

Aug. 29, 1944.

B. D. HOLBROOK

2,356,846

TELEPHONE SYSTEM

Filed Aug. 13, 1943

8 Sheets-Sheet 1

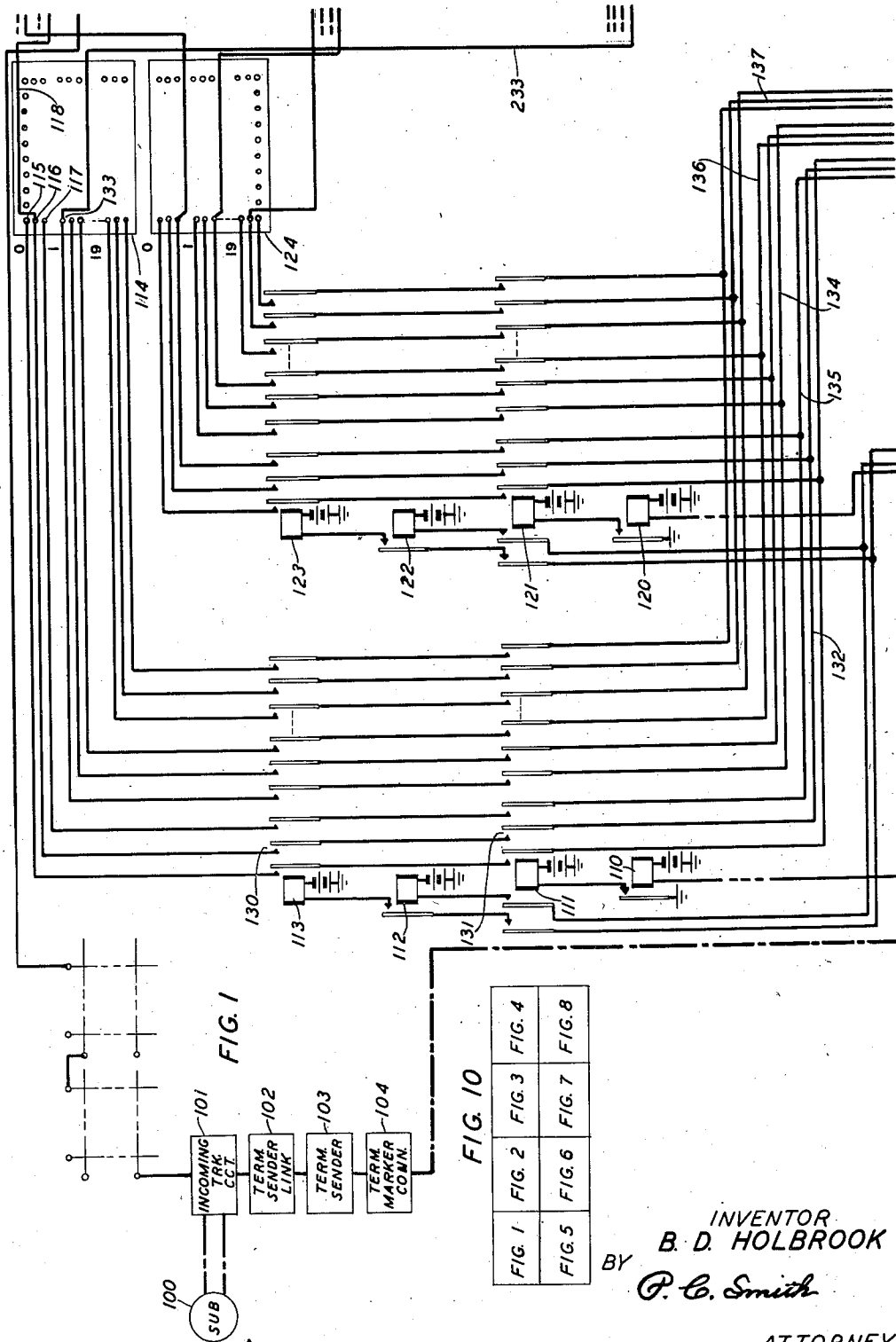


FIG. 10

FIG. 1	FIG. 2	FIG. 3	FIG. 4
FIG. 5	FIG. 6	FIG. 7	FIG. 8

INVENTOR
B. D. HOLBROOK
BY
P. C. Smith

ATTORNEY

Aug. 29, 1944.

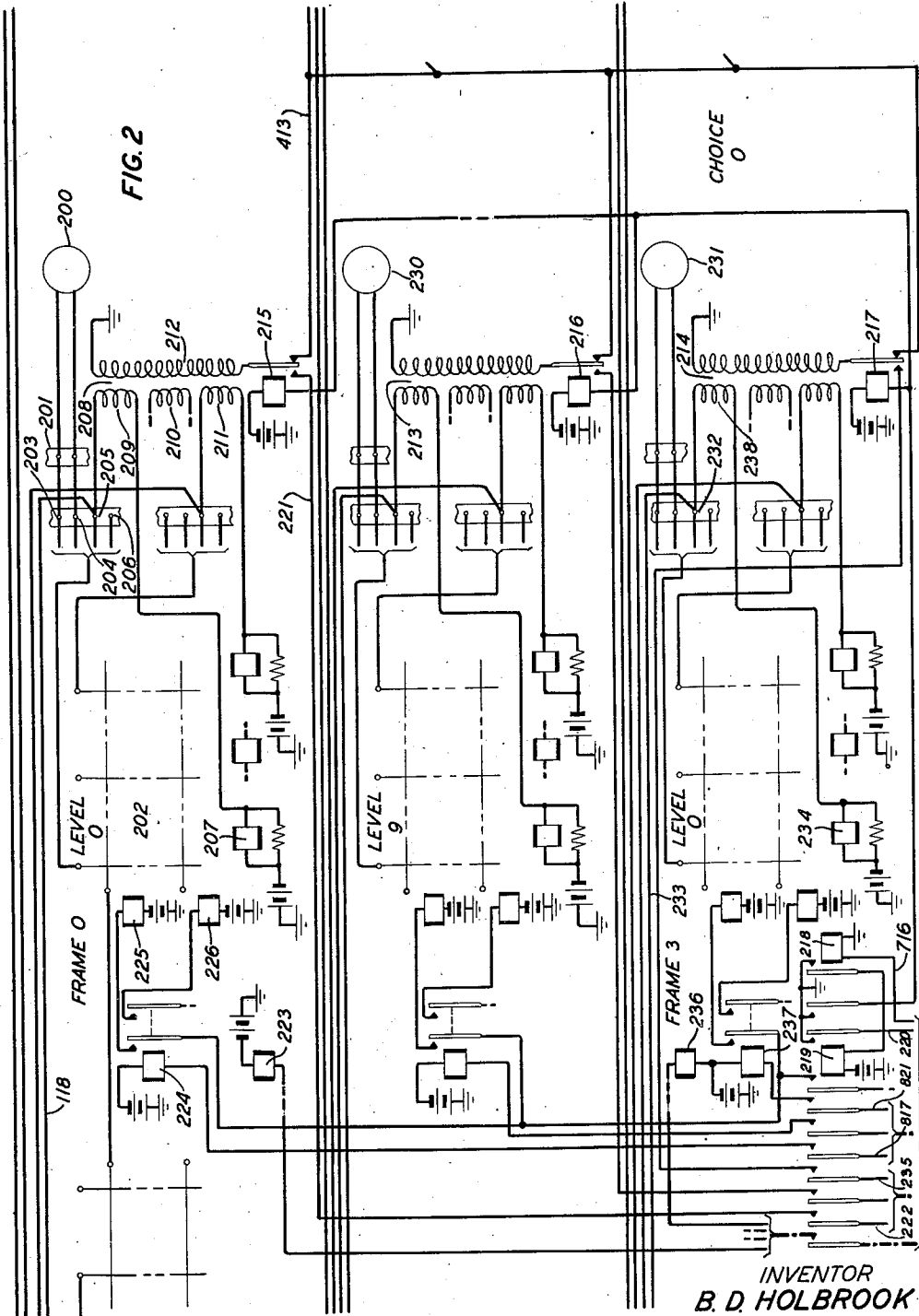
B. D. HOLBROOK

2,356,846

TELEPHONE SYSTEM

Filed Aug. 13, 1943

8 Sheets-Sheet 2



INVENTOR
B. D. HOLBROOK
BY *P. C. Smith*
ATTORNEY

Aug. 29, 1944.

