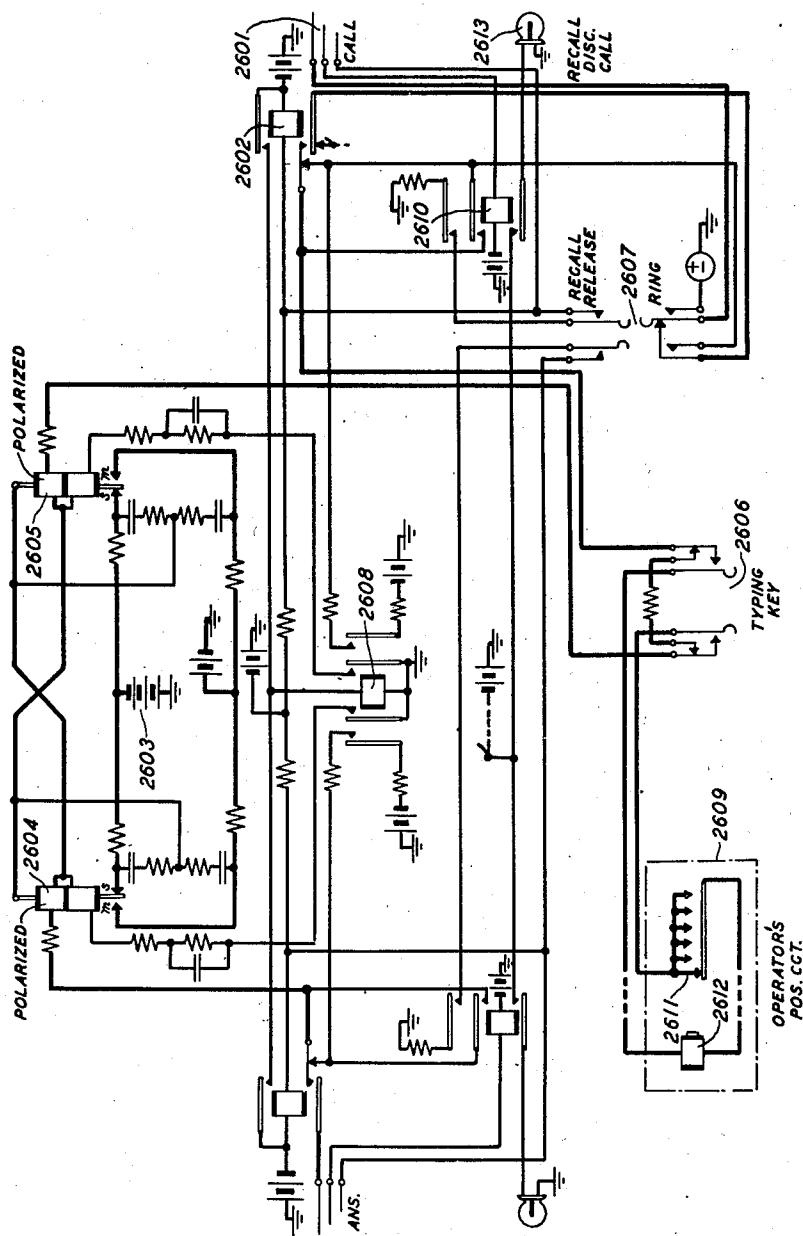
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 25

FIG. 26



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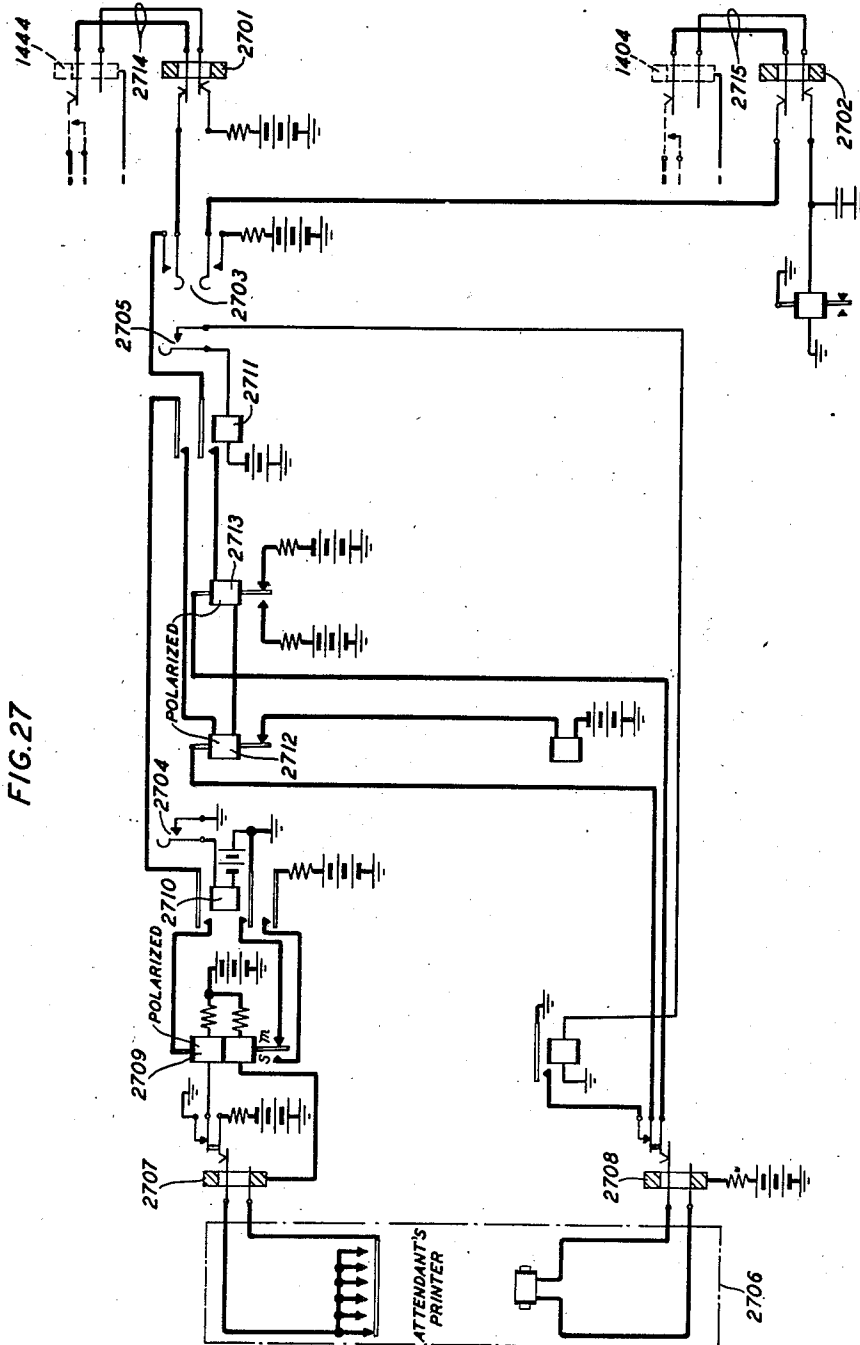
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TELETYPEWRITER EXCHANGE SYSTEM

Filed Feb. 21, 1942

26 Sheets-Sheet 26



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UNITED STATES PATENT OFFICE

2,368,715

TELETYPEWRITER EXCHANGE SYSTEM

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Application February 21, 1942, Serial No. 431,854

29 Claims. (Cl. 178—2)

This invention relates to communication systems and particularly to switching systems for interconnecting machine telegraph subscriber stations.

In an application of Fitch et al., Serial No. 173,958, filed November 11, 1937, is a disclosure of a telegraph satellite or line concentrating system; this system consists in brief of subscribers stations, a satellite office or station, and one or more central stations connected to the satellite station by trunks together with means whereby any subscriber may call and become connected over a switch at the satellite office to a trunk to the central office and whereby an operator at the central office may select any idle trunk and cause by remote control from the central office the connection of a subscriber line to the trunk for intercommunication with or through the central office. Certain improvements upon or modifications of the Fitch system have been invented and among these is one disclosed in the application of Krecek Serial No. 348,629, filed July 31, 1940. One requirement of certain telegraph subscribers is that they be able to connect their machines in line with a plurality of others for a so-called conference which consists of three or more subscribers connected so that each in turn may communicate to all the others. To connect a single subscriber upon a satellite system with two or more others reached through the central office of the satellite system offers no particular problem. However, the main object of satellite systems is to provide a considerable number of subscribers' stations with service over a small number of trunks. If then several subscribers upon the same satellite system desire a conference this would tie up as many trunks as the number of subscribers (if the conference connection were made at the central office). Moreover, in a satellite system of "n" trunks, for example, if more than "n" subscribers wished to be put upon one or several conferences simultaneously, this could not be done. Consequently, a major problem solved by this invention is the problem of connecting a considerable number of subscribers whose lines extend to a satellite office in a conference without tying up more than a single trunk after the conference is established; by means of this trunk, if desired, the conference can be extended to or through the central office to other subscribers, trunks, stations or groups of stations or conference circuits at the same or other satellite offices.

An object of the invention is to provide in an automatically operated telegraph line concentrating unit, or satellite, switching center, a conference circuit to which two or more specially arranged subscriber stations connected to the concentrating unit, can be interconnected auto-

matically under control of an operator at the master, or central, office.

Another object is to adapt the conference circuit for manually adding thereto the same subscriber stations and any other stations in the concentrating unit by the concentrating unit attendant.

Still another object is to arrange the conference circuit for manual operation only.

According to the present invention the satellite teletypewriter system may be provided with conference circuit equipment at an automatically operated concentrating unit center to permit intercommunication between a trunk from the master, or central, office and two or more subscriber lines directly connected with a teletypewriter line concentrating unit located at the switching center intermediate the central office and a group of subscriber stations. Subscriber stations served by offices other than the line concentrating unit may be connected to the same conference over the trunk from the operator position at the central office. The connections may be established automatically under control of an operator at the central office or they may be established on a manual basis, with patching cords, by the attendant at the line concentrating unit switching center.

The specific embodiment of the invention as herein disclosed is described as being incorporated in a system otherwise according to the disclosure of the Krecek application Serial No. 348,629, supra, and except for minor variations of inconsequential nature certain figures of the drawings hereof correspond to figures of the Krecek disclosure according to the following table:

Figure of this application	Figure of Krecek
3	4
4	6
5	8
6	9
7	11
8	13
9	10
10	12
11	14
12	16
17	20
18	17
19	21
20	18
21	22
22	23
23	24
24	15
25	19

In describing this invention specific recital has been made herein of the details of setting up calls and using the conference circuit to establish conference connections. It will be noted that Krecek uses reference characters of which the first digit

or two digits identify his figure number and this plan in the main has been retained herein. Thus in Krecek's supervisory relay 1114 (Fig. 11) corresponds to supervisory relay 714 (Fig. 7) herein. Numerous other similar correspondences will be noted by which reference can be made to the Krecek disclosure for general description of operation of parts of the system not outlined herein in great detail. In this manner the description herein is directed more particularly to the present invention. However, reference may be made to Krecek for any further detail and by reference the disclosure of Krecek is made a part hereof to the same extent as though the entire description had been included in extenso.

As specifically disclosed, one conference network, whether operated on a manual or on an automatic basis, provides for a maximum of ten subscriber conference branches and one trunk conference branch. For manual operation the trunk conference branch is patched to a trunk extending to the operator position at the central office and the subscriber conference branches may be patched to any ten subscriber lines. When automatic operation is required each subscriber line to be arranged for connection to the conference network, is modified by the addition of a subscriber conference applique circuit together with a common automatic control circuit. Each subscriber line arranged for automatic connection to the conference network is assigned an unlisted number or designation in addition to the regular or listed number and an unlisted number is also assigned to the trunk conference branch. Should there be only one hundred numbers available in the teletypewriter line concentrating unit, as in this system of 10×10 selections, the number of subscriber lines which could be arranged for automatic connection to the conference network would be limited to 49. The number of subscribers which may be served by a line concentrating unit arranged for automatic conference connection would be reduced accordingly.

However, as described in Fitch, supra, a satellite system of the two-digit type may be extended to over one hundred subscribers by use of non-numerical code designations, i. e., about 30×30 , with a five-unit code selection system, or to any number, by using three or more digit selective systems, within the limits of permissible complexity of apparatus. Moreover, although specifically disclosed in connection with a system as per Krecek the principles of the invention are obviously applicable in systems as per Fitch et al., Serial No. 173,958, Lucek, Patent No. 2,228,279, January 14, 1941 and Kinkad et al., Serial No. 348,628 filed July 31, 1940, now Patent No. 2,340,599, granted Feb. 1, 1944. Moreover, certain aspects of the invention are considered to be even more broadly novel and involve, for example, the principle of remote selection and control of normally idle and unconnected lines or channels to connect them operatively to a common channel of telegraph or other intercommunication.

For automatic operation the operator at the central office switchboard secures access to the conference circuit in the same manner that access to a line concentrating unit subscriber line is secured; by setting up, on a teletypewriter, the two-digit number assigned to the trunk conference branch circuit. After the conference circuit is seized and connected to the trunk, which is held busy, the operator will proceed over a second trunk to call the unlisted number of the first subscriber involved. When the called subscriber

answers, he is advised of the conference and instructed to remain on the line. The subscriber's line circuit is then automatically transferred to the conference network under control of the operator at the central office. The operator will then proceed in the same manner to add to the conference network the other desired subscribers, one at a time. When all the desired subscribers' lines have been transferred to the conference network, the second trunk is released and the operator re-connects her teletypewriter to the cord circuit associated with the first trunk which extends to the conference network. The operator will send a "break" signal and then challenge the subscribers connected to the network and the conference may start. Any subscriber line not arranged for automatic connection to the conference network may be added to the conference by means of a manual patching, between subscriber line jacks and jacks in the subscriber conference branch by the line concentrating unit attendant. Similar patching may be made in order to complete calls during emergency conditions.

For manual operation of the conference network, the operator at the central office switchboard will proceed the same as for automatic operation until the conference circuit is seized and connected to the trunk. Instead of calling the first subscriber involved, the operator will communicate with the line concentrating unit attendant who will then establish all desired connections by patching between subscriber line jacks and jacks in the subscriber conference branch. When all desired subscriber lines have been connected to the conference network, the attendant will advise the operator over the first trunk, the subscribers will then be challenged by the operator after which the conference may start.

Busy and out-of-order signals are the same as are used in the line concentrating unit disclosed in the joint application of K. E. Fitch et al., Serial No. 173,958, supra.

The drawings consist of twenty-six sheets. The first sheet contains Fig. 1 and Fig. 2.

Fig. 1 is a diagram showing the relative arrangement of Figs. 3 to 27, inclusive;

Fig. 2 is a like representation of the placing of Figs. 3 to 27, with designating captions assigned to the various blocks in the relative arrangement;

Fig. 3 shows a local subscriber station circuit;

Fig. 4 shows a subscriber line circuit which will operate with either a local subscriber station circuit or the toll subscriber line circuit and terminates at the concentrating unit switching center;

Figs. 5 and 6 show the link circuit, in other words, the crossbar type switch used to establish at the switching center connections between subscriber circuits and trunk circuits extending to distant master, or central, offices;

Figs. 7 and 8 show the terminating equipment at the concentrating unit switching center of a trunk circuit extending to the central office;

Figs. 9, 10, 11 and 12 together show a sequence circuit at the concentrating unit center. Fig. 9 shows the subscriber line sequence circuit, Figs. 10 and 11 show the trunk sequence circuit and Fig. 12 shows certain common controls referred to herein as the sequence master control;

Figs. 13, 14, 15 and 16 together show the conference circuit at the concentrating unit center. Fig. 13 shows the subscriber conference branches; Fig. 14 shows a single trunk conference branch;

Fig. 15 shows the conference subscriber applique circuits; Fig. 16 shows the conference automatic control circuit;

Fig. 17 shows the all-trunks-busy circuit at the concentrating unit center;

Figs. 18, 19, 20 and 21 show a director circuit at the concentrating unit center;

Figs. 22 and 23 show the miscellaneous alarm circuits at the concentrating unit center;

Fig. 24 shows the terminal telegraph repeater at each end of the trunk line between the concentrating unit center and the central office as well as the patching and testing jack arrangements;

Fig. 25 shows the terminating equipment at the central office of the trunk circuit;

Fig. 26 shows an operator cord circuit and an operator position circuit at the office switchboard; and

Fig. 27 shows a portion of a test circuit which is employed for communication between the attendant at the concentrating unit switching center and the operator at the central office and between such attendant and the subscriber at a subscriber station, the portion shown being that which provides the communication path between the attendant and the operator.