B. D. HOLBROOK

2,356,846

TELEPHONE SYSTEM

Filed Aug. 13, 1943

8 Sheets-Sheet 3

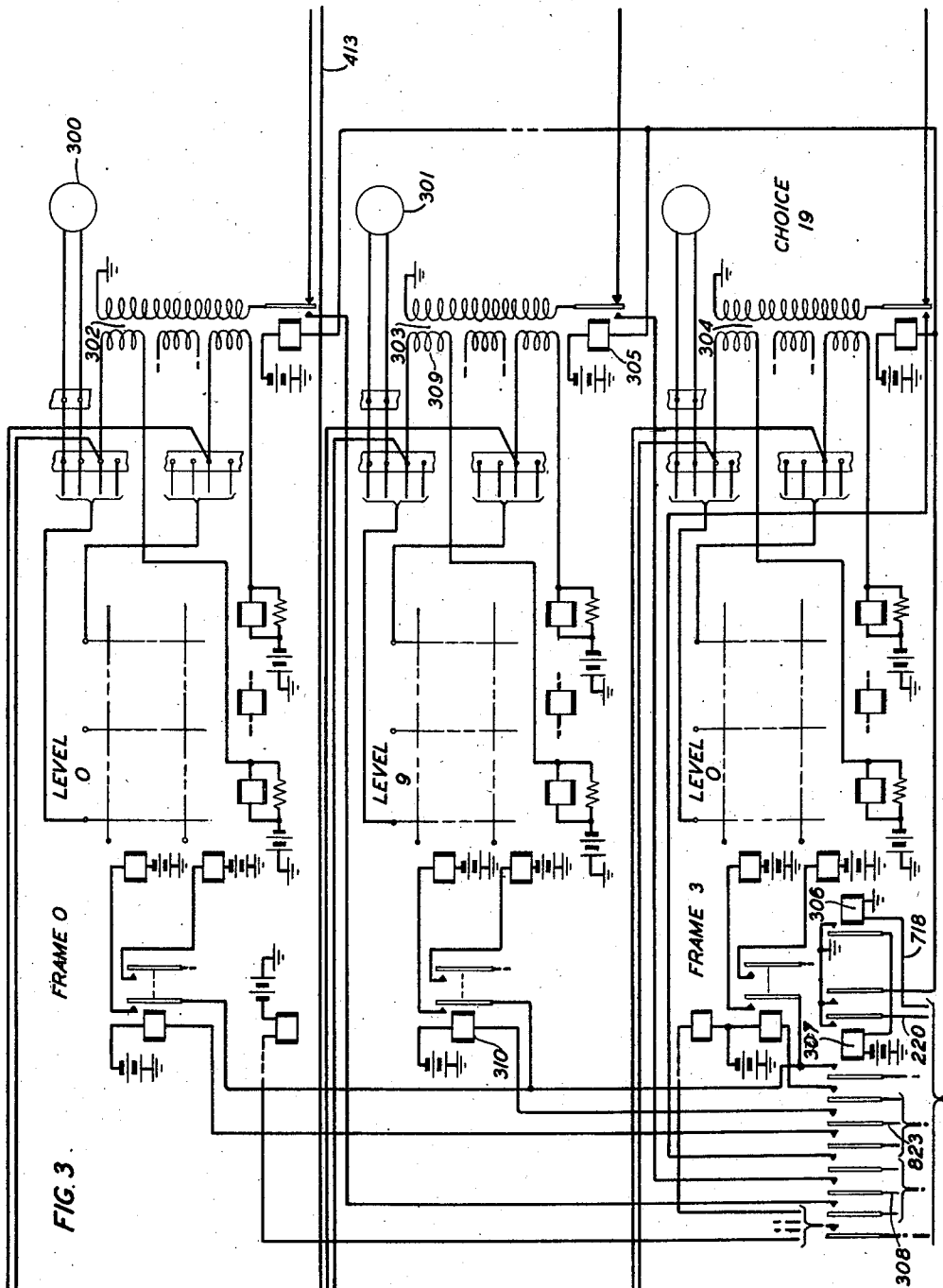


FIG. 3

INVENTOR
B. D. HOLBROOK
BY *P. C. Smith*
ATTORNEY

Aug. 29, 1944.

B. D. HOLBROOK

2,356,846

TELEPHONE SYSTEM

Filed Aug. 13, 1943

8 Sheets-Sheet 4

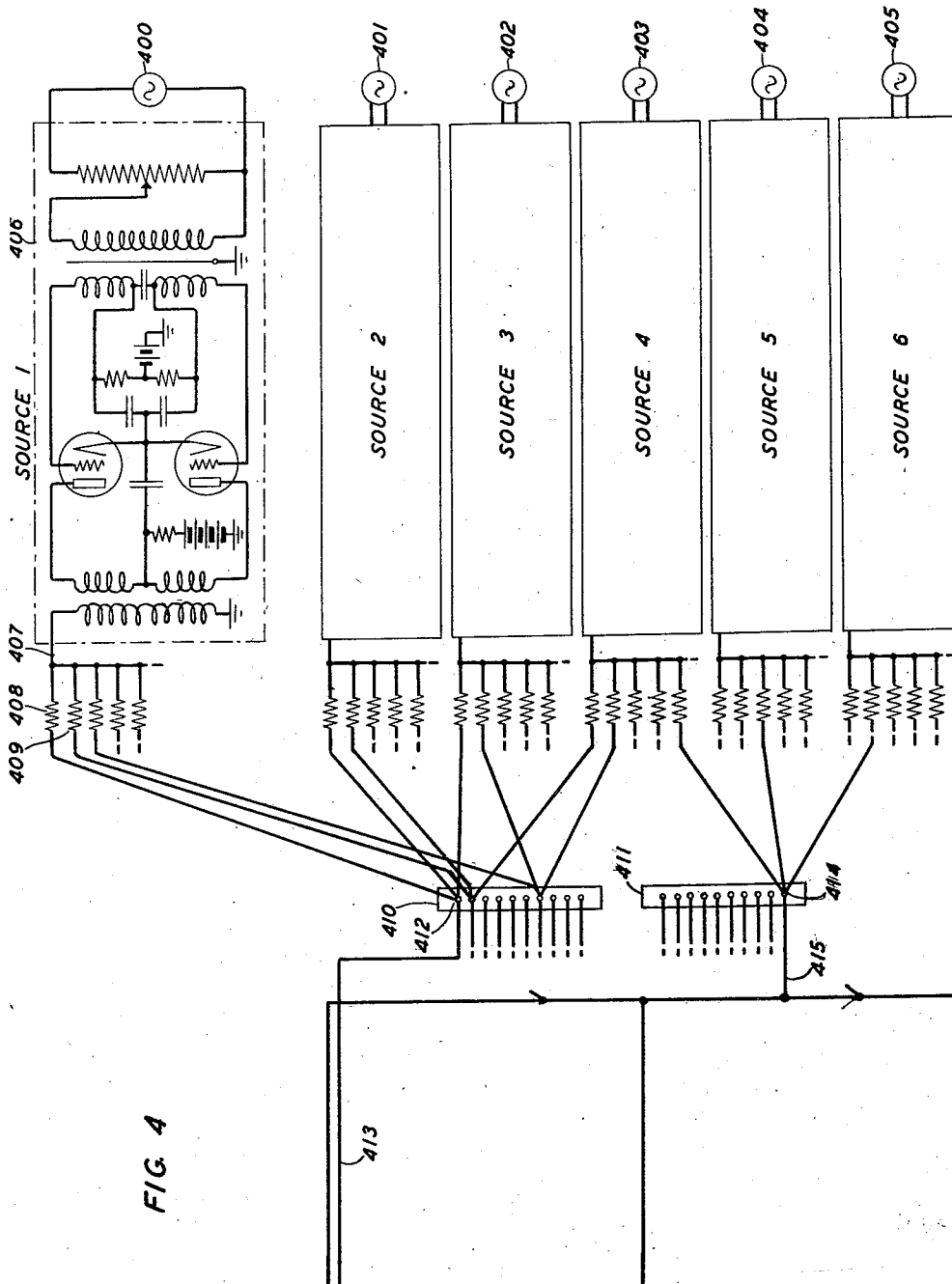


FIG 4

INVENTOR
B. D. HOLBROOK
BY *P. C. Smith*

ATTORNEY

Aug. 29, 1944.

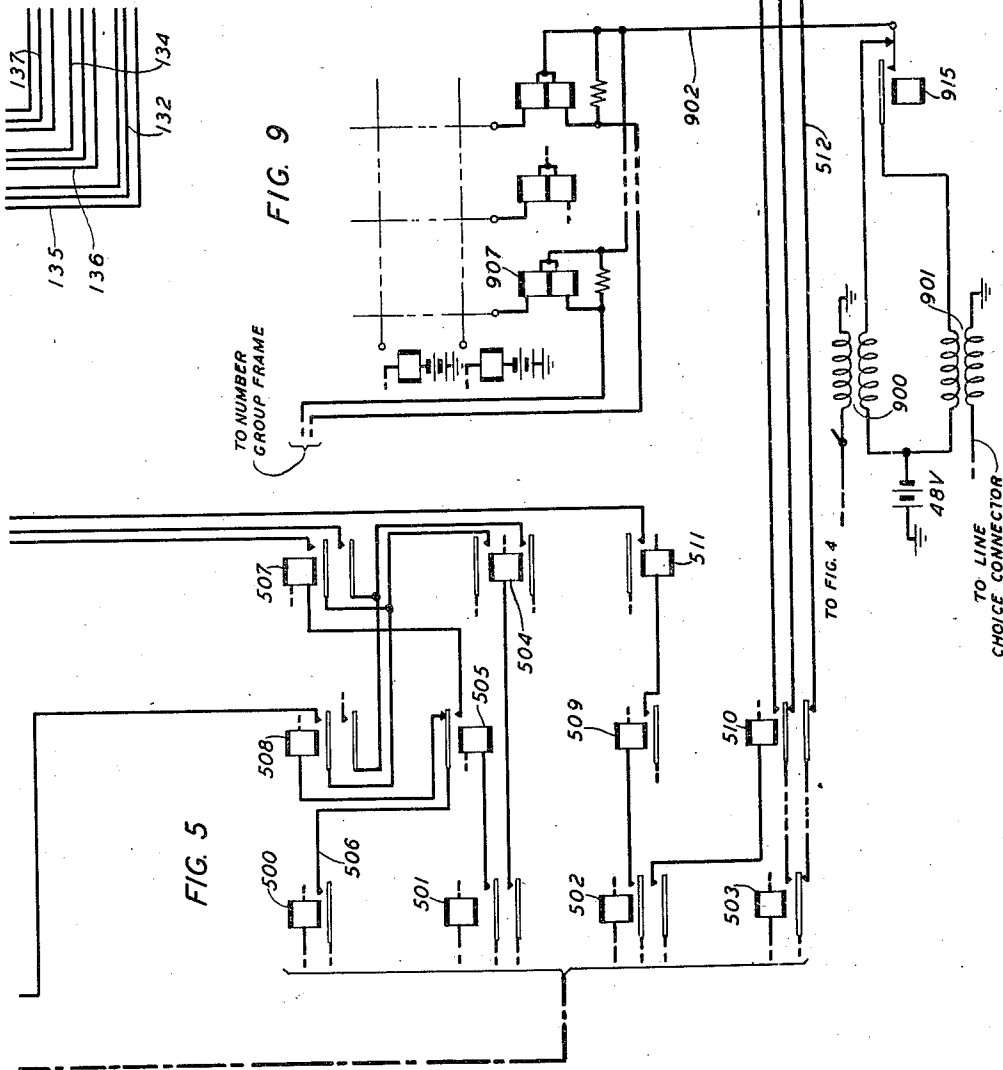
B. D. HOLBROOK

2,356,846

TELEPHONE SYSTEM

Filed Aug. 13, 1943

8 Sheets-Sheet 5



INVENTOR
B. D. HOLBROOK
BY *P. C. Smith*

ATTORNEY

Aug. 29, 1944.