For the purpose of this specification "an applique circuit" may be defined as an assemblage of circuitally interconnected elements supplementing a principal assemblage of circuit elements (which is generally complete and usefully operable in and of itself) to perform or permit the performance of supplemental or additional functions.

The numbering of apparatus and parts of the circuit shown on the various figures, for the most part, follows a plan in which the first digit or digits represent the figure number. Thus reference characters on Fig. 3, for instance, are numerals in the 300 series, the hundred digit designating the figure. Likewise, for example, all of the reference characters in Fig. 25 lie in the 2500 series and thus begin with the designating numeral 25. In some cases, in order to avoid the tracing of a conductor through many sheets, it is terminated in one sheet with a label. Thus conductor 602 in Fig. 6 which extends to Fig. 18, is labeled in Fig. 6 "To conductor 1802." Similarly, in Fig. 18 this conductor is labeled "To conductor 602." There are a few exceptions to this plan in which conductors originating in one figure and extending to other figures keep the same designation in the various figures.

The complete operation of the system is set forth hereinafter under various headings, as follows:

Local subscriber station—Fig. 3

In Fig. 3 there is illustrated in schematic circuit a local subscriber station connected with the concentrating unit or switching center by a pair of conductors 300 and 301. In idle condition, conductor 300, known as the tip, is connected to a ringer 302 so that incoming calls to this station will be indicated by the sounding of the ringer 302 through the application of ringing current to the tip conductor 300 at the concentrating unit center. When the local subscriber station is in use, switch 303 is operated to connect the tip conductor 300 to conductor 304 and thence through the loop comprising upper winding of relay 305, brush arm 312, resistance 307 and break key 308 in parallel, transmitting contacts 309 to the ring conductor 301. Under cer-

tain conditions, as described in the copending application of J. A. Krecek, supra, current will flow through the circuit at a value of about 20 milliamperes for a marking condition and zero for a spacing condition. With steady marking currents established by the conditions at the concentrating unit center, the operation of the transmitting contacts 309 in series with this circuit, will reduce the current to the spacing value.

The biasing, or lower, winding of relay 305 has a current of an intermediate value flowing there-through so that with no current flowing through the upper winding in the spacing condition, the armature will remain on its spacing contact, but with the marking current flowing through its upper winding, the biasing winding will be overcome and the relay will move to its marking contact. Incoming marking and spacing signals will, therefore, operate the printer magnet 311 in the proper manner and these same current variations caused by the operation of transmitting contacts 309 will cause the operation of relay 305 to again operate the printer magnet 311 for the purpose of making local copy.

Under idle conditions of the distributor 312, the loop circuit through the subscriber station is closed. Therefore, when the start magnet 313 is operated which attracts latch 334 and releases the brush arm 312 and the distributor arm 312 begins to travel over its segments, spacing signals will be created by the opening of the loop and marking signals will be created by the closing of the loop.

For a detailed description of the operation of the circuits shown in Fig. 4, reference may be had to the application of J. A. Krecek, supra. Other types of subscriber stations such as shown and described in the Krecek application may also be employed in the system.

Subscriber line circuit, Fig. 4

This circuit may be used either to connect a local subscriber station circuit such as that shown in Fig. 4 to the concentrating unit office or any one of several toll subscriber stations (not shown) terminating in the toll subscriber line circuit, also not shown. The functions of the subscriber line circuits are as follows:

(1) This circuit is arranged to register the subscriber calling-in signal and to start the sequence circuit to permit routing the call over an idle trunk circuit to the master, or central, office.

(2) This circuit lights the call lamp when the subscriber calls, until his call is routed to the master, or central, office.

(3) This circuit, when all available trunk circuits are busy, is ordered to release the sequence circuit and to attach itself to the all-trunks-busy circuit for the purpose of transmitting to the subscriber information concerning the availability of the trunk circuits. Connection to the all-trunks-busy circuit is maintained until the subscriber disconnects.

(4) When the subscriber disconnects after receiving information from the all-trunks-busy circuit, this circuit returns to normal.

(5) When the subscriber line on an outward call is connected to a trunk circuit, the line circuit returns to normal, releasing the sequence circuit.

(6) This circuit is arranged on an optional basis to register the particular outlet a key selection subscriber wishes to reach, and to start the sequence circuit in an effort to route the call to that outlet.

(7) When arranged for key selection of outlets, this circuit lights the call lamp steadily if a primary outlet is required or flashes it at sixty interruptions per minute if the second outlet is desired. In either case the lamp functions until the call has been routed to the master office.

(8) This circuit is provided with a set of test jacks which will permit testing the subscriber line for line conditions and for transmission and for testing the subscriber line circuit.

(9) The test jacks of this circuit are also available for semiautomatic and full manual operation of the concentrating unit in case of failure of automatic apparatus.

(10) One of these test jacks can be used to make the particular line test busy, out-of-order or unassigned to inward calls, but in the case where the subscriber line is arranged for automatic connection to a conference circuit an additional jack in the subscriber line applique circuit is used in conjunction with said one test jack.

(11) The test jacks are available for continuous monitoring of the subscriber lines by means of a test circuit.

The test jacks can also be used to patch a subscriber line to a practice circuit or a conference circuit.

Link circuit, Figs. 5 and 6

The link circuit comprises a switching instrumentality well known in the art as a "cross bar switch," certain forms of which are described in United States patents to Reynolds 2,021,329 dated November 19, 1935 and Reynolds 2,047,383 dated July 14, 1936.

As disclosed, a cross bar switch comprises sets of contacts usually arranged vertically and crossing or coordinate sets of contacts arranged horizontally. Horizontally arranged contacts in a horizontal row, or in several horizontal rows in the case of a system using the several switches, are prepared by a selecting magnet, which in the present case, is associated with a trunk. When a horizontal row of contacts is prepared by a selecting magnet and a holding magnet, which is associated with an entire vertical column of contacts, is operated the set of contacts at the crossing point of the row associated with the selecting magnet and the column associated with the holding magnet are brought into conductive engagement. Immediately thereafter the selecting magnet may be released and other contacts of its horizontal row will not be brought into engagement when other holding magnets are operated but the set of contacts already engaged will remain engaged until the holding magnet which caused them to become engaged is released.

Usually the operation of the holding magnet operates or causes to be operated other contacts which render the line or circuit associated with the holding magnet busy during the time the holding magnet is maintained energized.

This circuit acts as a selectable connecting medium between trunk circuits and subscriber line circuits connected to the concentrating unit center and between trunk circuits and the conference circuits. The functions of this circuit are as follows:

(1) When a selecting magnet and a holding magnet are operated in the proper sequence, the trunk circuit with which the selecting magnet is associated will be connected to the subscriber line circuit with which the holding magnet is associated.

(2) Off-normal contacts on the selecting magnet insure, upon the establishment of a connection, that the magnets are operated in the correct sequence.

(3) When the holding magnet is operated it will lock under control of the trunk circuit in order that the selecting magnet may be released.

(4) The holding magnet contacts perform the "cut-off" function required in the associated normally arranged subscriber line circuit upon establishment of a call. It likewise performs a "cut-off" function in conjunction with the subscriber line applique circuit in the case of lines arranged for automatic connection to the conference circuit.

Terminating equipment at the concentrating unit center of the trunk circuit, Figs. 7 and 8

This circuit is designed as the terminating equipment at the concentrating unit center end of a two-way trunk extending to the central office. This circuit possesses automatic signaling supervision features and is arranged to be connected between a toll line repeater and a concentrating unit subscriber with loop transmission on a 0—20 milliampere bases. The functions of the circuit are as follows:

(1) On an outward call from a concentrating unit subscriber when the trunk is preselected by the sequence circuit, this circuit sends a continuous "mark" to the central office, and lights the trunk-busy lamp.

(2) Under conditions set forth in the immediately preceding paragraph (1) this circuit awaits the reception of "ringing" from the central office as a trunk verification test before ordering the link circuit to connect the particular calling subscriber line to the trunk circuit.

(3) Under the conditions set forth in preceding paragraph (1) this circuit, simultaneously with the sending of the "mark," grounds a conductor extending to the miscellaneous alarm circuit shown in Figs. 22 and 23, which is timing the interval required for the routing of the outward call.

(4) If the link circuit has connected the calling subscriber to the trunk, the sequence circuit is dismissed and the subscriber's station is held connected to the trunk under control of the power switch at the subscriber station set while the trunk is made busy to other calling concentrating unit subscriber stations.

(5) Under the conditions set forth above in paragraph (3) whereby a conductor extending to the miscellaneous circuit was grounded to time the interval required for the routing of the outward call and the interval as determined by the alarm circuit has been exceeded without the appearance of "ringing" from the central office, the miscellaneous alarm circuit orders the trunk-busy lamp extinguished, the particular trunk removed from service, the calling subscriber being given an opportunity to attempt to place his outward call over the next idle available trunk while a characteristic trouble signal is sent from the sequence circuit to the trunk for retransmission to the manual end which in this case is at the central office.

(6) While awaiting the answer of the operator at the central office the subscriber can "flash" the operator. Under this condition this circuit sends "mark" and "space" signals to the central office in unison with the operation of the power switch at the subscriber's station set.

(7) If the calling subscriber abandons an

outward call before the operator at the central office answers, this circuit sends a permanent space signal to the central office and when the reception of continuous ringing ceases, orders the link to disconnect the subscriber's line from the trunk, removing the busy appearance of the trunk to other calling subscribers and also extinguishing the trunk-busy lamp.

(8) When the operator at the central office answers the outward call the continuous ringing is replaced by a "mark" signal, upon the reception of which this circuit advances to the half duplex transmission stage in which it is capable of distinguishing between normal teletypewriter signals, break signals or disconnect signals from either end.

(9) When a prolonged space signal is received from the concentrating unit subscriber, this circuit transmits a space to the central office and after approximately two-thirds of a second ascertains if the subscriber has disconnected. If the subscriber has disconnected, this circuit continues to send a space signal to the central office, returns to the full duplex system of transmission but remains in condition to permit the "rering" of the disconnected subscriber station. If the space signal is the result of a "flash" from the subscriber station, the circuit functions as if the subscriber had disconnected during the "off" operation of the power switch and returns to half duplex transmission, transmitting a "mark" as soon as the switch is again turned "on." If, however, the space signal resulted from the transmission of a "break" from the subscriber station this circuit replaces the space sent to the central office by "ringing" for the remainder of the "break" signal received from the subscriber station, remaining at the same time in the half duplex transmission condition. At the conclusion of the break this circuit transmits a "mark" to the central office.

(10) When a prolonged space signal is received from the central office this circuit continues to send a space signal to the subscriber station. After two-thirds of a second has elapsed followed by the reception of "ringing" from the central office the circuit remains in the half duplex transmission condition and continues to send space to the subscriber. After 5.5 seconds of space received from the subscriber station this circuit sends periodic "mark" and "space" signals to the subscriber station as long as the reception of "ringing" from the central office continues. When a "mark" is received from the central office at the end of the "ringing" period, this circuit sends a "mark" signal to the subscriber.

(11) Under the conditions set forth in the immediately preceding paragraph (10) if a continuous space is not followed by "ringing" the circuit acts exactly as described under paragraph (10) provided the subscriber disconnect signal has not been registered in the trunk. If the subscriber disconnect signal has already been registered the reception of a space signal of one second duration from the central office causes this circuit to order the link circuit to disconnect the subscriber line from the trunk, returning the trunk circuit to normal.

(12) When the trunk circuit is seized at the distant end for an inward call the circuit receives a mark signal which after one-half a second has elapsed results in ordering the sequence circuit to connect a director circuit to the trunk, at the same time marking the trunk busy to outward calls and lighting the trunk-busy lamp.

(13) If the attached director circuit fails to get ready to receive the teledirecting pulses, miscellaneous alarm circuit after an interval orders the sequence circuit to manufacture a characteristic trouble signal, and transmits it to the trunk for retransmission to the central office, removing the director circuit and extinguishing the trunk-busy lamp.

(14) When a director circuit is attached and ready to receive teledirecting pulses it orders this circuit to send a continuous mark signal to the central office.

(15) With the director circuit attached if a prolonged space signal is received from the master office as a result of the operator's disconnect signal, this circuit, after one-third second orders the sequence circuit to dismiss the director circuit and after one second returns to normal.

(16) With the director circuit attached, if a two-thirds second space signal followed by "ringing" is received as a break signal from the operator, this circuit orders the sequence circuit to release the director circuit. If at the conclusion of "ringing" a mark signal is received, the sequence circuit is again ordered to connect a director circuit to the trunk, but if at the conclusion of ringing, a space signal is received, the trunk circuit returns to normal.

(17) When the teledirecting pulses are received they are transmitted to the director circuit which decodes the information and tests the called line, ordering the link circuit to connect it to the trunk circuit if the line is idle.

(18) If the called line is busy, out of order, or unassigned, signals characteristic of these conditions are produced in the director circuit, transmitted to the trunk circuit and retransmitted to the central office.

(19) When the called line is attached to the trunk, the sequence circuit and the director circuit are dismissed and the trunk again sends a space signal to the central office. At the same time automatic ringing of the subscriber line is begun if the circuit is so arranged. If the circuit is not arranged for automatic ringing the inward operator sends a ringing signal which, in this circuit, orders ringing to be connected to the line.

(20) When a subscriber answers at the called station this circuit during the silent interval disconnects the automatic ringing, sends a mark signal to the central office and advances into the half duplex transmission stage in which it is capable of distinguishing between normal teletypewriter signals and break or disconnect signals from either end.

(21) If the called line is to be started on an unattended basis, continuous ringing is received from the central office, causing continuous ringing to be sent to the subscriber station as shown and described in the copending application of J. A. Krecek, supra.

(22) After continuous ringing has exceeded nine seconds in an attempt to start an unattended station, as shown and described in the Krecek application, supra, this circuit sends a permanent mark to the called station. If the station has been started, this circuit sends a mark to the central office and advances to the half duplex transmission stage. If the station has not started after nine seconds, the circuit continues to send a space to the central office and a mark to the subscriber station until appropriate action is taken by the operator at the central office.

(23) After a subscriber has disconnected, the operator can "rering" the subscriber station.

(24) This circuit is provided with jacks to permit manual connection to subscriber lines in case of failure of the automatic equipment and to the conference circuit.

Sequence circuit, Figs. 9, 10, 11 and 12

This circuit was designed for use in a line concentrating unit and is essentially a subscriber and trunk sequence circuit so arranged as to permit the routing of only one call at a time in either direction through the automatic switching line concentrating unit. The functions of the circuit are as follows:

(1) This circuit is arranged to permit only one subscriber at any one time the privilege of routing and establishing of a call through the line concentrating unit, providing a call is not being received from a distant central office.

(2) This circuit is arranged to permit only one call at any one time from the central office to seize a director circuit and to be routed and established through the line concentrating unit, provided the routing privilege had not been seized by a subscriber calling the central office.

(3) In the case of trouble on an outward call attributed, after a two-second interval, by the alarm circuit in general, to the subscriber line terminating circuit, the link circuit, or to any part of this circuit used on an outward call, this circuit is arranged (1) to attempt to free the sequence circuit, (2) to remove and lock out of future outward service, under control of the release key, the particular subscriber station and the particular group of subscriber stations containing the calling subscriber station, and (3) to light a lamp indicating the group placed out of outward service.

(4) In case of trouble on an outward call in the trunk conductors or parts of the repeaters or trunk relay equipment at the line concentrating unit or at the central office, as indicated by the alarm circuit after a two-second interval, the circuit is arranged (1) to attempt to free the sequence circuit, (2) to remove and hold the trunk out of outward service under control of a release key, (3) to flash a lamp indicating the trunk removed from outward service, and give to the subscriber the next idle satisfactory trunk available.

(5) This circuit is arranged to allot, in a predetermined order, idle trunks to subscriber stations when calls thereat are initiated to the distant central office. When the concentrating unit center is arranged for two outlets with provision for overflow of calls from one outlet to another, the circuit is designed to pick an idle trunk in the particular trunk group to which the subscriber's station is predeterminedly connected or to which access is desired and, failing to find an idle trunk in this group, to hunt for an idle trunk in the other trunk group before connecting to the all-trunks-busy circuit. If the concentrating unit center is arranged for a single outlet or two outlets without overflow provision between outlets, this circuit is arranged to hunt for an idle trunk in the trunk group to which the subscriber's station is predeterminedly connected or to which access is desired and, failing to find one, to connect to the all-trunks-busy circuit associated with that group of trunks.