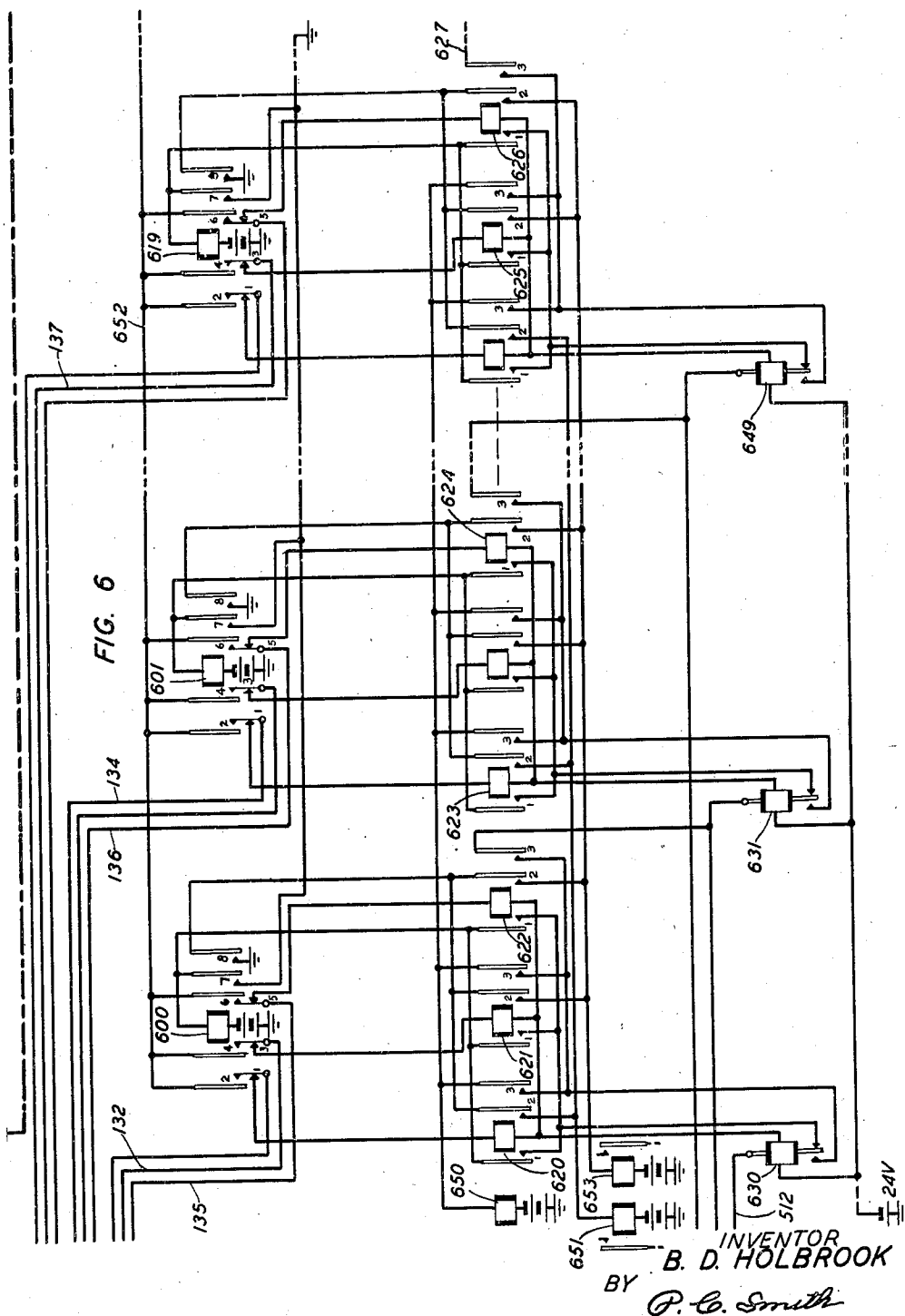
B. D. HOLBROOK

2,356,846

TELEPHONE SYSTEM

Filed Aug. 13, 1943

8 Sheets-Sheet 6



Aug. 29, 1944.

B. D. HOLBROOK

2,356,846

TELEPHONE SYSTEM

Filed Aug. 13, 1943

8 Sheets-Sheet 7

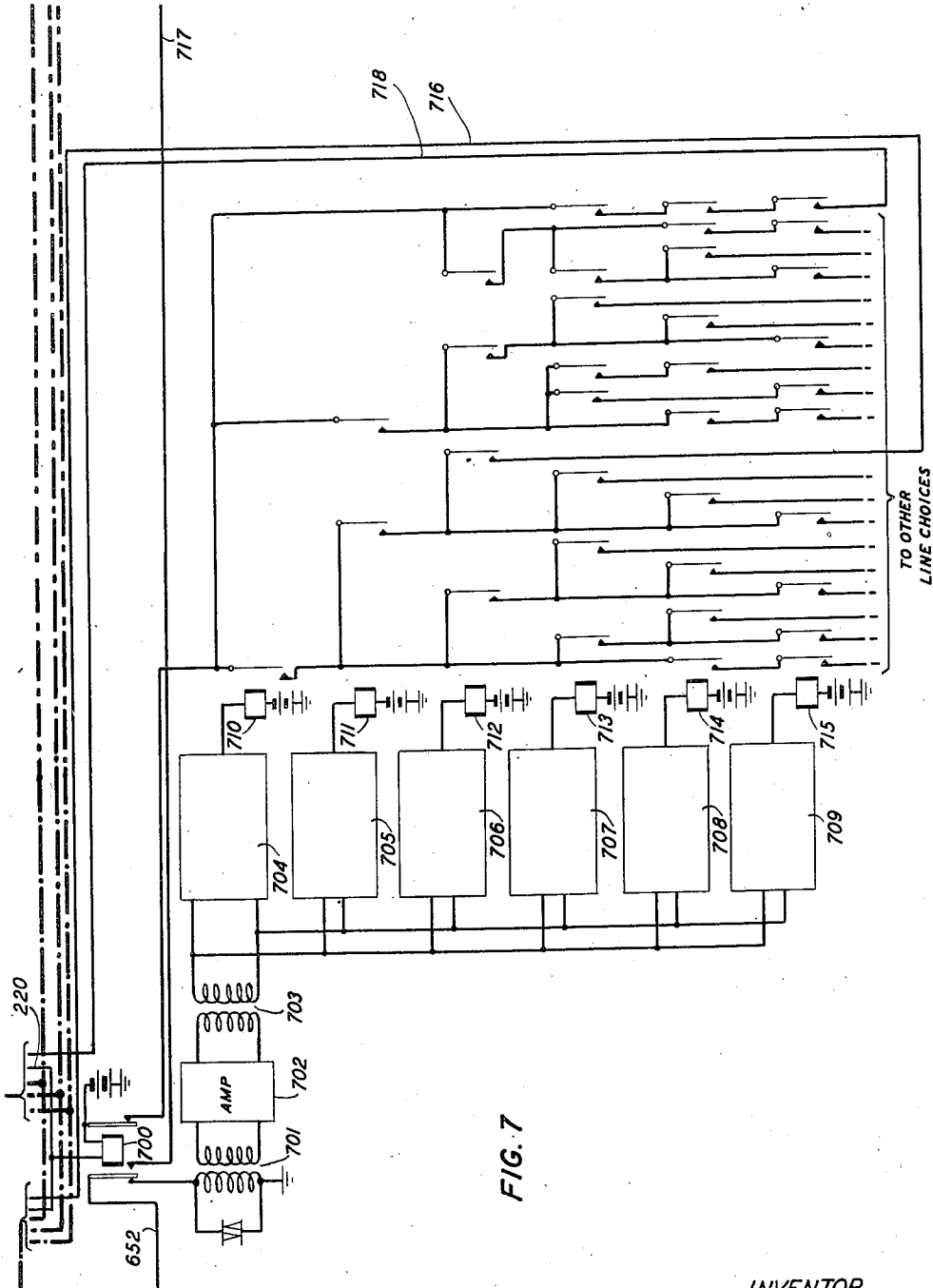


FIG. 7

INVENTOR
B. D. HOLBROOK
BY *P. C. Smith*
ATTORNEY

Aug. 29, 1944.