(6) When the subscriber line has arranged for key selection of outlets, this circuit in conjunction with the subscriber line circuit is arranged

to select an idle trunk in the trunk group selected by the subscriber. If the concentrating unit center is arranged for overflow between outlets, the circuit will hunt for a trunk in the other outlet if all trunks in the first outlet are busy.

(7) This circuit is arranged to cause the selected trunk to repeat a calling signal to the central office when seized from a calling subscriber station.

(8) In case all trunks of a group are busy, this circuit is arranged to cause the all-trunks-busy circuit to measure the length of time this condition persists.

(9) In case a subscriber places an outward call when all trunks to which he might be connected are busy, this circuit is arranged to connect the calling subscriber station to the all-trunks-busy circuit which manufactures an "all-trunks-busy" signal which is sent to the subscriber station.

(10) This circuit is arranged to advance the trunk chain to the next idle trunk immediately after each subscriber calling the central office has obtained a routing through the line concentrating center and before the sequence circuit is permitted to handle the next call in either direction.

(11) This circuit is arranged to keep the trunk chain in a "fixed" condition during the entire period that the sequence circuit is attempting to route an outward call through the concentrating unit center.

(12) This circuit is arranged to permit the miscellaneous alarm circuit to function to time the duration required for routing an inward call to the line concentrating unit center.

(13) In the case of a failure to make preliminary tests on the routing of an inward call where it has been determined that trouble may be in the trunk or trunk sequence circuit the miscellaneous alarm circuit after an interval of four seconds causes this circuit to function to (1) remove or hold trunks out of service under control of a key, at the same time flashing a lamp associated with the trunk circuit, (2) attempt to free the sequence circuit and (3) send the characteristic reorder signal to the distant end.

(14) In case of a failure to complete the routing of an inward call when it has been determined that the trunk or trunk sequence circuit has not caused failure, the miscellaneous alarm circuit after an interval of ten seconds causes the sequence circuit to act as described in the immediately preceding paragraph (13) except that the trunk is removed temporarily under control of a mark signal from the central office and the lamp lights steadily instead of flashing.

(15) If one or more trunk calls from the central office are awaiting service, this circuit is arranged to start and keep the distributor motor "in speed."

(16) This circuit is arranged to operate on a manual basis outward to the central office if the outward central office key is operated and if an idle trunk is selected by means of its associated call key.

(17) This circuit is arranged to operate on a manual basis for inward calls from the central office if the inward central office key is operated. The local attendant's teletypewriter is connected to the trunk by means of the call key and busy test circuit to obtain information concerning the inward call after which the local attendant teletypewriter is released and the called station is connected by the same means.

(18) This circuit is arranged to operate on a

manual basis for both inward and outward calls when the manual service key is operated.

(19) This circuit is provided with a night alarm utilizable during periods of manual operation to indicate the reception of an inward or an outward call.

Conference circuit, Figs. 13, 14, 15 and 16

This circuit is an essential part of the described embodiment of the present invention. It is designed for installation at the automatic switching concentrating unit center in a satellite teletypewriter exchange system, as a conference circuit to which specially arranged subscriber stations can be attached automatically for communication purposes under the control of an operator at a central office. These same subscriber stations and others connected to the concentrating unit center can be added manually to the conference by the concentrating unit attendant. The conference circuit can also be used if manual operation only is desired. Its functions are as follows:

(1) The manual operator at the central office obtains the use of an idle conference circuit by calling in the regular way for a special number associated with the conference circuit.

(2) When the conference circuit is connected to the trunk over which the operator called the conference number, power is applied to the conference circuit branches and conference control circuit. The "unlisted" conference numbers at this time cease to test "unassigned." The "unlisted" conference numbers are those respectively assigned to certain subscriber stations in addition to the regular numbers used when an individual connection is established for private communication.

(3) The conference circuit sends a "space" signal to the trunk to which it is connected.

(4) The operator at the central office, in order to add a specially arranged subscriber station, that is, one of said certain subscriber stations, to the conference circuit, calls over another trunk referred to herein as an "order" trunk, for the unlisted conference number assigned to the particular subscriber line.

(5) If the subscriber line is idle, the conference applique circuit associated with such line seizes the conference control circuit.

(6) If the subscriber line is busy, or out of order, the director circuit will so inform the operator at the central office.

(7) The conference control circuit, upon seizure, supplies a resistance ground long enough to operate the "hold" magnet associated with the called subscriber line, connecting the line to the "order" trunk and making the line test busy to other calling operators. The conference control circuit also makes all other unlisted conference numbers test "unassigned."

(8) The called line connected to the trunk causes the "order" trunk to dismiss the director thereby permitting a signal to be sent to the operator to ring the called subscriber station.

(9) In concentrating units arranged for automatic ringing of the called subscriber stations, the trunk dismisses the director circuit and automatically rings the called subscriber station.

(10) Before the subscriber answers, the called subscriber line is held to the trunk under control of the trunk circuit and, in turn, under control of the calling operator.

(11) If the subscriber fails to answer the operator can dismiss the subscriber line from the

"order" trunk by removing her cord circuit from the trunk jack.

(12) When the subscriber answers, the conference control circuit causes the "order" trunk supervisory relay to operate.

(13) If the subscriber accepts the conference, the operator sends a two-second break signal which the control circuit uses to connect the subscriber line to the next idle conference branch immediately after the termination of the break signal.

(14) The connection of the subscriber line to the conference subscriber branch causes the conference control circuit to release the "order" trunk supervisory relay and approximately 1½ seconds later, to release the subscriber "hold" magnet, freeing the "order" trunk but at the same time making the subscriber line test busy to other calling operators and partially returning the subscriber conference applique circuit to normal and disconnecting it from the control circuit.

(15) If the subscriber refuses to accept the conference, the operator disconnects from the trunk after receiving his disconnect signal, returning the subscriber conference applique circuit to normal.

(16) The connection of the subscriber line to a conference branch lights the busy lamp associated with that branch and causes the branch to contribute a mark signal under control of the subscriber instead of the normal mark obtained during the idle period of the branch.

(17) After the subscriber applique circuit partially returns to normal, (a) the conference branch just selected releases its select magnet and prepares to use the next idle branch for the addition of another subscriber line, (b) the conference control circuit returns to normal and makes the remaining unlisted subscriber lines test "assigned."

(18) If more concentrating unit subscriber lines are to be added to the conference, the operator waits until the disconnect lamp changes as an indication of the reconnection of a director circuit to the calling trunk and then repeats the process for the next subscriber line, calling for the unlisted conference number assigned to the desired subscriber line.

(19) If no other subscriber line is to be added, the operator disconnects from the "order" trunk after she receives the disconnect signal.

(20) Following the function set forth in paragraph (19) the operator sends a one-second break over the conference trunk which the conference circuit uses to make all remaining unlisted conference numbers test "unassigned" and thus prevent any further addition to the conference circuit. After that the operator types for the start of the conference.

(21) If a subscriber line has no "unlisted" or "secret" conference number, the line is not arranged for automatic connection to a conference, and should such line be desired in the conference, the operator calls the attendant at the concentrating unit station, who manually patches the subscriber line to the next idle conference branch.

(22) In case of failure of automatic equipment the attendant at the concentrating unit station can set up the conference by manual patching under instructions from the operator at the central office.

(23) When a conference subscriber station is disconnected from the progress of a conference, the subscriber line associated therewith remains connected to the conference until the operator at

the central office disconnects from the conference trunk.

(24) When all subscriber lines connected to a conference disconnect, the operator at the central office receives a disconnect signal.

(25) The conference circuit is arranged to prevent a new call originated by a disconnected subscriber after all such subscribers have disconnected, from recalling the operator over the conference trunk.

(26) Upon the reception of a disconnect signal the operator at the central office withdraws the cord circuit from the jack of the trunk to which the conference circuit had been connected, releasing the conference circuit and all automatically connected subscriber lines attached to the conference circuit.

(27) When a conference circuit is released with manually connected subscriber lines a disconnect lamp lights and an alarm is given to indicate to the concentrating unit attendant that the patches should be withdrawn. The alarm and lamp are retired when the patches are withdrawn.

(28) In the case of a completely manually arranged conference, orders for disconnection are received from the operator at the central office.

(29) Each subscriber conference branch is equipped with a busy key to make a branch out of service.

(30) Each subscriber applique circuit is equipped with a jack by which the unlisted conference number can be manually made busy or out of order.

All-trunks-busy circuit, Fig. 17

This circuit is designed for use in a line concentrating unit station as an originating source of "no circuit" condition whereby "letters" and a series of "K" signals are transmitted to calling subscribers under certain conditions, at the same time providing "no circuit" time integrating registers in addition to subscriber overflow registers. The functions of the circuit are as follows:

(1) When all trunks reaching a given outlet are busy this circuit is arranged to measure the length of time this condition persists.

(2) When all trunks associated with this circuit are busy the circuit is designed to: (a) produce and send to each calling subscriber a "letters" ("no circuit") signal; (b) registers on the subscriber's overflow register the number of attempts subscribers make during the all-trunks-busy period; (c) measures the continuous duration of the production of these "letters" signals giving an audible and visible alarm if the time exceeds a predetermined interval; (d) continues to produce the "letters" signal as long as a subscriber keeps his loop closed.

(3) Whenever a trunk becomes idle this circuit is arranged to produce a series of "K" signals at approximately forty per minute and send these signals instead of the "letters" to the waiting subscribers.

Director circuit, Figs. 18, 19, 20 and 21

This circuit is designed for use in a line concentrating unit to receive the telegraph pulses sent by the distant operator's teletypewriter at the central office and to decipher these pulses, thereby causing the selection of the called subscriber line. The functions of this circuit are as follows:

(1) Upon receipt of an inward call from the operator at the central office the sequence circuit will connect the director circuit to the trunk circuit on which the call is waiting. The distributor motor is then started and after it has attained

a proper speed, a director ready, ("DR") signal will be transmitted to the distant end to indicate to the operator at the central office that the call may be routed through the line concentrating unit.

(2) The distributor motor will be stopped after the director has been dismissed unless there is another incoming call awaiting completion. In the latter case the motor will be kept running but the other parts of the circuit will be restored to normal awaiting the new call.

(3) The start magnet of the director circuit is held operated while the distributor motor is coming up to speed to reduce clutch drag.

(4) A "figures" teletypewriter character received from the operator at the central office will indicate that the operator has recognized the "DR" signal and will cause the director circuit to accept the next two characters transmitted from the central office as the called subscriber line.

(5) The next two teletypewriter characters received from the central office are separated into dot elements by the receiving distributor causing the proper selection relays to be operated.

Miscellaneous alarm circuits, Figs. 22 and 23

The miscellaneous alarm circuit is designed for use at the line concentrating unit station. It is arranged primarily to time the interval during which the sequence circuit is in use and is arranged to give appropriate alarms, if a specified time limit is exceeded, giving at the same time an indication of the possible circuits in trouble. The circuit is also arranged to give an alarm when the battery or grounded chain of the sequence remains open. The functions of the circuit are as follows:

(1) On an outward call from the local subscriber the miscellaneous alarm circuit times the interval in which the sequence circuit is used to see that it does not exceed $2\frac{1}{2}$ seconds.

(2) On an outward call when the sequence circuit is in use for more than $2\frac{1}{2}$ seconds the miscellaneous alarm circuit is arranged to indicate whether the trouble is in the trunk alone or in any of the other circuits called into use. In case the miscellaneous alarm circuit decides that the trunk is in trouble it is arranged to give a minor alarm, flash a trunk lamp and to cause the removal of the particular trunk circuit from service. In case the miscellaneous alarm circuit determines that any of the other circuits in use on the particular call are in trouble, the circuit is arranged to light a supervisory lamp and to give a minor alarm, and to cause the removal of the subgroup of subscribers' lines containing the calling subscriber's line from outward service.

(3) After removing the particular trunk or the particular subgroup of subscribers' lines from service, the miscellaneous alarm circuit is arranged to detect the ability of the sequence circuit to return to normal and to light a sequence lamp and bring in a major alarm, if it fails to do so within one-half second.

(4) On an inward call to the local subscriber the miscellaneous alarm circuit begins timing, as soon as the inward call has received preference from the sequence circuit, being arranged to time the interval required to obtain a director circuit and to give an alarm if this period exceeds $2\frac{1}{2}$ seconds. In this case the miscellaneous alarm circuit is arranged to cause the removal from service of the trunk in trouble, flash the lamp associated with the trunk and at the same time light the supervisory lamp, bringing in a minor

alarm. The alarm circuit continues to function as indicated in the immediately preceding paragraph (3).

(5) When informed over a conductor extending from the director circuit at the concentrating unit center that the director circuit has moved off normal, the miscellaneous alarm circuit waits a total of four seconds for the director circuit to place ground on another particular conductor. The director places ground on the second-mentioned conductor if the distributor motor has attained speed, if the director-ready signal reached the associated loop repeater and if a mark signal sent over the trunk from the central office has been registered in the distributor circuit.

(6) If the miscellaneous alarm circuit times out before the second-mentioned conductor in the immediately preceding paragraph (5) is grounded but after the first-mentioned conductor was grounded, the alarm circuit is arranged: (a) to cause the associated director circuit to lock in a "stuck" condition; (b) to bring in an audible and visible alarm associated with the director circuit; (c) after the director circuit has been locked in a "stuck" condition to remove the trunk circuit from service under control of a key and cause a lamp associated with this trunk to flash or, if a third and a fourth conductor extending to the trunk terminating equipment at the concentrating unit center are grounded when the alarm circuit times out to remove the trunk circuit from service temporarily under control of a mark signal sent from the central office causing a lamp associated with the trunk to light steadily, and in either case orders the sequence circuit to send back the characteristic trouble signal to the operator; (d) after allowing approximately one-half second, the director circuit having been locked in a "stuck" condition, the miscellaneous alarm circuit is arranged to test for failure of the sequence circuit to release and to bring in an audible major alarm and light the sequence lamp if the sequence circuit fails to release; (e) if the sequence circuit has been released the miscellaneous alarm circuit is arranged to replace the "stuck" director circuit with another spare director circuit if one is available.

(7) If the second-mentioned conductor in the immediately preceding paragraph (5) is grounded, the miscellaneous alarm circuit permits the director circuit ten seconds to complete all its functions.

(8) If the miscellaneous alarm circuit times out after ten seconds, the alarm circuit is arranged to function as follows: (a) orders the sequence circuit to send the characteristic trouble signal to the trunk as a reorder signal and then removes the trunk from service under control of a "mark" signal received from the distant central office lighting a lamp associated with this trunk, but returns the director circuit back to service; (b) after approximately one-half second test for failure of the sequence circuit to release and if the sequence circuit fails to release, brings in an audible major alarm and lights the sequence lamp.

(9) If two director circuits are provided in the concentrating unit the miscellaneous alarm circuit in taking a director circuit out of service will give a minor alarm provided the spare director circuit is available and not in trouble. If the second director circuit is in trouble the circuit will give a major alarm.

(10) The circuit is arranged to permit manual

transfer from one director circuit to another at a time when the sequence circuit is not in use due to the routing of a call through the concentrating unit center and when the director circuit transferred to is available and not in trouble.

(11) The circuit is arranged to prevent the use of a sequence circuit on a new call for one-half second after the sequence circuit has otherwise returned to normal after timing out.

(12) The circuit is arranged to furnish a time delay between the operation of the selector magnet of the crossbar switch and the application of ground for the operation of the hold magnet of the crossbar switch.

(13) The circuit is provided with keys associated with each type of trouble indicated to permit removal of the audible alarm leaving a lamp to indicate the trouble condition and with keys to release the locked-in trouble indication and also an alarm cut-off key which prevents the alarm circuit from timing out.

(14) This circuit is arranged to light a connection lamp as an indication that a selector magnet of the crossbar, or link, circuit has operated.

(15) This circuit is arranged to prevent the director circuit from interfering with the miscellaneous alarm circuit when both director circuits fail, or if the single director circuits fail, or if the single director circuit falls in a single director circuit unit.

(16) If the battery or ground chain of the sequence circuit remains open for approximately forty-five seconds, this circuit is arranged to give a major sequence alarm and light a sequence battery or sequence ground lamp to indicate which chain is open.

(17) This circuit is arranged to prevent the routing of a call if the selector magnet of a link circuit is falsely operated and to give an alarm if this condition persists for approximately forty-five seconds.

Terminal telegraph repeaters, Fig. 24

The outward path from the two-way trunk termination at the concentrating unit center is extended into a terminal telegraph transmitter and the inward path from this terminal telegraph transmitter extends to the concentrating unit. In a similar manner a terminal telegraph transmitter is provided at the distant central office and from it the outward path extends to the central office termination. The outward path over which telegraph signals are transmitted from the concentrating unit to the central office extends to the central office termination equipment. The terminal telegraph transmitters are well known and are only generally described herein.

Terminating equipment at the central office of the trunk circuit, Fig. 25

This circuit is designed as the terminating equipment at the central office, of the two-way trunk extending to the concentrating unit center. This circuit possesses automatic signaling supervision features and is arranged to be connected between a toll line repeater and a teletypewriter switchboard operator's position. As hereinbefore stated, the companion terminating equipment at the concentrating unit center is arranged to operate with 20-milliamper metallic

local subscribers' lines. The functions of the circuit are as follows:

(1) In the idle condition, both the inward and outward transmission paths are spacing.

(2) A call from the concentrating unit center will be received as a marking signal on the outward path. This action will be followed in one-half second by the lighting of the busy lamps, application of a busy test potential to the sleeve multiple, and the application of ringing current, or 20-cycle dot signals, to the inward path. After one-half second additional time the line lamp will light. Marking signals of less than one-second duration would not be registered as calls.

(3) In the call-before-answer period if the subscriber recalls, the disconnect interval will return the outward path to spacing and will extinguish the line lamps. Resumption of the call will relight the line lamps.

(4) If the subscriber abandons the call before the operator has answered, the outward path will return permanently to spacing and the line lamp will be extinguished. The 20-cycle dot signal will be removed from the inward path after four seconds and the busy condition will be removed after an additional $1\frac{1}{2}$ seconds.

(5) When the operator answers the call, the line lamp will be extinguished and a marking condition will supplant the 20-cycle dot signals on the inward path. The busy lamps will remain lighted.

(6) During the communication signals from the subscriber's station toward the operator's office will be transmitted over the outward path. Signals from the operator's office to the subscriber will be transmitted over the inward path. Between the full and half duplex converting repeater and the connected cord circuit signals in both directions will be transmitted over the tip conductor. No supervisory action will take place as a result of teletypewriter signaling. The ring or supervisory conductor to the cord circuit will, therefore, remain open during communication.

(7) A break signal from the cord circuit will be repeated to the inward path as a spacing signal which will be supplanted by 20-cycle dot signals after a delay of two-thirds of a second. At the end of the break signal the circuit will return to marking. A break signal from the subscriber will appear as a spacing condition on the outward path followed in two-thirds of a second by 20-cycle dot signals. Throughout the entire break signal interval, however, a spacing condition will be applied toward the cord circuit. No supervisory action will result from break signals in either direction.

(8) A discount from the subscriber will return the outward path to spacing. After one second ground will be applied to the ring conductor of the cord circuit to light the supervisory lamp.

(9) A recall signal from the subscriber is the same as a disconnect signal followed by a new call. When the outward path returns to marking as a result of the new call, the ground will be removed from the ring conductor to cause the supervisory lamp in the cord circuit to flash. The interrupted ground will be removed when the sleeve is either opened or grounded.

(10) When the operator connects to the trunk to originate a call, a marking condition will supplant the idle, or spacing, condition of the inward path. Ground applied to the ring conductor will light the supervisory lamp of the cord circuit.

(11) When the distant concentrating unit cen-

ter is prepared to receive the call-directing characters the outward path will become marking. This will result in the removal of ground from the ring conductor to extinguish the supervisory lamp. The action of remotely controlling the directing of a call to a desired line through the agency of the operator's teletypewriter at the central office and the director circuit at the concentrating unit center will be referred to herein after as teledirection.

(12) After the operator has sent the call-directing pulses and the desired subscriber's line has been selected or, as herein stated, the operator has teledirected, the outward path will return to the spacing condition to relight the supervisory lamp.

(13) When the called subscriber answers, the outward path will again become marking to extinguish the supervisory lamp. Thereafter, the circuit will be conditioned to perform the functions outlined above in paragraphs (6), (7), (8), and (9).

(14) If the desired subscriber's line is busy, out-of-order busy or unassigned, the concentrating unit will transmit teletypewriter signals to indicate which of the three conditions exist.

(15) When the operator abandons the call after receiving the busy, out-of-order busy or unassigned signal by disconnecting from the trunk, the equivalent of a break signal will be sent to dismiss the concentrating unit call-directing equipment. When this equipment has been dismissed, the outward path will be returned to spacing and this will, after five seconds, cause a spacing condition to supplant the 20-cycle dot signals applied to the inward path. After $1\frac{1}{2}$ additional seconds the busy condition will be removed from the trunk.

(16) If the operator disconnects the cord circuit in error during communication, the circuit will revert to the call-before-answer condition as set forth above in paragraph (3) which may be abandoned by the subscriber as stated above in paragraph (4) if the operator fails to reestablish the connection.

(17) When the operator disconnects from the trunk at the end of a communication following the subscriber's disconnect, the inward path will return to the idle or spacing condition. After a delay of $1\frac{1}{2}$ seconds the busy condition will be removed.

Operator's cord and position circuit, Fig. 26

The purpose of the cord circuit provides means for interconnecting operators' positions, open loop subscriber lines, and intertoll trunk circuits for receiving and sending supervisory signals, and for repeating teletypewriter communication from one connected circuit to another or to a group of circuits. Optional equipments provide for an operator's lockout feature. The purpose of the operator's position circuit is to provide a switching system by means of which any line connected to a cord circuit may be connected to the switchboard operator's teletypewriter. The functions of the circuit are as follows:

(1) Provides for answering incoming calls from subscriber lines, or from intertoll trunk circuits with the answering cord and for establishing teletypewriter communication via the operator's position circuit.

(2) Provides for answering an incoming call with an optional provision for a lockout feature which renders the transmission circuit inopera-

tive, and signals the interfering operator during the interfering period.

(3) Provides for a visual busy test for both the answering and the call cords, arranged to light a busy lamp in the position circuit when the tip of either cord makes contact with the sleeve of a jack which has a busy test potential due to another connection.

(4) Provides for signaling open loop subscriber lines by use of continuous ringing current.

(5) Provides for signaling an intertoll trunk circuit by associating the position circuit with the cord circuit by means of a typing key so that the break key of the operator's teletypewriter may transmit the open circuit signal.

(6) Provides for repeating teletypewriter communication by means of a single line repeater in the cord circuit.

(7) Provides for receiving and transmitting recall signals.

(8) Provides for receiving and transmitting disconnect signals.

Operator position circuit

The purpose of the operator's position circuit is to provide a switching system by means of which a line connected to a cord circuit may be connected to the switchboard operator's teletypewriter. The functions of the circuit are:

(1) Means are provided whereby the switchboard operator may transmit and receive teletypewriter signals when any line circuit is connected to a cord circuit.

(2) The switchboard operator has complete remote control over outlying station sets equipped for unattended service.

(3) Means are provided whereby the switchboard operator may test a line for a busy, practice, or out-of-order condition.

(4) Means are provided whereby a switchboard operator may send a recall or disconnect signal over an intertoll trunk.

(5) Means are provided whereby the switchboard operator will receive a distinctive disconnect signal in case of a double connection.

(6) Means are provided whereby the switchboard operator may release the locked-in recall signal.

(7) Means are provided whereby the switchboard operator may apply ringing current to the line connected to the answering end of the cord circuit.

(8) Means are provided whereby the switchboard operator may send a toll call signal in the direction of either end of the cord.

DESCRIPTION OF OPERATION

The operator originates an inward call

As hereinbefore stated, the conference circuit and features cooperating with it to enable advantage to be taken of its function is the novel part of the system described herein. The conference circuit is used only on calls inward over a trunk as viewed from the satellite office and these calls originate at the operator position in the central office. However, a subscriber connected to the satellite office directly may call the central office and the operator may answer his call with the answering plug of a cord and use the calling plug thereof to extend a call back to the satellite office and seize the conference circuit to set up a conference in which the calling subscriber will be connected in the same manner

that any subscriber beyond the central office would be connected thereto.

The terminating equipment located at the central office and shown in Fig. 25 is normally in the condition shown, that is, in the idle condition, both the inward and the outward transmission paths being in a spacing condition. No relay or tubes are energized except relay 2500 which is held to spacing by the spacing condition of the outward path. Relay 2500 will keep condenser 2501 discharged during the idle condition.

During the idle condition, the repeaters, or terminal telegraph transmitters shown in Fig. 24 are in the positions shown. Likewise, the inward and the outward transmission path extending to the trunk terminating equipment at the concentrating unit center are spacing during the idle condition. Relays 812 and 802 are maintained in the position shown by the spacing condition of the inward path.

The master, or central, office operator originates a conference call by connecting the calling plug 2601 to trunk jack 2538 and operating teletypewriter key 2606 to its alternate positions. Sleeve relays 2602 and 2525 and relay 2610 and off-normal relay 2521 operate. In response to the operation of these relays and the teletypewriter key, a transmission circuit is closed extending from grounded negative battery 2603, spacing, or right-hand, contact and armature of polarized relay 2604, through the upper and lower winding, in parallel, of polarized relay 2605, the path through the upper winding being traceable over the left-hand operated contacts of key 2606, through the transmitting contacts 2611 and the winding of printer magnet 2612 of the operator teletypewriter 2609, right-hand operated contacts of key 2606, front contact and lower armature of relay 2602, normal contacts of ring key 2607, tip conductor of plug 2601 and jack 2538, upper armature and contact of relay 2525, through the upper windings, in series, of polarized relays 2540 and 2541, armature and spacing, or right-hand, contact of polarized relay 2519 to grounded positive battery 2550; the path through the lower winding of relay 2605 being traceable through the network of an artificial line extending to ground at the inner right-hand armature and contact of relay 2608 which operated in response to the operation of relay 2602. Relays 2540 and 2541 under the influence of the current in the line circuits closed through their upper windings, operate to their respective marking contacts. Relay 2541, upon operating, sends a marking condition over the inward path including conductors 2506 and 2406, through the terminal telegraph transmitter 2403, over conductors 2404 and 2405, through the terminal telegraph transmitter 2402, conductors 2401 and 801, through the upper winding of polarized relay 812, back contact and outer, upper armature of relay 813, through the upper winding of polarized receive relay 802 to grounded positive battery. The operation of the transmitters 2403, 2402 are the same type as employed in the system disclosed in the copending application of J. A. Kreck, supra. The circuit just traced prepares the concentrating unit center for an incoming call.

The ground connection at the upper armature and contact of relay 2520, which is present at one end of the circuit extending over ring conductors of jack 2538 and plug 2601, and which operated relay 2610 as hereinbefore stated causes cord supervisory lamp 2613 to light until a marking condition is placed on the outward path 800 by the

concentrating unit as an indication that the concentrating unit is prepared for teledirection. The marking condition is placed on the outward path in the following manner. Relay 812 operated to marking in the circuit hereinbefore traced and closed a circuit extending from ground at the armature and marking contact of relay 812, make-before-break contacts associated with armature No. 6 of off-normal relay 704 through the filaments, in series, of vacuum tubes 803, 804, 805, 806 and 807, resistance 809, conductor 810, resistance 811, to grounded positive battery 842 and the filaments of the vacuum tubes are energized. After approximately one half second, tube 804 functions causing the operation of relay 820 and then relays 817 and 745 operate in turn. Relay 817, upon operating, removes relay 812 from the control of the grid of vacuum tube 804, keeping relays 820 and 817 operated and places a ground at the operated No. 5 armature and contact of off-normal relay 704 on conductor 752 which extends to the subscriber's sequence circuit to operate start relay 1004 as will be hereinafter described. Relay 745, upon operating, (1) operates off-normal relay 704 which upon operating connects power to the loop repeater and ground on the winding of relay 715, (2) removes ground at its No. 1 armature and contact, from conductor 746 which extends to the call key 1005 in the subscriber's sequence circuit, (3) prepares to lock under the control of relay 821 and (4) places ground on conductor 732 which extends through the winding of relay 1002 in the sequence circuit, thereby operating the chain relays of the sequence circuit to make this trunk test busy to calling subscribers and also to light the trunk busy lamp 706. Ground at No. 5 armature of relay 704 when connected to conductor 752 orders the sequence circuit to connect a director circuit to the trunk for the purpose of receiving the teledirecting pulses. The sequence circuit when it attaches a director circuit, grounds conductor 753 which results in the operation of relay 720 and, in turn, the select magnets similar to magnet 600 which are associated with the same trunk.

Director ready signal

If an attached director circuit is prepared to receive the teledirecting pulses, it connects a ground to conductor 736 which causes polarized relays 700 and 701 to operate to their respective marking, or right-hand positions. Relay 700 therefore sends a continuous marking signal to the master, or central, office, as an indication that the attached director circuit is ready to receive pulses. The manner in which the sequence circuit connects the director circuit to the particular trunk selected by the operator is described in the application of J. A. Krecek, supra.

As hereinbefore stated, ground is present on the outer upper armature and back contact of transfer relay 2520 at the master office to light cord supervisory lamp 2613 until a marking condition is received from the concentrating unit center over the outward path 2507 as an indication that the concentrating unit office is prepared for teledirection. The marking condition of the outward path 2507 will result in the operation of transfer relay 2520 to extinguish the cord supervisory lamp 2613 to indicate the condition to the operator who will then transmit the teledirection characters. If the number called is busy, or out of order busy, or unassigned, distinctive teletypewriter signals will be sent from the concentrating unit center to indicate the condition to the op-

erator. If the line, that is the particular conference circuit, is idle, connection will be established to it by the concentrating unit termination of the trunk first selected by the operator. Since in this case the called line, that is conference circuit is idle, the equivalent of a disconnect condition will exist and the outward path will return to spacing to relight the cord supervisory lamp by the release of transfer relay 2520 during the time the desired conference trunk is being connected.

Receiving teledirecting pulses at concentrating unit station

The director circuit is arranged to receive the teledirecting pulses and is part of a system which provides an unattended switching arrangement whereby a small group of trunks extending from a master office may serve a larger number of subscribers whose lines are connected at a satellite type of office known herein as the line concentrating unit station. The director circuit functions on inward calls from the master central office only, receiving and deciphering the number typed by the operator at the master office and causing the selection of the proper conference circuit. As hereinbefore stated, when the operator at the master office seizes the trunk, the trunk terminating equipment at the line concentrating unit center functions to cause the sequence circuit to attempt connection to the director circuit in use. When the trunk at the line concentrating unit station receives permission to route the call through the concentrating unit station, the sequence circuit connects this director circuit to the particular trunk. The inward transmission path from the trunk circuit is in a marking condition and is connected to the inward path conductor 801 and then over the upper windings, in turn, of polarized relays 812 and 802, to grounded positive battery. Relays 812 and 802 operate. Relay 802, upon operating, closes a circuit from grounded battery and resistance 815, over the marking contacts of relay 802, conductors 818, 718, through the middle upper armature and contact of relay 1007 to operate relay 2002 in the director circuit, while the transmission lead to the trunk is connected over conductors 1014 and 736.

Relay 2005 when operated serves to connect ground to thereby send the director ready signal out over conductors 1014 and 736 through the loop repeater to the master station as hereinbefore referred to and described in detail in the application of J. A. Krecek, supra.

In response to the director ready signal, the operator at the master office transmits a "Figures" teletypewriter character to the concentrating unit center at which point such received character will cause the director circuit to accept the next two characters transmitted by the operator. The next two characters represent the called number of the desired conference circuit. The telegraph pulses corresponding to the "Figures" and two subsequent characters incoming at the concentrating unit center are repeated by relay 2002 which is normally held to its marking, or right-hand, contact as shown. The distributor motor 2112 is operating but the receiving contacts 2100 and 2102 of the distributor are not operating because the start magnet 2101 is released latching the clutch. As soon as a character is received, the start pulse of the character sends relay 2002 to its spacing position which causes the start magnet 2101 to operate thereby allowing the cams designated 2100, to successively

operate the receiving contacts. The motor speed and receiving contacts are adjusted so that at the time the first selecting pulse of the character is received, the secondary winding No. 1 of relay 2110 is momentarily connected to the armature of relay 2002. If the first pulse is marking, relay 2110 will operate and lock to its marking, or right-hand, contact. Similarly, relay 2109 will be left either spacing or marking depending on the character of the second pulse. The reception of the "Figures" character then proceeds as follows:

Code element	Relay 2002	Register relays	Fan relays operated
1.....	Marking.....	2, 110	2112 and 2124.
2.....	do.....	2, 109	2121 and 2123.
3.....	Spacing.....	2, 107	
4.....	Marking.....	2, 106	2119.
5.....	do.....	2, 105	2118.