B. D. HOLBROOK

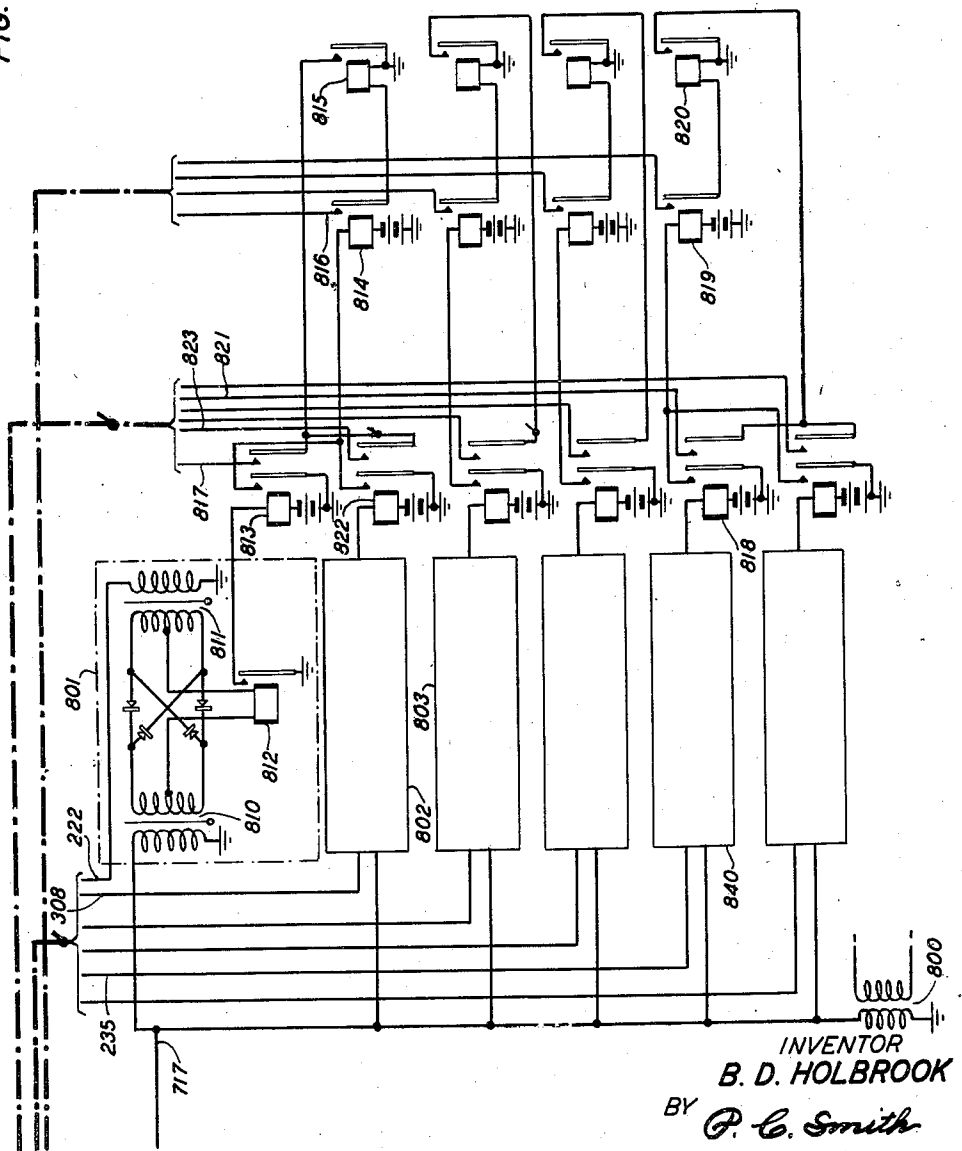
2,356,846

TELEPHONE SYSTEM

Filed Aug. 13, 1943

8 Sheets-Sheet 8

FIG. 8



INVENTOR
B. D. HOLBROOK
BY *P. C. Smith*
ATTORNEY

UNITED STATES PATENT OFFICE

2,356,846

TELEPHONE SYSTEM

Bernard D. Holbrook, Madison, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application August 13, 1943, Serial No. 498,465

10 Claims. (Cl. 179—22)

This invention relates to cross bar telephone systems and has for its object to facilitate the establishment of connections in such a system.

In the cross bar system, for example, as disclosed in Patent 2,201,573, granted May 21, 1940, to W. W. Carpenter et al., and in more detail in Patent 2,232,371, granted February 13, 1941, to J. W. Dehn et al., each switch unit comprises one hundred contact elements which provide junctions between ten incoming elements and ten outgoing elements. The switches which serve the subscribers' lines are known as primary line switches and one to seven of these switches are arranged in a horizontal group known as a level, ten levels of which are arranged vertically to constitute a frame, four frames comprising a line choice. One subscriber's line is connected to each of the incoming elements and, therefore, a choice may serve from 400 to 2800 lines, the number of switches included in a level and, therefore, the number of lines in that level being determined by traffic conditions. However, as set forth, in the above-mentioned Carpenter et al. patent, the position of the lines on the switches is entirely independent of the directory number, and a cross-connecting frame, known as a number group frame, is used for directing the selection of a line when called.

In the establishment of terminating connections, a terminating sender and terminating marker are employed, the sender receiving the line designation from the originating equipment and transferring it to the marker. From this registration the marker first selects a set of cross-connecting terminals representing a group of twenty line numbers within which the wanted line number lies. By this selection the marker determines the number group frame on which the terminals of the wanted number are mounted and by means of the number group connector selects a number frame and operates a hundred-block relay and a twenty-block relay on that frame. With the twenty-block relay operated the marker is ready to obtain information concerning the called line.

For the establishment of a connection to the wanted line it is necessary that the marker know the line choice within which the line is located, the frame within the choice and the level on the frame. It is also necessary to know whether the wanted line is an individual line, a party line or one of a group of lines leading to a private branch exchange and, if a party line, whether it is a tip or ring party. Furthermore, the marker

must know whether the wanted line is busy or idle.

Heretofore, the twenty-block relay has extended three circuits from the marker to sets of cross-connecting terminals on the number group frame. Associated with these number terminals are two sets of control terminal strips. One set of strips includes forty strips, one for each level of the four frames in any one choice. A second set of strips serves to identify the class of the line and the line choice, with a maximum of thirty strips to cover three line classes and ten choices.

When both the location of a line and its class of service is determined and a number is assigned thereto, two of the number terminals are cross-connected to the control terminal strips in accordance therewith. The third number terminal is connected directly to the winding of the line hold magnet and, therefore, to the sleeve of the line for determining its busy or idle condition.

With such an arrangement, therefore, the successful establishment of a connection depends upon the correctness and continuity of three cross connections, the establishment and maintenance of which requires constant vigilance.

In accordance with the present invention, such maintenance effort is decreased by providing means for obtaining the necessary information regarding the location of a called line over a single cross connection.

A feature of the invention is the use of alternating current for supplying the necessary information concerning the location of the line over such a single cross connection.

More specifically, the single cross connection is made between a number terminal and the sleeve terminal of the line to which the number belongs. This cross connection is used to simultaneously determine the busy condition of the line and the class of the line by means of a direct current circuit. Subsequently, alternating current signals individual to the choice in which the line is located are transmitted from the frame over the cross connection to the marker to control the connection of the marker with the proper line choice, after which a signal is transmitted from the marker over the cross connection to the frame and by way of the frame connector back to the marker to identify the level and frame on which the line appears.

A clearer understanding of the invention will be obtained from a consideration of the following description in connection with the drawings in which:

Fig. 1 shows schematically two number group

connectors and a portion of an incoming telephone connection;

Figs. 2 and 3 show parts of two line choices and the line choice connectors associated therewith;

Fig. 4 shows a plurality of alternating current generators;

Fig. 5 shows schematically the registers and translating means of a marker;

Fig. 6 shows the line test and class relays of the marker;

Fig. 7 shows the means for receiving and translating the alternating current signals transmitted from the switch frames;

Fig. 8 shows the means for receiving and recording the alternating current signals transmitted from the marker;

Fig. 9 shows an alternative method of connecting the alternating current signals to the sleeve conductors; and

Fig. 10 shows the arrangement of Figs. 1 to 8. A call originated by a subscriber at substation 100 is extended by equipment at the originating office, not shown, to an incoming trunk circuit 101 which is connected with an idle terminating sender 103 through a terminating sender link 102. The number of the wanted subscriber is then recorded in the terminating sender 103 after which the sender operates the terminating marker connector 104 to summon an idle terminating marker, parts of which are shown in Figs. 5 to 8.

When the sender and marker have been connected, the designation is transferred to the marker and recorded on a set of registers represented by thousands relay 500, hundreds relay 501, tens relay 502 and units relay 503. The hundreds relay 501 indicates whether the hundreds digit is greater or less than five by operating relay 505 for digits greater than five and indicates the position of the digit in either series by operating one of five relays such as relay 504. The thousands relay 500 marks one of ten conductors such as conductor 506, which is extended to one of two relays like relay 507 or relay 508 according as relay 505 is or is not operated. Therefore, the joint operation of the thousands and hundreds register identifies a group of five hundred lines by operating one of a set of twenty relays such as relays 507 and 508.

The tens register, represented by relay 502, discriminates between even and odd tens digits by operating relay 510 for odd digits and identifies blocks of twenty numbers by operating one of a set of five relays, such as relay 509, which in turn operates relay 511. The units register relay 503 grounds one of ten conductors, which are extended to twenty conductors, over the front and back contacts of relay 510.

The joint operation of relay 504 and relay 507 or relay 508 selects a number group frame by completing a circuit for a marker preference relay such as relay 110 or 120. In each number group connector there is a marker preference relay for each marker and these preference relays are arranged in a chain so that only one marker can attach itself to a number group frame at a time. Assuming that the terminal of the wanted number is on frame 114, preference relay 110 is operated as soon as the frame is idle, operating a multicontact relay 111 which closes the necessary connections between the marker and the number frame. With relay 111 operated, the hundred block relay 112 is operated under the control of relays 507 and 504, there being one relay 112 for each hundred numbers included

in the number groups. With relay 112 operated, twenty-block relay 113 is operated under the control of relays 112 and 511, there being one such relay for each twenty numbers in the number groups associated with the frame.