With relays 2110, 2109, 2107, 2106 and 2105 operated as above, it will be noted that none of the locking paths of these relays pass through the winding of relay 2115 but if any one is operated in the reverse direction, relay 2115 will be operated. Relay 2115 will therefore release only when a "Figures" character is received. The succeeding stop pulse is marking which causes magnet 2101 to release. A momentary closure of telegraph ground by the stop pulse distributor contact causes relay 2111 to operate to its marking, or right-hand, contact, overcoming the effect of its bias to the spacing, or left-hand, contact. The timing condenser 2125 causes relay 2111 to remain on its marking, or right-hand, contact for .030 second after the stop pulse distributor contacts open. This allows time for the operation of relay 2112 which locks to ground at the right-hand armatures and contacts of relay 2005 and prepares a path for operating relay 2032 when relay 2111 returns to its spacing or left-hand contact. In this way relay 2032 operates and locks to ground at relay 2005 and transfers the marking contact of relay 2111 along to succeeding counting relays in preparation for the registration of the next two digits.

The reception of "Figures" has therefore set up a combination of relays 2110, 2109, 2107, 2106 and 2105, locking direct to battery instead of through the winding of relay 2115 thereby releasing relay 2115 and allowing the next two characters to be registered. Therefore, "hits" on the line are ineffective to produce false calls unless they occur after the operator has sent a preliminary "Figures." When the "Figures" character is received the following relays are already operated: Relays 2000, 2004, 2010, 2016, 2007, 2005, 2001, 2122, 2121, 2119, 2118, 2124, 2123, 2012, 2032, 2002, and the register relays 2110, 2109, 2106 and 2105 are in their marking, or right-hand, positions and relays 2107 and 2111 are in their spacing positions. The operation of relays 2122, 2121, 2119, 2118, 2124 and 2123 perform no useful function at this time, the latter relays are part of the group identified herein as the fan relays.

Reception and deciphering of the first digit

The first digit of the called number of the desired conference circuit will be repeated by relay 2002, broken up, pulse by pulse by the distributor contacts and recorded by relays 2110, 2109, 2107, 2106 and 2105 in much the same way as the "Figures" character was received. Relay 2110 is op-

erated in accordance with the position of relay 2002 at the middle of the first pulse, relay 2109 according to the second pulse, and so forth. In each case the operating winding, that is, the lowermost, can quickly overcome the holding winding, that is, the middle or uppermost, of relays 2110, 2109, 2107, 2106 and 2105, but otherwise the relays hold in whichever direction they are operated under control of motor start relay 2004. The following table indicates the condition of relays 2110, 2109, 2107, 2106 and 2105 resulting from transmission of numerical characters. In the following table "M" indicates marking and "S" indicates spacing.

Character		Relay condition				
Lower case	Upper case	2110	2109	2107	2106	2105
Figures	Figures	M	M	S	M	M
P	0	S	M	M	S	M
Q	1	M	M	M	S	M
W	2	M	M	S	S	M
E	3	M	S	S	S	S
R	4	S	M	S	M	S
T	5	S	S	S	S	M
Y	6	M	S	M	S	M
U	7	M	M	M	S	S
I	8	S	M	M	S	S
O	9	S	S	S	M	M

It will be noted that relay 2110 in its marking, or right-hand, position, operates relays 2122 and 2124 of the fan relay group. Similarly the other fan relays are operated when their associated register relay is marking. Also relay 2115 will be operated during the reception of the first digit but performs no useful function after "Figures" character has been received. At the conclusion of the reception of the dot element of the particular character sent relay 2111 again operates to its marking, or right-hand, position and is again held for an additional period of .030 second. In operating to its marking, or right-hand, contact relay 2111 causes the operation of relay 2036, which locks to ground furnished by relay 2005 and furnishes ground through the normal contact of relays 2035, 2034, 2029 and 2033, to the armature of relay 2118. From the armature of relay 2118 it is fanned out by means of the operated or non-operated pulse registering relays to one of ten conductors designated in Fig. 21 by the numerals 0 to 9 which eventually causes the operation of any one of a relay group consisting of ten relays 1900 to 1909, the selected relay being associated with the particular conductor of conductors 0 to 9. The fan relays being operated in various combinations provide for the selection of any one of the ten conductors designated 0 to 9. They may be selected as follows:

Fan relay operated

0	1	2	3	4	5	6	7	8	9
(2121)	(2122)	(2122)	(2122)	(2123)	(2118)	(2124)	-----	(2121)	(2119)
(2120)	(2121)	(2123)	-----	(2119)	-----	(2120)	(2121)	(2120)	(2118)
(2118)	(2120)	(2118)	-----	-----	-----	(2118)	(2120)	-----	-----
-----	(2118)	-----	-----	-----	-----	-----	-----	-----	-----

The particular selected relay corresponds to the tens group of the particular called number assigned to the conference circuit desired and when operated, locks in series with relay 1912 to off-normal ground furnished by relay 2005. Relay 1912, upon operating, (1) removes grounded battery from the operating winding of all relays of the group designated 1900 to 1909 preventing the operation of another relay in this group on

this call; (2) causes the operation of relays 1910 and 1911 which definitely removes any relays of the group 1900 to 1909 from their associated fanning-out conductors 0 to 9; (3) closes at its right-hand armature and contact a circuit extending to the miscellaneous alarm circuit (Figs. 22 and 23) which later supplies ground to operate the hold magnet of the link circuit in case the desired conference circuit is idle. Relay 2036, upon operating, prepares a path for the operation of relay 2035. When relay 2111 returns to its spacing, or left-hand, contact after .030 second relay 2035 will operate and ground will be supplied to a contact on a particular relay of those designated 1900 to 1909, which is operated, causing the operation of a pair of relays associated with the particular tens group of the desired conference trunk. There are ten pairs of relays respectively associated with the ten groups of ten subscriber lines each, the desired conference circuit taking the place of a subscriber's line in one of these groups. In Figs. 18 and 19 of the drawings, relays 1833 and 1834 represent one group, relays 1917 and 1918 represent another group and relays 1920 and 1921 represent still another group. The relays of the selected pair, upon operating, respectively connect the fanning-out conductors 0 to 9 to their respectively corresponding conductors over the operated contacts, the selected pair being that in which the "tens" digit of the number of the called conference circuit is allocated.

Relay 2035, upon operating: (1) locks to ground at relay 2005; (2) opens the operating path of relay 2036 and prepares a path for the operation of relay 2037; (3) connects ground to conductor 2003 which extends to the sequence master control circuit (Fig. 12) where it is instrumental in fixing the trunk advance change and in preventing the release of any link circuit in use on an established call. When the first digit is received the following relays are already operated: relays 2000, 2004, 2010, 2016, 2007, 2005, 2001, 2012, 2032, 2036, 2035, one of the relays 1900 to 1909, relays 1912, 1910, 1911 and one of the pairs of relays which pairs are respectively represented by relays 1833 and 1834, 1917 and 1918 and 1920 and 1921. Relay 2002 is in its marking, or right-hand, position, relay 2111 is in its spacing, or left-hand, position and relays 2110, 2109, 2107, 2106 and 2105 and those of the fan relay group are operated according to the character just received.

Reception and deciphering of second digit

The second digit of the desired conference trunk is received, registered and made to operate the fanning-out relays in the same way as described for the first digit.

Relay 2111 operates to its marking, or right-hand, position, while the stop segment 2102 is grounded and thereby causes the operation of relay 2037. Relay 2037, upon operating, (1) connects at its outer left-hand armature and contact a high resistance circuit including grounded positive battery to the lower winding of relay 2002 to prevent any additional incoming pulses from being registered; (2) locks to ground at relay 2005; and (3) opens the operating paths of relay 2035 and the relays of operated pair, such as that designated by relays 1833 and 1834 or 1917 and 1918 or 1920 and 1921, and prepares a path for the operation of relay 2034.

When relay 2111 returns to its spacing, or left-hand, contact it causes the operation of relay

2034. Relay 2034, upon operating, (1) connects grounded battery through the windings of relays 2039 and 2040 to the armature of relay 2118 and through the fanning-out circuit to one of conductors 0 to 9 to the desired conference circuit; and (2) causes the operation of the slow-acting relay 2041. The selection set up in the director remains set up therein while the test of the conference circuit is taking place.

Testing conference circuit

The connection of battery through the windings of relays 2039 and 2040 to the desired conference circuit enables these two relays to determine if the particular conductor of conductors 0 to 9 extended by the selected pair of relays 1833 and 1834 or 1917 and 1918 or 1920 and 1921, is terminated in a direct ground which causes the operation of both relays 2039 and 2040, or a relatively high resistance out-of-order ground, which results in the operation of relay 2039 only. In case no ground is available neither relay 2039 or 2040 operates. This test takes place during the slow-operating time of relay 2041 which begins to operate when relay 2034 operates. As soon as relay 2041 operates off-normal ground at relay 2005 is connected to the armature of relay 2039. Assuming the desired conference circuit to be idle, in which case ground is not connected to the particular one of conductors 0 to 9 closed through any pair designated by relays 1833 and 1834, or 1917 and 1918, or 1920 and 1921, relay 2039 will be non-operated and ground connected to its armatures by relay 2041 will cause the operation of relay 2029. Relay 2029 upon operating, (1) removes relays 2039 and 2040 from the particular one of conductors 0 to 9 which conductor extends to the desired conference circuit, and replaces these relays by relay 2042; (2) causes the release of relay 2034 by removing ground; (3) prepares a path for the operation of relay 2030; and (4) locks to ground at relay 2005. The release of relay 2034 causes relay 2041 to slowly release. During the time that relays 2034 and 2041 are releasing, ground through the low resistance winding of relay 2207 in the miscellaneous alarm circuit is connected to the left-hand side of winding of relay 2042 to the particular one of conductors 0 to 9 which extends to the desired conference circuit. Under the assumed condition of the conference circuit being idle, battery on the hold magnet, say magnet 530 for the conference circuit shown, of the crossbar switch in the link circuit permits relay 2042 to operate but due to the high resistance of the circuit the hold magnet remains unoperated. Relay 2042, upon operating, opens the operating path of relay 2030 and closes a path to operate relay 2043. When relay 2041 releases ground supplied by relay 2005 is connected to the armature of relay 2042, which, having operated, causes the operation of relay 2043. Relay 2043 upon operating (1) locks to ground at relay 2005; (2) short-circuits the winding of relay 2042; and (3) holds open the operating path to relay 2030. With the winding of relay 2042 short-circuited ground through low resistance supplied by the miscellaneous alarm circuit, connected through the fanning-out relays of the director circuit to the particular one of conductors 0 to 9 which extends to the idle desired conference circuit, will cause the operation in the link circuit of the hold magnet. The desired conference circuit will therefore be connected to the calling trunk which will function to release the

sequence circuit. The sequence circuit in turn will function to remove the ground at the outermost upper armature of relay 1007 from the operating circuit of relay 2000. Relay 2000, therefore, releases removing off-normal ground from various parts of the circuit including relays 2007 and 2005 and releasing relay 2004 unless conductor 1820 is held grounded at the innermost upper armature of a trunk sequence circuit start relay, such as relay 1004 for the trunk shown in Figs. 7 and 8, indicating that an inward call over another trunk is awaiting completion. Relay 2005, upon releasing, removes off-normal locking ground from a considerable part of the circuit. If relay 2004 releases the motor will be stopped and all remaining parts of the circuit will be deenergized. If, however, relay 2004 is held operated, the motor is kept running and relays 2110, 2109, 2107, 2106 and 2105, and the associated fanning-out relays are locked in the condition in which they were operated by the last digit. When the next call comes in the operation will be as described above except as follows: Relay 2103 now operates immediately since the motor is running at full speed and relays 2007 and 2005 follow at once upon receiving a closure of the "stop pulse" contacts of the distributor. Before the stop pulse is reached relays 2110, 2109, 2107, 2106 and 2105 may be operated to spacing through back contacts of relay 2007, but in any case the circuit waits to receive "Figures" before proceeding with the call. The operation continues as described hereinbefore.

The conference circuit being in an idle condition, the director circuit, in the manner hereinbefore described, orders the link circuit to connect the idle conference circuit to the calling trunk which extends to the master office. The hold magnet, say magnet 530, upon operating, locks in series with relay 715 which operates, operating in turn relay 713. The trunk circuit shown in Fig. 7 is connected to the conference circuit by the combined operation of hold magnet 530 and select magnet 600, the connection being effected at contact set 602.

Inward call to busy conference circuit

The operation upon a call to a busy conference circuit is described in the application of J. A. Kreck, supra, for a busy line. Likewise, connection to unassigned or impossible numbers, recorder signals, failure of the director circuit and returning stuck direction circuit to service are in their operations the same as described in the Kreck application.

The conference circuit located at the concentrating unit center is divided into three main divisions: (1) the subscriber line applique circuit and associated vertical in the conference connector (a special link circuit); (2) the automatic conference control circuit; and (3) the conference circuit proper with a maximum eleven branches, that is, ten subscriber conference branches and one trunk conference branch. Division No. 1 is the special equipment required for each subscriber line which is arranged for automatic connection to a conference circuit. Division No. 2 is a group of relays responsible for ordering the particular subscriber line connection to the next idle subscriber conference branch, and division No. 3 contains the polar relays responsible for carrying on of the telegraph communications during a conference and contain, in addition, supervisory equipment for

each subscriber conference branch. The number of subscriber conference branches in this circuit is ten, as disclosed. In general the calling of the subscriber's unlisted number is the key which opens the way for his ultimate connection to a conference branch and differentiates that call to him from a non-conference call.

Operator obtains the use on the conference circuit

The operator desiring to set up a conference circuit in the concentrating unit uses a calling trunk to the unit and in the normal way types the special number assigned to the conference circuit as hereinbefore stated. If the conference circuit is in use or if some manual patches still remain in any of the subscriber conference branches, the director circuit in the unit will report the conference circuit busy. If the conference circuit is idle, the link circuit will be ordered to connect it to the calling trunk which, for purposes of identification, will hereinafter be called the conference trunk. This operation was hereinbefore described with the operation of hold magnet 530. The connection of the conference circuit to the conference trunk brings the ring conductor 532 of the conference trunk into the trunk conference branch, the circuit being traceable from ground through the upper winding of polarized relay 714, upper normal contacts of jack 719, conductor 729, operated contacts of set 602, conductor 630, outer left-hand armature and contact of hold magnet 530, conductor 532, normal contacts of jack 1404, through the winding of relay 1405, resistances 1406 and 1407 to grounded battery 1408. Relay 1405 operates and closes an obvious operating circuit for relay 1409. Relay 1405 operates in a circuit which extends through the winding of relay 714 of the conference trunk, but the high resistance of the path prevents the operation of supervisory relay 714. Relay 1409, upon operating, turns power on all the conference circuit branches and the conference control circuits. Relay 1409, upon operating, (1) connects ground at its middle upper armature; (a) to a path extending through the upper winding of polarized send relay 1413, through the lower winding of polarized send relay 1314 of subscriber conference branch No. 1 and the lower windings, in series, of the polarized send relays of the remaining nine subscriber conference branches, to grounded positive battery 1315, and (b) to a path extending over conductor 1416, through the uppermost winding of relay 1600, conductors 1601 and 1602, to grounded positive battery 1408; (2) connects ground at its innermost lower armature to the second group of five subscriber conference branches; (3) at its innermost upper armature and contact grounded battery is connected to the first group of five subscriber conference branches; (4) at its middle lower armature and contact, grounded battery being connected to the second group of five subscriber conference branches; (5) at its outermost upper armature and front contact, ground is connected to the first group of five subscriber conference branches; and (6) at its outermost lower armature and contact, grounded battery is connected to the windings of relays 1606 and 1604 in the conference control circuit.

With battery thus connected in the conference branches and the conference control circuit shown in Fig. 16, a mark signal is prepared for transmission to the trunk circuit, now referred to as the conference trunk, when the tip conductor of the conference trunk is closed through

in the trunk conference branch, but for the time being only a space signal is received by the conference trunk, which acts as if a subscriber called in the ordinary way had not yet answered. Battery is available for all unlisted numbers which at this period of the operation cease to test "unassigned."