With relay 113 operated three test circuits are prepared for each of the twenty lines having the numbers selected by that relay. As set forth above, lines may be of three classes and a test circuit of each class is provided in the marker for each of twenty lines, the twenty-block relay, such as relay 113, extending these test circuits to twenty sets of cross-connecting terminals on the frame 114. For example, terminals 115, 116 and 117 are individual to the first number of the group of twenty belonging to relay 113. When this number is assigned to a line and the class of the line and its location on the primary line switch frame is determined, the sleeve contact of the line at the primary line switch frame is cross connected to one of the terminals 115, 116 or 117. If the line is an individual line, the ring party on a party line or the last line of a group leading to a private branch exchange, the cross connection will be made with terminal 116. If the line is the tip party on a party line, the cross connection will be made with terminal 115 and if it is a first or an intermediate line leading to a branch exchange, connection will be made with terminal 117.

A similar set of terminals in the first vertical row is provided for each of the twenty lines in the group connected with relay 113. Each twenty-block relay has a similar vertical row of terminals, and each line is connected to the one terminal of its associated set which corresponds to the class of the line.

A subscriber's line, such as line 200, when it enters the office, is connected to a distributing frame 201, from which the line is extended to one of the primary line switches, for example switch 202, in accordance with traffic requirements. The line itself is connected to the line terminals 203 and 204, while individual to the line terminals 203 and 204 are the sleeve or busy marking terminal 205 and the message register terminal 206. At the number group frame, assuming that line 200 is an individual line, sleeve terminal 205 will be connected over jumper 118 to terminal 116.

Therefore, the operation of twenty-block relay 113 closes a circuit from 48-volt central office battery through the winding of hold magnet 207, winding 209 of transformer 208, sleeve terminal 205, jumper 118, number group terminal 116, contact 130 of relay 113, contact 131 of relay 111, conductor 132, contact 3 of relay 600, winding of relay 621, winding of polarized relay 630 to 24-volt battery. If the line is busy, ground from an incoming trunk circuit is connected to sleeve terminal 205 over the established connection. Relay 621 operates whether the line tested is busy or idle, but relay 630 is so polarized that it operates only if the line is busy. Similar circuits are closed for each of the twenty lines having numbers in the group identified by twenty-block relay 113.

After the number group frame has been seized, a time interval is measured to permit all of the test relays to operate, after which ground is connected under the control of the units register to the conductor identifying the individual number in the group of twenty. Since line 200 was assumed to be the first line in the group, the units register will ground conductor 512.

If line 200 is busy so that relay 630 operates, a circuit is closed from ground on conductor 512 over the left contact of polarized relay 630, contact 3 of relay 621, to battery through the winding of busy back relay 650. Relay 650 brings about the release of the sender and marker and the transmission of a busy signal to the calling line.

If line 200 is idle and relay 630 does not operate, ground connected to conductor 512 completes a circuit over the right contact of polarized relay 630, contact 1 of relay 621, winding of relay 600 and battery. Relay 600 at contact 7 locks to off-normal ground and at contact 8 closes a circuit from ground over that contact, contact 2 of relay 621 to battery through the winding of relay 653 which operates to prepare the incoming trunk circuit for applying ringing current to the ring conductor of the called line. At contacts 1, 3 and 5 relay 600 disconnects the test circuits from the test relays 620, 621 and 622 and at contacts 2, 4 and 6 connects these circuits together and over conductor 652 to the multifrequency receiving circuit of Fig. 7.

Fig. 4 discloses a multifrequency transmitter comprising a plurality of current sources 400 to 405 each arranged to transmit current of a different frequency than the others. Each source has an adjustable amplifier, such as amplifier 406, associated therewith for transmitting current of the desired volume to the output conductor 407. The output conductors 407, etc. are connected through individual resistances to distributing racks 410 and 411, where individual frequencies are grouped to obtain a plurality of signal combinations. The six individual frequencies may be combined in groups of three to give twenty different combinations to identify twenty line choices which is the maximum number of choices used in one office. As shown, sources 400, 401 and 402 are connected over terminal 412 and conductor 413 to line choice 0 of Fig. 2, while sources 403, 404 and 405 are connected over terminal 414 and conductor 415 to line choice 19 of Fig. 3. Other combinations identify intermediate line choices. It will be obvious that individual sources for generating the necessary three-frequency currents may be mounted directly on the line frames, if preferred.

Each level of each frame of each choice is provided with a transformer, having a winding for each line in the level and a common winding. For example, transformer 208, which is individual to level 0 on frame 0 of line choice 0 has a winding 209 individual to line 200, windings 210, 211, etc. individual to other lines and the common winding 212. Each level also has a relay such as relay 215 individual thereto and the signal conductor is connected in multiple over the back contacts of these relays to the common windings of all of the transformers of the choice. For example, signal conductor 413 is connected over the back contact of relay 215 to the common winding 212 of transformer 208. Similarly conductor 413 is connected over the back contact of relay 216 to the common winding of transformer 213 and over the back contact of relay 217 to the common winding of transformer 214. It may be noted that in Figs. 2 and 3 a resistance is shown connected in parallel with the hold magnet windings to reduce the impedance of the circuit to alternating current signals. When the testing circuit above traced through winding 209 was closed the multifrequency signaling current from conductor 413 was transmitted by trans-

former 208 to the testing circuit, but was ineffective since the test relays like relays 621 and 630 are unresponsive to these high frequency currents.

The receiving circuit of Fig. 7 comprises an input transformer 701, an amplifier 702 and an output transformer 703 connected in multiple to filters 704 to 709 which in turn control relays 710 to 715. Each of these filters is tuned to pass one of the frequencies of sources 400 to 405. Therefore, when the test circuit is extended to conductor 652, three relays are operated which identify these three frequencies.

In Fig. 7, only simple circuits have been shown including armatures of relays 704 to 709 in order to provide the twenty circuits for operating marker preference relays at the line choice connector. In practice, these relays would control circuits similar to those disclosed in applicant's Patent 2,317,191, granted April 20, 1943, to insure the operation of a marker preference relay when and only when the correct number of relays is operated, together with means for measuring a time interval, and making a trouble record if an incorrect number of relays is operated at the end of the time.

Since frequencies from sources 400, 401 and 402 were transmitted to the test circuit, relays 710, 711 and 712 are now operated, completing a circuit from battery at the back contact of relay 700, contacts of relays 710, 711 and 712, conductor 716, winding of marker preference relay 218 of the line choice connector belonging to choice, No. 0 to ground. These marker preference relays are arranged in a chain as in the case of the number group frames so that only one marker has access to one line choice at a time. Relay 218 closes an obvious circuit for multicontact relay 219 which connects ground to conductor 220 as a signal that the connection with the line choice has been completed. Ground on conductor 220 operates relay 700, which disconnects the test circuit from the choice identifying circuit of Fig. 7 and extends it to the level identification circuit of Fig. 8.

In addition, relay 219 closes parallel circuits for operating relays 215, 216, 217, etc., there being one such relay for each level of the four frames making up the choice. Each of these relays operates to disconnect the common winding of the associated transformer from the multifrequency sources of Fig. 4 and connect it with a conductor individual to the level. For example, relay 215 operates under the control of relay 219, disconnecting winding 212 of transformer 208 from conductor 413 and connecting it to conductor 221 which is individual to level 0 on frame 0. This conductor extends over a contact of the multicontact relay 219 to conductor 222 which, in turn, extends to the level identification circuit of Fig. 8.

The level identification circuit is made up of a plurality of matching circuits 801, 802, 803, etc. each comprising a double balanced modulator. A source of alternating current which is individual to the market is applied through transformer 800 to conductor 717 which extends to the test circuit and also extends in multiple to the input transformer 810 of the matching circuit 801 and the corresponding transformers of the other matching circuits 802, 803, etc. There is one such matching circuit for each of the levels in a line choice, that is, there are forty matching circuits.

Current applied over conductor 717 to the test circuit is transmitted from the individual

winding 209 to the common winding 212. When a level relay, such as relay 215 operates, it connects the common winding 212 of the associated transformer 208 to conductor 222 as above described. Conductor 222 is extended at this time to the output transformer 811 of the matching circuit assigned to level 0 of frame 0. With current of the identical frequency flowing in transformers 810 and 811, direct current flows through the winding of relay 812 and that relay operates, in turn operating relay 813 to inform the marker that the wanted line is located in level 0 of frame 0. In the other matching circuits the relay corresponding to relay 812 cannot operate, since alternating current is connected to only one end of the associated double balanced modulator.

For a more complete description of the operation of the modulator employed in the matching circuits of Fig. 8, reference may be made to Patent 2,301,961, granted to M. A. Logan on November 17, 1942. Circuits of this type may also be used for the line choice identification in place of those shown in Fig. 7.

Relay 813 closes an obvious circuit for the associated frame relay 814 which closes a circuit from ground through the winding of relay 815, over conductor 816 and through equipment at frame 0 to the winding of relay 223 operating both relays when the frame is idle. Relay 223 prepares the frame circuit for completing a terminating call and relay 815 supplies ground to the level indicating relay 813 which extends this ground over conductor 817 to the winding of horizontal group relay 224 which in individual to the 0 level of the frame. With relay 224 operated, the operating circuits for the ten select magnets 225, 226, etc., corresponding to the ten line junctors which serve line 202, are extended through to the marker where the marker proceeds to select an idle channel, operates the incoming and secondary line switches and operates hold magnet 207 over the test circuit thereby completing the connection between the incoming trunk circuit 201 and line 200. Ground from the incoming trunk circuit is extended through the switches to sleeve terminal 205, holding magnet 207 operated. The release of the marker following the completion of the talking circuit releases all of the relays of the line choice connector. These operations take place as described in the above identified Dehn et al. patent.

Assuming that line 231 is the tip party on a party line, the corresponding sleeve terminal 232 will be connected over jumper 233 to the terminal 133 of the associated set of number terminals. When the line 231 is called, the set of terminals including terminal 133 will be selected in the manner described for line 200. A circuit will then be closed from battery through the winding of hold magnet 234, winding 238 of transformer 214, sleeve terminal 232, jumper 233, number group terminal 133, contacts of twenty-block relay 113 and multicontact relay 111, conductor 134, contact 1 of relay 601, windings of relays 623 and 631 in series to 24-volt battery. If line 231 is idle, only relay 623 operates and a circuit is closed from ground through the units register, right contact of polarized relay 631, contact 1 of relay 623 to battery through the winding of relay 601. Relay 601 locks and closes a circuit from ground over its contact 8, contact 2 of relay 623 to battery through the winding of relay 651 which prepares the incoming trunk circuit to signal the tip party. Since line 231 is also located in choice 0, the selection of that choice by

the circuits of Fig. 7 takes place as described for line 200, the common windings of transformers 208, 213 and 214 being connected in multiple to the same multi-frequency source. After relay 219 operates, in turn operating relay 217, the common winding of transformer 214 is connected to conductor 235 and thence to the matching circuit 840. Relay 818 operates to indicate that the wanted line is on level 0 of frame 3. Relay 818 operates frame relay 819 which connects relay 820 to relay 236 to determine when the frame is ready for completing the call. Relay 820 supplies ground to relay 818 which extends this ground to conductor 821 and the winding of horizontal group relay 237 which functions to close the select magnet circuits as did relay 224. The completion of the connection takes place in the usual manner.

The operation in the case of a terminal hunting group will now be described. The first group of terminals on number group frame 124 has been shown as constituting a single group of lines serving a single subscriber. It will, of course, be understood that such terminal hunting groups may appear on any number group frame and may include any desired number of lines. Lines 300 and 230 which are the first and an intermediate line of the group have their sleeve terminals connected to the bottom terminals of the associated terminal sets on the number group frame, while line 301 which is the last line of the group has its sleeve terminal connected to the center terminal in the number group set.

When the number of the subscriber served by this group of lines is dialed, the marker operates preference relay 120, followed by multicontact relay 121, hundred-block relay 122 and twenty-block relay 123. When relay 123 operates it connects the sleeve terminals of lines 300, 230 and 301 over contacts of relay 121 to conductors 135, 136 and 137 respectively. Conductor 135 extends over contact 5 of relay 600, through the winding of relay 622 to the winding of relay 630 and 24-volt battery; conductor 136 extends over contact 5 of relay 601, winding of relay 624 to the winding of relay 631 and 24-volt battery; conductor 137 extends over contact 3 of relay 619, winding of relay 625, winding of relay 649 to 24-volt battery.

Assuming first that line 300 is idle, relay 622 operates and relay 630 does not, thereby operating relay 600. Relay 600 causes the operation of relay 653 to control the ringing of the selected line. Other operations take place as previously described.

Assuming that only the last line of the group, that is line 301 is idle, relays 622 and 630, 624 and 631, similar relays of the intermediate test circuits, and relays 625 are operated. When ground is connected to conductor 512 a circuit is closed over the left contact of relay 630, contact 3 of relay 622, left contact of relay 631, contact 3 of relay 624 and over similar contacts on the intermediate test relays, right contact of relay 649, contact 1 of relay 625 to the winding of relay 619 and battery.

It may be noted that for a terminal hunting group having more than twenty lines so that the test circuit of the twentieth line is connected to relay 626, if all of the lines in the one twenty block are busy, ground is extended to conductor 627 to control the selection of another block of lines for test, in a manner similar to that shown in the Dehn et al. patent.

When relay 619 operates it connects conductor

137 to conductor 652. The common winding of transformer 303, associated with the switch level in which line 301 is located, is connected over the back contact of relay 305 to conductor 415 and the multifrequency source connected to terminal 414, in parallel with the common windings of the other transformers belonging to choice 19. Therefore a signal made up of the frequencies of sources 403, 404 and 405 is transmitted to the line choice selecting equipment of Fig. 7, resulting in the operation of relays 713, 714 and 715. These relays in turn connect battery to conductor 718, operating marker preference relay 306. Relay 306 operates multicontact relay 307 which connects the marker with the circuits of line choice 19.

Relay 307 grounds conductor 220 to operate relay 700 and also operates relay 305 and the other level relays, connecting the common winding of transformer 303 to conductor 308. With relays 700 and 305 operated, current from source 800 is connected in parallel to the input transformers of the matching circuits and to the test circuit over which it extends to winding 309 of transformer 303, where it is transmitted to the common winding and over conductor 308 to the output transformer of matching circuit 802. Relay 822 therefore operates to indicate that the wanted line is located in level 9 of frame 0. Relay 822 operates frame relay 814 which tests the frame as above described. When relay 815 operates, ground is extended over contacts of relays 815 and 822, conductor 823 and contact of relay 307 to the winding of horizontal group relay 310 and battery. The further operations of the circuits are the same as previously described.