In automatic ringing offices, ringing current is transmitted by the conference trunk but reaches nowhere as will now be described. The ringing current source which is connected to conductor 748 transmits ringing current when the hold magnet 530 of the link circuit operates and locks in series with relay 715. Relay 715, upon operating, operates in turn relay 713. Relay 713 upon operating, (1) opens at its inner lower armature and back contact a circuit extending over conductor 752 and through the winding of start relay 1004 thereby causing the sequence circuit to dismiss the director circuit; and (2) closes at its outer upper armature and front contact a circuit extending from grounded battery through the winding of relay 727, back contact and No. 2 armature of relay 725, back contact and lower armature of relay 750, inner lower armature and back contact of relay 712, outer upper armature and front contact of relay 713, upper armature and back contact of relay 726, front contact and outer upper armature of relay 745 to grounded interrupter 751. Relay 727 operates under the influence of interrupter 751 and thereby applies ringing current from the continuous ringing source to the circuit traceable over the front contact and upper armature of relay 727, conductor 709, jack 754 in its normal condition, tip conductor of the trunk connected to contact set 602 of the link circuit, but as stated above nothing responds at this time to the automatic ringing current.

Operator reaches a subscriber station by means of the unlisted conference number of the subscriber's station

In order to reach a subscriber whose line has been equipped for automatic connections to the conference circuit for the specific purpose of ultimately connecting the subscriber line to a subscriber conference branch, the operator inserts another cord circuit into another trunk in the same manner as establishing a new call and then transfers her position circuit to said other cord circuit.

The operator then types the unlisted conference number associated with the subscriber line. This second trunk for purpose of identification will be hereinafter called the "order" trunk. The operator transmits the characters, or digits, of the unlisted conference number associated with the desired subscriber station and the director circuit in a manner as hereinbefore described decodes the two transmitted characters into dot elements by the receiving distributor causing the proper register and fan relays to operate. If the subscriber line is busy the director circuit will so inform the operator. If idle, the director circuit will place a resistance ground on the conductor of group numbered 0 to 9, the conductor being in particular the one associated with the called subscriber station, or, in other words, the conductor corresponding to the conference number assigned to the called subscriber station, thereby causing the operation of relay 1525 of the conference subscriber applique. The operating circuit for relay 1525 is traceable from grounded negative battery at the outermost lower armature and contact of

relay 1409, conductor 1437, upper armature and contact of relay 1606, conductors 1607, 1609 and 1611, inner upper armature and contact of start relay 1612, conductors 1613 and 1614, make-before-break contacts of relay 1525 through the winding of relay 1525, conductor 1515, back contact and lower armature of relay 1516, conductor 1517, back contact and outer lower armature of relay 1518, normally closed contacts of jack 1549, conductor 1519 which corresponds with the particular conductor of group numbered 0 to 9, contacts and middle left-hand armature of relay 1917, conductor No. 1, inner left armature and back contact of relay 1803 (one of the director transfer relays), conductor No. 1, front contact and outer left-hand armature of relay 2122, front contact and right-hand armature of relay 2121, front contact and outer right-hand armature of relay 2120, back contact and right-hand armature 2119, front contact and left-hand armature of 2118, conductor 2126, contact and inner left-hand armature of relay 2033, outer left-hand armature and front contact of relay 2029, front contacts of relay 2043, conductor 2063, back contact of relay 1802, conductor 1920, right armature of relay 1912, through the winding of relay 2207, to ground on relay 2200. Relay 1525 operates and thereby (1) locks to the particular conductor 1519; (2) closes at its middle lower armature and contact an operating circuit for relay 1520; (3) shunts the back contact and lower armature of relay 1516 from the locking path to ground of relay 1525; and (4) prepares at its outermost lower armature and contact an operating circuit for relay 1621. Relay 1520 operates and (1) completes at its No. 3 armature the operating circuit for slow-release relay 1621; (2) splits at its No. 1 armature the subscriber's ring conductor, bringing both ends into the control circuit; (3) extends at its No. 2 armature the subscriber's tip conductor 1522, through the winding of polarized relay 1623; (4) connects at its armatures 4, 5, 6, 7 and 8, respectively, other control conductors from the conference subscriber applique to the conference control circuit; (5) closes at its No. 7 armature a ground connection to a circuit traceable over conductor 1624, through the winding of start relay 1612, conductors 1611, 1609 and 1607, contact and upper armature of relay 1606, conductor 1437 to grounded battery at the outermost lower armature and contact of relay 1409 and start relay 1612 operates; (6) operates relay 1621 in a path extending over conductor 1625, outermost lower armature of relay 1525, conductor 1526, No. 3 contact on relay 1520 to ground at the inner upper armature and contact of relay 1516 and (7) prepares at its No. 7 armature a locking circuit for relay 1626.

Start relay 1612, upon operating (1) causes all other conference circuits having unlisted conference numbers to again test "unassigned;" (2) removes at its outer lower armature and back contact the ground located at the middle upper armature and contact of relay 1409, from the grid of vacuum tube 1627; (3) closes at its outer lower armature and front contact an energizing circuit for the filament of vacuum tube 1627, the energizing circuit being traceable from grounded battery 1408, resistance 1407, conductor 1602, filaments of vacuum tube 1627, front contact and outer lower armature of relay 1612, conductor 1416 to ground at the middle upper armature and front contact of relay 1409; (4)

closes at its outer upper armature and contact an operating circuit for select magnet 1502 which is associated with the first idle level of the conference connector switch, the circuit being traceable from ground at the outer upper armature and contact of start relay 1612, conductor 1628, upper armature and back contact of relay 1318, conductor 1319, through the winding of select magnet 1502, to grounded battery. Magnet 1502 operates to prepare the contacts of set 1503 to interengage. Relay 1621, upon operating, closes a circuit extending from ground at the upper armature and back contact of relay 1629, armature and back contact of slow-to-release relay 1630, resistance 1631, armature and contact of relay 1621, conductor 1632, No. 6 armature and contact of relay 1520, conductor 1533, then through Figs. 11, 8, 7 and 6 to conductor 435 in Fig. 4, lowermost normal contact of jack 436, conductors 437 and 438 and then through Figs. 6, 7, 8 and 11 to conductor 1534 in Fig. 15, inner upper armature and back contact of relay 1518, conductor 1535, then through Figs. 15, 11, 8, 7 and 6 to conductor 631, through the winding of a subscriber's line hold magnet 533 to grounded battery. Hold magnet 533 operates and closes at its inner armature and contact a circuit traceable from ground, conductor 512 and through Figs. 6, 7, 8, 11 and 15 to conductor 1536, through the winding of relay 1516 to grounded battery. Relay 1516 of the conference subscriber's applique operates. The operating circuit for subscriber line hold magnet 533 has a parallel path which extends over the outer upper armature and contact of relay 1518, conductor 1537, then through Figs. 15, 11, 8, 7 and 6 to conductor 523, conductor 524, operated contact set 601, sleeve conductor of the "order" trunk, the sleeve conductor corresponding to conductor 722 of the conference trunk. Subscriber line hold magnet 533 upon operating connects at its outer armature and front contact the ring conductor of the "order" trunk which conductor corresponds to conductor 729 of the conference trunk, conductor 604, outer armature and front contact of magnet 533, conductor 509, then through Figs. 6, 7, 8, 11 and 15 to conductor 1538, armature No. 4 and contact of relay 1520 to the conference control circuit. Relay 1516, upon operating, (1) connects subscriber line tip conductor 412 which extends through Fig. 4, Figs. 6, 7, 8, 11 and 15 then to conductor 1506, upper armature and back contact of the hold magnet of the conference connector switch, conductor 1522, front contact and outer upper armature of relay 1516, conductor 1539, then through Figs. 15, 11, 8, 7 and 6 to conductors 535 and 536, through the operated tip contact of a set corresponding to set 601 to the tip conductor of the "order" trunk; (2) opens at its inner upper armature and contact the operating circuit for relay 1621 of the conference control circuit, which now releases; and (3) furnishes at its lower armature and front contact a locking ground for relay 1525 while it keeps a busy condition on the conference number associated with the called subscriber's line.

The "order" trunk proceeds to discharge the director circuit and when so arranged begins to ring the called subscriber's station; otherwise the operator manually rings the subscriber's station. Marking potential supplied by the "order" trunk operates relay 1623 which again connects ground to the grid of vacuum tube 1627 thereby

preventing the tube from becoming conductive. At this stage of the call the subscriber line remains connected to the "order" trunk solely because the trunk holds the subscriber line hold magnet operated. The subscriber line can therefore be disconnected at the pleasure of the operator at the central office at which the call originated. If, therefore, the subscriber does not answer the call, the operator can withdraw from the "order" trunk, which in turn will cause the trunk to release the subscriber line hold magnet. The hold magnet, in turn, releases relay 1516, which in turn releases relays 1525, 1520, 1623 and 1612, returning the circuit to normal.

The conference subscriber answers

When the conference subscriber answers battery potential on ring conductor 409 is impressed on a circuit extending over the make-before-break contacts of conference connector magnet 1501, conductor 1540, No. 1 armature and front contact of relay 1520, conductor 1541, through the Nos. 1 and 2 windings of relay 1600 to ground. Relay 1600 operates to its contact and thereby closes a circuit for operating relay 1603, the circuit being traceable from ground, armature and contact of relay 1600, conductor 1651, through the winding of relay 1603, conductors 1608 and 1607, back contact and upper armature of relay 1606, conductor 1437 to grounded battery at the outermost lower armature and front contact of relay 1409, and relay 1603 operates. Relay 1603, upon operating, (1) greatly reduces the bias current in the No. 3 winding of relay 1600 by adding resistance 1641 into the energizing circuit for winding No. 3 of relay 1600, the energizing circuit being traceable from grounded positive battery 1408, resistance 1407, conductor 1602, resistances 1641 and 1642 through winding No. 3 of relay 1600, conductor 1416 to ground at the contact and outermost upper armature of relay 1409; (2) closes a circuit extending from grounded positive battery 1408, resistance 1407, conductor 1602, upper armature and front contact of relay 1603, contact and armature No. 4 of relay 1520, conductor 1538, through Figs. 15, 11, 8, 7 and 6 to conductor 509 in Fig. 6, front contact and outer left-hand armature of subscriber line hold magnet 533, ring conductor 604, operated contact of set corresponding to set 601, ring conductor such as 729, of the order trunk, upper normally closed contacts of the "order" trunk, jack, such as jack 719, to the upper winding of an "order" trunk polarized relay, such as 714, thereby operating the relay, such as relay 714, in the "order" trunk; (3) and prepares at its inner lower armature and contact an operating circuit for hold magnet 1501 in the conference connector crossbar switch. The relay, such as relay 714, in the "order" trunk circuit, causes the "order" trunk circuit to enter the transmission stage and the operator communicates with the subscriber.

Assume that the trunk circuit shown in Fig. 7 is the "order" trunk at this time. When the called subscriber answers and relay 714 operates in the first silent interval, relay 714 closes at its spacing, or left-hand, contact a circuit extending from ground at armature No. 2 and contact of relay 704, armature and spacing contact of relay 714, through the winding of relay 725 to grounded battery, and the other extending from the armature and spacing contact of relay 714, innermost upper armature and contact of

relay 712, armature No. 3 and contact of relay 745, through the winding of transfer relay 814 to grounded battery. Relays 725 and 814 operate. Relays 700 and 701 meanwhile operate to their marking, or right-hand, positions as shown thereby transmitting a marking signal to the operator at the central office as an indication that the called subscriber has answered. Relay 701 in its marking, or right-hand, position connects ground over conductors 763 and 737 to the grid of subscriber break vacuum tube 805. Relay 725, upon operating, (1) closes at its No. 5 armature and contact an obvious operating circuit for relay 726, permitting it to lock under control of relay 713; (2) locks under control of relay 728; (3) furnishes an additional operating path for relay 704; (4) places the grid of subscriber break vacuum tube 805 under the sole control of relay 701 and (5) prevents further ringing of the subscriber's line.

Relay 814, upon operating, effectively arranges the loop repeater to operate on a half duplex basis and changes the timing condition on the cut-through vacuum tube 804. The circuit is now in the transmitting condition and continues to function as described in the pending application of J. A. Krecsek, supra.

Conference subscriber refuses to accept conference calls

If the conference subscriber, after answering, refuses to accept the conference call, relay 1600 on the conference control circuit releases as soon as the subscriber disconnects. Relay 1600, upon releasing, causes the release of relay 1603, which, in turn, removes grounded battery 1408 from the ring conductor 1538 of the "order" trunk, thereby releasing relay 714 of the "order" trunk and registering a subscriber disconnect which is transmitted to the operator at the central office. When the disconnect signal is registered at the central office, the operator withdraws from the "order" trunk which finally results in the release of the subscriber line hold magnet 533, causing in turn the release of relays 1516, 1525, 1520, 1612 and 1623, returning the conference circuit to normal.

Transfer of a conference subscriber to an idle conference branch

If the conference subscriber accepts the conference call, the operator at the central office sends a two-second break signal. The transmission of the break signal to the subscriber causes the release of relay 1623 which, upon operating, removes ground from the grid of vacuum tube 1627. The removal of ground at the armature of relay 1623 causes condenser 1622 to begin charging from grounded positive battery 1408 and approximately one and one half second after the charging begins the plate current in vacuum tube 1627 is sufficient to operate relay 1643. Relay 1643 operates and closes at its armature and contact a circuit extending from ground, conductor 1644, lower armature and back contact of relay 1645, through the winding of relay 1629, conductor 1607, contact and upper armature of relay 1606, conductor 1437 to grounded battery at the outermost lower armature and contact of relay 1409. Relay 1629 operates and closes at its upper armature and front contact an operating circuit extending through the winding of relay 1630, conductors 1608 and 1607, contact and upper armature of relay 1606, conductor 1437 to grounded battery at the outermost lower armature and contact of relay 1409. Relay 1629, upon operat-

ing, closes at its lower armature and contact a circuit extending from grounded battery at the outermost lower armature and contact of relay 1409, through the winding of relay 1420, conductor 1634, lower armature and contact of relay 1629, conductor 1421 to ground at the back contact and upper armature of relay 1412. Relay 1420 operates and (1) locks in a path extending over conductor 1637, to ground at the inner lower armature and contact of start relay 1612; (2) connects the tip conductor 1417 of the conference trunk to the trunk conference branch and (3) at the same time increases the potential on ring conductor 532 of the conference trunk by shunting resistance 1406, thereby causing the conference trunk to act as if a subscriber had answered. This "trip" is advanced to trip the ringing in automatic ringing offices to prevent the first conference subscriber receiving a remnant of the automatic ringing.

At the conclusion of the "break" signal sent by the operator, relay 1623 again connects ground to the grid of vacuum tube 1627, causing the release of relays 1643 and 1629. Relay 1630 being of the slow-to-release type does not release at this time but the release of relay 1629 permits relay 1626 to operate in a path from ground at the upper armature and back contact of relay 1629, armature and front contact of relay 1630, through the winding of relay 1626, conductors 1609 and 1607, contact and upper armature of relay 1606, conductor 1437, to grounded battery at the outermost lower armature and contact of relay 1409. Relay 1626 operates and locks in a circuit under control of relay 1520. When finally relay 1630 releases a resistance ground is connected to a circuit extending from ground at the upper armature and back contact of relay 1629, armature and back contact of relay 1630, resistance 1631, conductor 1647, contact and upper armature of relay 1422, conductor 1434, outer upper armature and contact of relay 1626, inner lower armature and contact of slow-release relay 1603, No. 8 armature and contact of relay 1520, conductor 1546, through the winding of hold magnet 1501 associated with the conference subscriber in the conference connector switch. Relay 1420 being operated and the conference trunk having sent a mark signal of sufficient duration to cause the release of slow-to-release relay 1422 the operation of relay 1604 is insured and the possibility of ringing being sent to the first subscriber to be added to the conference circuit is precluded. Hold magnet 1501 operates and locks in series with relay 1323 in a circuit extending from ground at the outermost upper armature and front contact of relay 1409, conductor 1335, through the winding of relay 1323, conductor 1324, operated sleeve contact of set associated with selecting magnet 1502, through the winding of hold magnet 1501 to grounded battery, selecting magnet 1502 having been operated by start relay 1612 in a circuit traceable over conductor 1319, back contact and upper armature of relay 1318, conductor 1328 to ground at the outer upper armature and contact of relay 1612. Relay 1323 of the subscriber's conference branch operates but does not as yet cause the operation of relay 1311 although it lights the busy lamp 1325 associated with the subscriber's conference branch. Hold magnet 1501, upon operating, disconnects the subscriber line tip conductor 1506 and ring conductor 1507 from conductors 1522 and 1540, respectively, and connects them to corresponding tip and ring conductors 1511 and 1512 which are connected over the oper-

ated contacts of set 1503 to tip conductor 1504 and ring conductor 1505 respectively, conductor 1504 being extended in a path over conductor 1326, through the upper winding of receive relay 1327 to the armature and marking, or left-hand, contact of send relay 1314 in the subscriber conference branch, and conductor 1505 being extended in a path over conductor 1328, through the Nos. 3 and 2 windings, in series, of supervisory relay 1310 to ground. The subscriber conference branch sends a mark signal to the subscriber station and the subscriber's line being connected to the subscriber's station by means of switch 303, relay 1310 operates and the operation of relay 1310 operates relay 1311 of the subscriber's conference branch selected. Relay 1311 upon being operated removes the resistance ground from tip conductor 1326 of the subscriber conference branch, the resistance value in this ground being furnished by resistance 1330. This resistance ground normally had been creating a mark signal for that branch's contribution to the conference transmission circuit but now that the subscriber's loop is attached the loop performs that service. Relay 1311, upon operating, also operates relay 1412 in a circuit traceable from ground at the lower armature and contact of relay 1311, conductor 1331, through the lower winding of relay 1412, conductors 1432 and 1437 to grounded battery at the outermost lower armature and contact of relay 1409. Relay 1412 locks in its operated position over two circuits, one circuit traceable over the inner lower armature and contact of relay 1412, outer lower armature and contact and inner lower armature of relay 1420, conductor 1637, contact and inner lower armature of relay 1612 to ground, and the other traceable from grounded battery at the outermost lower armature of relay 1409, conductor 1432, through the upper winding of relay 1412 to ground. Relay 1420 having previously been operated now locks in the same locking circuit and also places relay 1420 under control of polarized relay 1432 which operates to its spacing, or right-hand, contact whenever the conference trunk transmits a space signal to the conference circuit whereby relay 1422 is operated.

Meanwhile, when hold magnet 1501 of the conference connector switch is operated, it effectively sends a space signal to the order trunk because it disconnects at its upper armature and back contact, tip conductor 1506 from tip conductor 1522, and at its lower armature disconnects ring conductor 1507 from ring conductor 1540 to cause the release of relay 1600. Relay 1600, upon releasing, causes slow-release relay 1603 to release. Relay 1603, upon releasing, removes at its upper armature and front contact battery potential from grounded positive battery 1408, from the ring conductor 1538 which is connected to the ring conductor of the "order" trunk, thereby resulting eventually in the registration of a disconnect signal in that trunk and finally in a disconnect signal before the operator at the central office. Relay 1603, upon releasing (1) also increases the bias current in winding No. 3 of polarized relay 1600, by shunting resistance 1641; (2) opens at its inner lower armature and front contact the operating circuit for hold magnet 1501 in the conference connector switch, whereby the resistance ground (due to resistance 1631) connected to conductor 1647 and extending over the upper armature and contact of relay 1422, conductor 1434, outer upper armature and contact of relay 1626 is connected over the outer low-

er armature and back contact of relay 1603, through the winding of relay 1645, to grounded battery at the outermost lower armature and contact of relay 1409. Relay 1645 operates and opens at its upper armature and contact the operating circuit for relay 1623 which releases and again removes ground from the grid of vacuum tube 1627. After one and a half seconds relay 1643 again operates but this time relay 1645, being operated, the operation of relay 1643 results in the operation of relay 1518 of the conference subscriber applique. Relay 1518 upon operating (1) locks in parallel with hold magnet 1501, through the operated contacts of set 1503, the locking path of relay 1518 being completed over front contact and inner lower armature of relay 1518, conductor 1546, operated contacts of set 1503, conductors 1324, through the winding of relay 1323, conductor 1335, to the front contact and outermost upper armature of relay 1409 and a locking path for hold magnet 1501 being also traceable over conductor 1546, operating contacts of set 1503, conductor 1324, through the winding of relay 1323 to grounded conductor 1335; (2) opens the holding circuit of subscriber line hold magnet 533 which is traceable over conductor 631, through Figs. 6, 7, 8, 11 and 15 to conductor 1535, contact and outer upper armature of relay 1518, conductor 1537, through Figs. 15, 11, 8, 7 and 6 to conductors 523 and 524, operated contacts of set 601, conductor 722, through the winding of sleeve relay 715 of the "order" trunk to ground at the contact and middle upper armature No. 2 of relay 704 to ground, and hold magnet 533 releases; and (3) places at its inner upper armature and front contact a busy indication for the regular subscriber line number and at its outer lower armature and front contact a busy indication for the subscriber line unlisted number. Subscriber hold magnet 533, upon releasing, opens at its inner armature and contact the operating circuit for relay 1516 in the conference subscriber's applique and relay 1516 releases which, in turn, releases relays 1525 and 1520. Relay 1520, upon releasing, releases start relay 1612 and relay 1626 in the conference control circuit. Start relay 1612, upon releasing, reapplies at its back contact and outer lower armature the ground connection located at the middle upper armature and contact of relay 1409, to the grid circuit of vacuum tube 1627 whereby the vacuum tube becomes non-conductive and relay 1643 releases. Relay 1626, upon releasing, opens the operating circuit for relay 1645 which releases thereby returning the automatic conference control circuit to normal. Also start relay 1612, upon releasing, removes ground at its outer upper armature and contact from conductor 1628 and the grounded battery connected to the innermost upper armature and contact of relay 1409 applies sufficient current to the winding of relay 1318 to cause the latter relay in the selected subscriber's conference branch to operate. At this time all other unlisted, or conference, numbers again cease testing "unassigned." Relay 1318, upon operating, preselects the next idle level in the conference connector switch such as preparing the next selector magnet corresponding to magnet 1502, for operation. The selecting magnet of the next idle level will operate when start relay 1612 again operates. The relay corresponding to relay 1318 and located in the next subscriber's conference branch will similarly be held from operating when start relay 1612 again operates.

Addition of other conference subscribers' stations.

As hereinbefore stated the operator at the central office receives a disconnect signal after the conference subscriber line is connected to a subscriber conference branch. Slightly later the control circuit causes the release of the subscriber's line hold magnet, which again permits the operator to reach a director circuit. When a director circuit is attached the operator receives a lamp indication and, if other subscribers are to be automatically connected the operator repeats the routine hereinbefore described until all have been added. The action of the conference circuit remains the same as when the first subscriber was added except this time relay 1629 does not operate relay 1420 and relays 1420 and 1412 remain operated. Each new subscriber to be added is connected to the next idle level or subscriber conference branch.

Start of the conference and transmission.

After the operator has added the last subscriber line to the subscriber conference branch she awaits the reception of the disconnect signals over the "order" trunk and then disconnects from the "order" trunk which returns to normal. The operator then turns to the conference trunk and sends a one-second break signal to the concentrating unit. This space signal causes the operation of polarized relay 1432 to its spacing or right-hand contact and at the same time appears as a space signal in all conference subscriber loops. Relay 1432 causes the operation of relay 1422 and the slow release of relay 1604. Relay 1422, upon operating, will hold relay 1420 operated while relay 1604 will permit the operation of relay 1606 which locks up under control of off-normal relay 1409 and removes grounded battery from all remaining unlisted, or conference, numbers making them test "unassigned" and thus preventing any further addition to the conference circuit. At the conclusion of the break, relay 1432 operates to its marking, or left-hand, contact thereby releasing relay 1422.

The operator calls all the subscribers, and gives notice that the conference may be started. The transmission circuit of the conference circuit consists of two polar relays, such as, send relay 1314 and receive relay 1327 for each subscriber conference branch and three polar relays, such as send relay 1413, receive relay 1436 and relay 1432 for the trunk conference branch. The additional relay 1432 in the trunk conference branch is used for supervisory purposes. In general, the polarized receive relay of each branch transmits signals created by that branch into the conference as a whole while the polarized send relay transmits signals obtained from other branches into the particular branch. When the conference is marking, the circuit including the lower windings of the polarized send relays corresponding to send relay 1314 for each of the subscribers' conference branches and the upper winding of send relay 1413 of the engaged trunk conference branch, draw a series marking current causing the send relays to remain on their marking contacts as shown. This series circuit has a potentiometer arrangement on each end causing a current (say 10 milliamperes) to flow. In the subscriber conference branches the send relays corresponding to relay 1314 cause at their marking contacts a current supply to drive all polarized receive relays corresponding to relay 1327 in the subscriber conference branch shown

either because the attached subscriber loops are closed or because the resistance 1330 is connected to the tip conductor by the unoperated relay 1311. The lower windings of all the receive relays corresponding to relay 1327 in the subscriber conference branch shown, being short-circuited, have no current. In the trunk conference branch ground on the marking contact of the polarized send relay 1413 permits its associated receive relay 1436 to draw current from the conference trunk and to remain in its marking position.

The receive relay in the associated subscriber conference branch, such as relay 1327, becomes spacing under the influence of bias current in its lower winding at the time that the circuit of the upper winding is opened by the subscriber. This receive relay removes the short circuit from the upper winding of its associated send relay, such as relay 1314, and by applying ground to the left-hand side of the upper winding of its associated send relay, say relay 1314, permits a current to flow in the upper winding of said send relay, holding the send relay definitely to marking. This same ground also replaces one of the end potentiometers, causing a reversal of current in the lower windings of the send relays in all subscriber conference branches and in the trunk conference branch. The send relay in said branches operate to their respective spacing positions except the one in the branch that had created the space signal which remains marking because of current in its upper winding. When the subscriber again returns to the marking condition, the receive relay in his associated subscriber's conference branch goes marking, short-circuiting the upper winding of its associated send relay and removing the ground, which permits a ten-milliamperes marking current to flow in those sending relays which travel to their respective marking contacts.

The very same action occurs as described above if the conference trunk branch originates a space signal, except in this case the trunk conference send relay, such as relay 1413, remains marking because of current in its lower winding and other send relays in the subscriber conference branches engaged therewith become spacing.

The supervisory relay in the trunk conference branch, say relay 1432, monitors the signals received from the trunk. When a space is received, relay 1432 operates relay 1422 and holds relay 1420 operated, thus preventing the registration of a disconnect signal. The trunk circuit itself has a similar feature, but it must be used in the conference circuit because the disconnect signal arrangement once sprung remains locked up.

Connection to the conference circuit of a subscriber not arranged for automatic connection.

If the operation requires the addition of a subscriber station to the conference for whom no unlisted number is provided and whose line is therefore not arranged for automatic connection, a request may be made to an attendant at the concentrating unit station to add such additional stations manually. The operator reaches the attendant in the usual way by calling the attendant's line and leaves information on the connections required. The attendant tests the subscriber line and if idle reaches the subscriber station. If the conference is accepted the attendant patches between jacks associated with the line

circuit of the desired subscriber station such as jacks 436 and 440 of the subscriber line shown and jacks of the next idle subscriber conference branch, provided this is not the first subscriber station to be connected to the conference. If it is the first subscriber station to be added, the attendant holds the start key 1440 operated for a second before and while the patching plugs are inserted into jacks 1338 and 1339 on the idle subscriber conference branch. Thus the tip and the ring conductors of the desired subscriber line is connected to the subscriber conference branch causing the operation of relays, such as relays 1310 and 1311. Jack 1338 of the idle subscriber conference branch furnishes a busy condition for the subscriber station, such as on conductor 437 of the subscriber's line circuit shown in Fig. 4 and jack 1339 receives grounded battery from the subscriber's hold magnet 1501 to operate relay 1323 which, in turn, operates relay 1318 immediately. Relay 1323, upon operating, lights busy lamp 1325 and relay 1318 preselects the next idle subscriber conference branch.

Manual set-up of conference circuit

In case of failure of the automatic equipment or if the concentrating unit is not arranged for automatic conference connection, the attendant, upon instructions from the operator at the central office, can establish a complete conference manually. First, the attendant patches between the jacks of a trunk assigned as the conference trunk, say jacks 754 and 719, of the trunk shown in Fig. 7 and jacks of the trunk conference branch, say jacks 1401 and 1441 of the conference trunk branch shown in Fig. 14. In this circuit this causes the operation of relays 1405, 1422 and 1409. The attendant then adds the subscriber stations to the idle subscriber conference branches as required. While plugging the first subscriber station into the first idle subscriber conference branch the attendant holds the start key 1440 operated for approximately one second. This causes the operation of relay 1420 which thereby connects the tip conductor of the conference trunk to the trunk conference branch and causes the operation of relay 714 in the conference trunk. The addition of the first subscriber line, therefore, finally ends in the operation of relays 1420 and 1412. Relay 1311 takes over the function of holding relay 1420. After all required subscribers' lines have been added who could be reached, the attendant notifies the operator at the central office who, in turn, arranges to start the conference over the conference trunk. If the unit is arranged for automatic operation when it temporarily is being operated manually the operator sends the usual one-second break before starting the conference. The attendant reaches the operator over the conference trunk by patching between the test jacks 2701 and 2702 of the test circuit shown in Fig. 27 and jacks 1444 and 1404, respectively, in the trunk conference branch shown in Fig. 14. The attendant first prepares the test circuit by operating answer key 2703, send key 2704 and receive key 2705 at the subscriber side of the trunk. This holds the conference circuit to its marking condition as shown in Fig. 14.

The attendant's teletypewriter 2706 is plugged into jacks 2707 and 2708 and the signals transmitted by the attendant are repeated by polarized send relay 2709 over a circuit extending from the lower operated armatures of relay 2710, armature and contacts of relay 2709, upper operated arma-

ture of relay 2710, outer upper operated armature of relay 2711, through the windings, in series, of polarized relays 2712 and 2713, inner upper operated armature of relay 2711, operated contacts of answer key 2703, tip conductor of jack 2701, cord 2714, tip conductor of jack 1444, outer upper operated armature of relay 1420, through the upper winding of relay 1432 and lower winding of polarized receive relay 1436, armature and left-hand, or marking, contact of polarized send relay 1413, through winding No. 1 of polarized relay 1310 to grounded positive battery. Relay 1327 repeats the signals received from the attendant's teletypewriter to the trunk circuit, and relay 2713 repeats the same signals for a local record through the connection established at jack 2708. Signals transmitted by the operator at the central office are repeated by send relay 1413 over the circuit just traced, and receive relay 2713 then repeats such signals through the connection at jack 2708 to the attendant's teletypewriter printer magnet whereby the message is recorded for the attendant.

The answer key 2703 is released and reoperated to send a recall signal over the trunk to the operator. When the operator answers a call from the attendant the latter communicates any necessary information concerning his accomplishments and then disconnects patching cords 2714 and 2715.

A conference subscriber disconnects prematurely

If one or any number, but not all, of the subscriber lines connected to the conference circuit disconnect, a relay, such as relay 1310 in each of their associated subscriber conference branches releases, thereby releasing a slow-release relay, such as relay 1311. Relay 1311 in each case, upon releasing, connects a resistance ground, such as produced by resistance 1330, to the tip conductor of each branch, causing that branch to create a mark signal toward the conference circuit. The conference can, therefore, continue between the remaining subscribers. The message signals incoming over the conference trunk cause relays 1405, 1409 and 1420, among others, to be held operated. Relay 1420 being of the slow-release type causes all the subscriber lines engaged in a conference to be held connected to the conference circuit, even though one of the subscribers withdraws. The telegraph signals may operate the ringer at the prematurely disconnected station. All the subscriber lines originally established for a conference, remain attached to the conference circuit until the operator disconnects. New calls originated by a disconnected subscriber result in his reconnection to the conference circuit.

Disconnection of a conference circuit containing automatically connected subscriber's stations

When finally all conference subscriber stations have disconnected, relay 1420 of the trunk conference branch releases. The release of relay 1420 effectively creates a disconnect signal in the conference trunk, which signal is sent to the operator at the central office. At this time if a conference subscriber begins a new call his attempt ends up in the conference circuit and does not reach an operator as a recall signal; in fact, his machine will run open due to the loss of battery potential. The operator, upon receiving a disconnect signal withdraws from the conference trunk, causing it to release the hold magnet, such as magnet 530, which holds the conference cir-

cuit to the trunk. This releases relays 1405 and 1409. Relay 1409, upon releasing, removes power from the conference branches and control circuit, releasing all operated relays and returning the circuit to normal. Removal of ground by relay 1409 also releases all subscriber lines and the operated relays, such as relay 1518 of the subscriber conference branch shown in each of the conference subscriber applique circuits that were operated, thereby restoring the lines to normal.

Disconnection of conference circuit containing both automatic and manually connected subscribers' stations

When the operator at the central office disconnects from a conference trunk in answer to a disconnect signal, the automatic subscriber stations are released and the circuit returns to normal as indicated above. When relay 1409 is normal and plugs remain in any of the jacks of the subscriber conference branches, such as jacks 1338 and 1339, relay 1402 is caused to operate which sounds an alarm and lights a disconnect lamp 1442 as a signal for the attendant to remove the patches. Relay 1402, upon operating, also places a ground connection on subscriber station conductor 1403 of the conference number giving it a busy condition. When all patches are removed, relay 1402 releases restoring the circuit to normal.

Disconnection of the conference circuit manually set up

In this case when the operator receives the disconnect signal the operator reaches the attendant and orders the manual patching cords removed. When all cords are removed the circuit returns to normal.

Busy key

Each subscriber conference branch is equipped with a busy key 1343 which, upon operation, can remove a branch from service. As soon as relay 1409 operates, relays 1328 and 1318 of the subscriber's conference branch associated with the operator's key operates. Relay 1323, upon operating, lights the busy lamp 1325, and relay 1318, upon operating, prevents the pre-selection of that branch for a subscriber connection.

Busy and out-of-order jack of unlisted conference number

Each subscriber conference applique circuit is equipped with a jack, such as jack 1549, which, as far as the unlisted conference number conductor is concerned, functions the same as the corresponding jack, say jack 436, of the subscriber's line shown in Fig. 4. When, therefore, an attendant wishes to manually make a subscriber line arranged for automatic conference connections busy or out of order, the attendant patches both the jack in the subscriber conference applique and the corresponding jack of the subscriber line circuit to either the subscriber busy or subscriber out-of-order jacks as desired. In this connection it should be pointed out that when the conference circuit is normal, all unlisted conference numbers test "unassigned" to testing director circuits but that the manual busy or out-of-order condition inserted into the jack of the subscriber conference applique supplants the "unassigned" condition.

The conference circuit per se is the type of circuit which is sometimes called a "hub" telegraph circuit.

The application of Krecek, supra, discloses subscribers' stations which are capable of re-

ceiving messages even though unattended. In general, in a system of this type, an unattended station is one in which the answering function is controlled remotely over the trunk and subscriber's line from the central office by sending thereover a long ringing current. This ringing current has the ultimate function of operating a slow-operating relay and actuating contacts which are equivalent to the subscriber's answering key or switch. The operation of this relay to all intents and purposes performs the function of answering in behalf of the subscriber even though no attendant is present at the subscriber's station. The disconnect function is likewise accomplished by remote control from a central office or from any suitable teletypewriter communicatively connected to the established circuit by transmitting an "upper case H" or other selected code combination or sequence of code combinations. This actuates a contact of which the function and result is the same as though the subscriber had been present and had disconnected. Unattended subscribers' stations of this type are contemplated as a part of the system of this invention. Upon first thought one may question whether a conference with a person not present at the station is desirable. However, conditions may arise under which such a conference may be useful and desirable. Suppose, for example, that several persons at different stations wish to hold a conference and to leave a record of their telegraphically transmitted remarks at the station of some other person at a time when that other person's station is unattended, this may be done and the record of the unattended conference left for the information or action of the person whose station was unattended at the time of the conference. It is known, for example, that the difficulty of securing the simultaneous attention of several people, especially people of the class of business executives, increases in geometric ratio in proportion to the number of people involved. The use of the system of the present invention in connection with unattended subscribers' stations equipped for unattended service, therefore, increases the flexibility and, consequently, the utility of the system. The operation of adding an unattended subscriber's station to a hub conference circuit differs very little from that hereinbefore described, the principal difference being that upon calling the unattended station and receiving no response the operator causes the transmission of a sufficiently long period of ringing current, usually ten seconds, to actuate the slow-operating relay at the unattended subscriber's station and receives a simulated answering signal in the same manner as though the station were attended except that no response will be made to telegraphic questions or interrogations made over the circuit. The operator then connects the called unattended station's line to a conference circuit in the manner hereinbefore described. The only precaution to be observed is that a suitable automatic disconnect signal be sent to the unattended station at the end of the conference in accordance with a proper operating routine. In this type of operation all the operations of connecting a subscriber line to a conference circuit are under control of the central office.

What is claimed is:

1. In a communication system, a master office, a switching center, a plurality of main signaling circuits interconnecting said master office and

said switching center, a plurality of other signaling circuits connected to said switching center, and a conference circuit at said switching center for connecting selectively under control of said master office a selected plurality of said other signaling circuits to any one of said main signaling circuits in response to control signals received over another of said main signaling circuits.

2. In a communication system, a master office, a switching center, a plurality of signaling circuits interconnecting said master office and said switching center, a plurality of other signaling circuits connected to said switching center, a conference circuit at said switching center, means located at said switching center and responsive to signals received over any one of said main signaling circuits for determining whether or not said conference circuit is idle, other means at said switching center responsive to other signals received over another of said main signaling circuits for connecting one or more of said other signaling circuits through said conference circuit to said one main signal circuit.

3. In a communication system, a master office, a switching center, a plurality of main signaling circuits interconnecting said master office and said switching center, a plurality of local signaling circuits terminating at said switching center, a conference circuit at said switching center, means at said switching center responsive to signals incoming over any one of said main signaling circuits for connecting said conference circuit to said one of said main circuits, other means at said switching center responsive to signals incoming over any one of the other of said main signaling circuits for interconnecting through said conference circuit one or more of said local signaling circuits, and release means at said switching center for releasing for other use the one of the main signaling circuits used to connect a local circuit each time one of said local signaling circuits is connected through said conference circuit to said one main signaling circuit.

4. In a communication system, a master office, a switching center, a plurality of main signaling circuits interconnecting said master office and said switching center, a plurality of secondary signaling circuits connected to said switching center, a conference circuit at said switching center selectively arranged for connection to any one of said main signaling circuits, said conference circuit comprising a single trunk branch circuit arranged for automatic connection to any one of said main signaling circuits, a plurality of other branch circuits arranged for connection to said secondary signaling circuits, a plurality of applique circuits for respectively adapting certain of said secondary signaling circuits for connection to said branch circuits, and a control circuit for completing and maintaining for the duration of a conference the establishment of an extension of said one main signaling circuit through said single trunk branch circuit and one or more of said other branch circuits to one or more, respectively, of said secondary signaling circuits.

5. In a communication system, a master office, a switching center, a plurality of main signaling circuits interconnecting said master office and said switching center, a plurality of subscriber circuits connected to said switching center and each having listed and unlisted calling numbers, and a conference circuit at said switching center selectively arranged for connection to any

one of said main signaling circuits, said conference circuit comprising a single trunk branch circuit arranged for automatic connection to any one of said main signaling circuits, a plurality of other branch circuits arranged for completing an interconnection between said single trunk branch circuit and said subscriber circuits, means responsive to a distinctive signal received over one of the other of said main signaling circuits, and corresponding to the unlisted calling number of one of said subscriber circuits, for connecting said one of said other signaling circuits to one of said other branch circuits, and a control circuit having means responsive to a one-second break signal received over said one of said main signaling circuits for making the unlisted calling numbers of all the remaining said subscriber circuits test "unassigned" to prevent any further addition of said remaining signaling circuits to said conference circuit.

6. In a communication system in accordance with claim 5 wherein said conference circuit comprises means for holding said other of said main signaling circuits engaged in a connection after each connection of one of said subscriber circuits to one of said other branch circuits in readiness for the establishment of a connection between another of said subscriber circuits and another of said other branch circuits.

7. In a communication system according to claim 5 wherein said conference circuit comprises means for maintaining an established conference circuit connection when one of said subscriber circuits is disconnected from one of said other branch circuits.

8. In a communication system, a master office, a switching center, a plurality of main signaling circuits interconnecting said master office and said switching center, a plurality of subscriber circuits connected to said switching center, a conference circuit at said switching center selectively arranged for connection to any one of said main signaling circuits, said conference circuit comprising a single trunk branch circuit arranged for connection by remote control to any one of said main signaling circuits, a plurality of other branch circuits arranged to be connected to said subscriber circuits, a plurality of applique circuits responsive to other selective signals received over any one of said other main signaling circuits for adapting any one or more of said subscriber circuits for connection to one or more of said other branch circuits, a control circuit for completing and maintaining for the duration of a conference, the establishment of an extension of said one main signaling circuit through said single trunk branch circuit and one or more of said other branch circuits to one or more, respectively, of said subscriber circuits, and means independent of said applique circuits manually operable for establishing a connection of one or more of said subscriber circuits to one or more, respectively, of said branch circuits.

9. In a telegraph signaling system, a central office, a switching center, a plurality of telegraph trunks interconnecting said central office and said switching center, a plurality of subscribers' lines connected to said switching center, a conference circuit located at said switching center and arranged for engagement with any idle one of said trunks in response to certain signals received over said one trunk from said central office, means in said conference circuit responsive to other signals received over any idle one of the other of said trunks for selectively connect-

ing any desired number of available ones of said subscribers' lines to said one trunk.

10. In a telegraph signaling system, a central office, a switching center, a plurality of telegraph trunks interconnecting said central office and said switching center, a plurality of subscriber lines connected to said switching center, a conference circuit at said switching center selectively engageable with any one of said trunks in response to selective signals received over said one trunk, said conference circuit comprising a plurality of conference branches, one of said branches arranged for connection to said one trunk, and others of said branches arranged for connection one by one to said subscriber lines, a plurality of applique circuits each arranged to connect, in response to a selective signal combination received over any one of the other of said trunks, a selected one of said subscriber lines to the first idle one of said other branches and a control circuit arranged for seizure by any one of said applique circuits when the subscriber line associated with said one applique circuit is idle.

11. In a telegraph signaling system, a central office, a switching center, a plurality of telegraph trunks interconnecting said central office and said switching center, a plurality of subscribers' lines connected to said switching center, a conference circuit at said switching center arranged for engagement with any one of said trunks in response to appropriate signals received over said one trunk, said conference circuit comprising a plurality of conference branches, one of said branches arranged for connection to said one trunk and the other of said branches arranged for connection to said subscribers' lines, and a plurality of applique circuits each arranged to connect, in response to a particular signal combination received over any one of the other of said trunks, a certain one of said subscriber lines to the first idle one of said other branches.

12. In a telegraph system, a line or channel terminating at a switching office, coordinate switching means in said office, said coordinate switching means having two separate rows of sets of contacts associated with said line or channel, a trunk having sets of contacts in electrically transverse relation to one of said rows, a telegraph repeater having sets of contacts in electrically transverse relation to another of said rows, and means for closing a path selectively at the intersection of a set of contacts associated with said trunk or the intersection of a set of contacts associated with said repeater.

13. A system according to claim 12, including means for controlling said sets of contacts by remote control from a distant office to which said trunk extends.

14. A telegraph system having a conference hub, lines normally disassociated therefrom, a trunk extending from said conference hub to a central office, selective means remotely operable over said trunk for associating any selected one or more of said lines to said conference hub for telegraphic intercommunication between said line or lines through said hub.

15. A telegraph system having a conference hub, lines normally disassociated therefrom, a system of trunks extending from said conference hub to a central office, selective means remotely operable over said system of trunks for associating any selected one or more of said lines to said

conference hub for telegraphic intercommunication between said line or lines and said hub.

16. In an arrangement according to claim 15, means for connecting said conference hub over one of said trunks for electrical telegraphic communication between said hub through and over said trunk.

17. In a communication system wherein a line having a terminus at one point is selectable and testable by remote control from a remote point over electrically conducting means extending between the two points, means whereby a plurality of codes of different nature select said line, means for testing said line automatically upon selection thereof, and test means normally capable of giving a different indication as to the availability of said line dependent upon the code used for selection.

18. A satellite telegraph office, a line terminating thereat, a trunk from said satellite office to a remote point, selecting means operable over said trunk to select and test said line, said line being provided with two selectable termini and therefore being doubly selectable and having two test conductors associated therewith at said satellite office, means whereby one of said conductors normally tests "unassigned," and means whereby the other normally tests "idle."

19. A satellite telegraph office, a line terminating thereat, a trunk from said satellite office to a remote point, selecting means operable over said trunk to select and test said line, said line having two sets of seizable termini test conductors associated therewith at said satellite office, means whereby one of said conductors normally tests "unassigned," means whereby the other normally tests "idle," and means whereby said conductor which normally tests "unassigned" may be modified to test "idle" and thus permit the selection of said line by the selection corresponding to said normally "unassigned" test conductor.

20. A satellite telegraph office, a plurality of lines terminating thereat, a trunk from said satellite office to a remote point, selecting means operable over said trunk to select and test said lines, each of said lines being selectable by two codes, a test conductor associated with said line for one of said codes, means whereby said test conductor normally tests in a manner to indicate unavailability of said line, and means remotely operable from said remote point to change the normal test to a condition permitting connection thereto upon selection.

21. A satellite telegraph office, lines terminating thereat, trunks from said satellite office to a remote point, selecting means operable over one of said trunks to select and test any one of said lines, each said line being selectable through said selecting means by two codes, a test conductor normally associated with one of said codes normally testing "unavailable," means operable over one of said trunks for changing said "unavailable" condition to idle, and means thereafter operable over one of said trunks for connecting said line to a trunk for intercommunication.

22. In a telegraph system, means for transmitting permutation code combinations over a channel of transmission to a remote point, a line terminating at the remote point, selective apparatus at the remote point for selecting the line, means whereby said line is selectable by one code combination, and means operable under a special condition whereby said line is selectable by another code combination.

23. A printing telegraph system comprising a central station, a plurality of branch stations, printing telegraph equipment at said stations, a plurality of signaling channels terminating at said central station and common to each of said branch stations, switching means for extending said channels to the branch stations including switching means for extending one of said channels to a plurality of branch stations at one time, means including said printing telegraph equipment at the branch stations to control said switching means to connect a calling branch station to an idle channel extending to the central station.

24. A telegraph system having in combination, a line selector mechanism having a series of elements each adapted to occupy one of two different positions, a signal responsive means responsive to a permuted sequence of conditions for controlling the setting of said elements in different permutations, means operable in accordance with a particular permutation in which said elements are set to select a group of conductors, means for resetting said elements in another particular permutation, means operable under the control thereof for selecting the conductor of said group, said conductor effecting the selection of a multiple branch circuit, a group of lines and means operable by further selective permutations of said elements to select one of said lines, in combination with remote control means for connecting said selected lines to said multiple branch circuit.

25. In a system comprising a satellite office, outlying stations, lines respectively connecting said outlying stations to the satellite office, a central office, trunks interconnecting said satellite office and said central office, means remotely operable from and under the control of a central office to selectively call said outlying stations and connect a selected plurality of their lines to one of said trunks for telegraphic intercommunication between said selected plurality of stations.

26. In a system comprising a satellite office, outlying stations connected thereto by lines and a central office connected thereto by trunks, a

conference circuit at the satellite office selectable over a trunk and connectable to the trunk under the control of the central office, and means for holding said conference circuit to said trunk and simultaneously therewith selectively calling a subscriber's circuit over another trunk, in combination with means for connecting the selectively called subscriber's circuit to the conference circuit.

27. In a communication system, a plurality of communication channels having termini at a station, a selecting path for each channel with an associated test means for each selecting path, means whereby said associated test means normally test "unavailable," a conference circuit, means for selecting said conference circuit, and means operable incidental to selection of said conference circuit to change said associated test means to test "available."

28. In a system wherein a plurality of stations, A, B, C, etc., have channels of communication terminating at station S, a channel of communication from S to a station CO, means operable from station CO to put any selected ones of stations A, B, C, etc., into intercommunicative relation, and means operable under control of station CO whereby the record of intercommunication between the selected stations is recorded at any station or stations of the series A, B, C, etc., even though at the time completely unattended.

29. In a system comprising station S, a station CO, a plurality of stations A, B, C, etc., having channels of communication terminating at station S, channels of communication interconnecting station S and station CO, means operable over any one of the channels from station CO to put any one or more of stations A, B, C, etc., into intercommunicative relation, and means operable under the control of station CO whereby the record of intercommunication between the selected stations is recorded at any station or stations of the series A, B, C, etc., even though at the time completely unattended.

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