An alternative arrangement of the frame circuits is shown in Fig. 9. In this arrangement the hold magnets such as magnet 907 have two windings, one of which is connected to the sleeve of the line switch and the other of which is connected in parallel with a resistance to the number group frame. One side of each winding is connected to conductor 902 and thence to battery. Therefore, ground over the sleeve of the connection alters the potential on the number group frame connection to mark the line busy. In place of the multiple wound transformer such as transformer 208, two simple transformers, transformers 900 and 901, are provided per level, one for the line choice identification and the other for the level identification. A relay 915 is operated after the line choice connector operates, in the same way that relay 215 was operated, to transfer from one transformer to the other. With relay 915 normal, conductor 902 is connected over normal contacts of relay 915, through one winding of transformer 900 to the 48-volt central office battery. The other winding of transformer 900 is connected to the appropriate multifrequency source of Fig. 4. This source will be connected in parallel to the windings of other similar transformers associated with the same line choice. When the line choice has been identified and the connector relays operated, relay 915 is operated, connecting conductor 902 through one winding of transformer 901 to battery. The other winding of transformer 901 is connected over a contact of the line choice connector relay to the proper matching circuit of Fig. 8, thereby providing a circuit for identifying the frame and level in the manner previously described.

It will be understood that the circuits disclosed for supplying and detecting the alternating current signals are merely intended to be typical.

Alternating current signalling based on time division multiplex arrangements such as that disclosed in Patent 2,252,766, granted August 19, 1941, to W. H. T. Holden, or on phase discrimination arrangements such as disclosed in Patent 2,154,886, granted April 18, 1939, to A. E. Bachelet et al., may be substituted for the frequency discriminating arrangement employed.

What is claimed is:

1. In a telephone system, subscribers' lines of a plurality of types identified by directory numbers, automatic switches, control equipment common to said lines and said switches, a set of terminals individual to each directory number, a set of terminals individual to each line in said switches, each set of line terminals including a test terminal, means to individualize one of said number terminals with one of said sets of line terminals by connecting one of said number terminals with the test terminal of said set of line terminals by a single conductor, means responsive to the registration of a directory number in said control equipment to connect said control equipment with the corresponding number terminal, and means operated over said conductor to indicate to said control equipment whether the associated line is busy or idle and to set up in said control equipment all the information necessary for operating said switches to complete a telephone connection with said line.

2. In a telephone system, subscribers' lines of a plurality of types identified by directory numbers, automatic switches, control equipment common to said lines and said switches, a set of terminals individual to each directory number, a set of terminals individual to each line in said switches, each set of line terminals including a test terminal, means to individualize one of said number of terminals with one of said sets of line terminals by connecting one of said number terminals with the test terminal of said set of line terminals by a single conductor, means responsive to the registration of a directory number in said control equipment to connect said control equipment with the corresponding number terminal, and means operated over said conductor to indicate in said control equipment whether the associated line is busy or idle, the type of said line, and the location of said line terminals in said switches.

3. In a telephone system, subscribers' lines of a plurality of types identified by directory numbers, automatic switches, control equipment common to said lines and said switches, a set of terminals individual to each directory number, each said set of number terminals including a terminal for each type of line, a set of terminals individual to each line in said switches, each set of line terminals including a test terminal, means to individualize one of said number terminals with one of said sets of line terminals by connecting the test terminal of said set of line terminals with the terminal of said set of number terminals corresponding to the type of the associated line by a single conductor, means responsive to the registration of a directory number in said control equipment to connect said control equipment with the corresponding set of number terminals, and means operated over said conductor to indicate in said control equipment whether the associated line is busy or idle, the type of said line, and the location of said line terminals in said switches.

4. In a telephone system, subscribers' lines of a plurality of types identified by directory numbers, automatic switches, control equipment com-

mon to said lines and said switches, a set of terminals individual to each directory number, a set of terminals individual to each line in said switches, each set of line terminals including a test terminal, means to individualize one of said number terminals with one of said sets of line terminals by connecting one of said number terminals with the test terminal of said set of line terminals by a single conductor, means responsive to the registration of a directory number in said control equipment to connect said control equipment with the corresponding number terminal, and means operated over said conductor to indicate in said control equipment whether the associated line is busy or idle, the type of said line, and the location of said line terminals in said switches, said means comprising a direct current test circuit and a plurality of alternating current test circuits.

5. In a telephone system, subscribers' lines of a plurality of types identified by directory numbers, automatic switches, control equipment common to said lines and said switches, a set of terminals individual to each directory number, a set of terminals individual to each line in said switches, each set of line terminals including a test terminal, means to individualize one of said number terminals with one of said sets of line terminals by connecting one of said number terminals with the test terminal of said set of line terminals by a single conductor, means responsive to the registration of a directory number in said control equipment to connect said control equipment with the corresponding number terminal, means operated over said conductor to indicate in said control equipment whether the associated line is busy or idle, the type of said line and the location of said line terminals in said switches, said means comprising a direct current test circuit and a plurality of alternating current test circuits, and means to successively complete said test circuits over said conductor.

6. In a telephone system, subscribers' lines of a plurality of types identified by directory numbers, automatic switches, control equipment common to said lines and said switches, a set of terminals individual to each directory number, a set of terminals individual to each line in said switches, each set of line terminals including a test terminal, means to individualize one of said number terminals with one of said sets of line terminals by connecting one of said number terminals with the test terminal of said set of line terminals by a single conductor, means responsive to the registration of a directory number in said control equipment to connect said control equipment with the corresponding number terminal, means operated over said conductor to indicate in said control equipment whether the associated line is busy or idle, the type of said line, and the location of said line terminals in said switches, said means comprising a direct current test circuit and a plurality of alternating current test circuits, means responsive to the completion of said direct current test circuit for connecting one of said alternating current test circuits to said conductor, and means responsive to the completion of said one alternating test circuit to connect another of said alternating test circuits to said conductor.

7. In a telephone system, subscribers' lines of a plurality of types identified by directory numbers, automatic switches arranged in choices, each choice comprising a plurality of frames and each frame comprising a plurality of levels, con-

trol equipment common to said lines and said switches, a set of terminals individual to each directory number, a set of terminals individual to each line in said switches, each set of line terminals including a test terminal, means to individualize one of said number terminals with one of said sets of line terminals by connecting one of said number terminals with the test terminal of said set of line terminals by a single conductor, means responsive to the registration of a directory number in said control equipment to connect said control equipment with the corresponding number terminal, means operated over said conductor to indicate in said control equipment whether the associated line is busy or idle, and the type of said line, first sources of alternating current individual to each of said choices, other sources of alternating current individual to said control equipments, means to successively connect one of said first sources of alternating current and one of said other sources of alternating current to said conductor, and means in said control equipment responsive to said alternating currents to record the location of said line terminals in said switches.

8. In a telephone system, subscribers' lines of a plurality of types identified by directory numbers, automatic switches arranged in choices, each choice comprising a plurality of frames and each frame comprising a plurality of levels, control equipment common to said lines and said switches, a set of terminals individual to each directory number, each said set of number terminals including a terminal for each type of line, a set of terminals individual to each line in said switches, each set of line terminals including a test terminal, means to individualize one of said sets of number terminals with one of said sets of line terminals by connecting the test terminal of said set of line terminals with the terminal of said set of number terminals corresponding to the type of the associated line by a single conductor, means responsive to the registration of a directory number in said control equipment to connect said control equipment with the corresponding set of number terminals, means operated over said conductor to indicate in said control equipment whether the associated line is busy or idle and the type of said line, first sources of alternating current individual to each of said choices, other sources of alternating current individual to said control equipments, means to successively connect one of said first sources of alternating current and one of said other sources of alternating current to said conductor, and means in said control equipment responsive to said alternating currents to record the location of said line terminals in said switches.

9. In a telephone system, subscribers' lines of a plurality of types identified by directory numbers, automatic switches arranged in choices, each choice comprising a plurality of frames and each frame comprising a plurality of levels, control equipment common to said lines and said switches, a set of terminals individual to each directory number, a set of terminals individual to each line in said switches, each set of line terminals including a test terminal, means to individualize one of said number terminals with one of said sets of line terminals by connecting one of said number terminals with the test terminal of said set of line terminals by a single conductor, means responsive to the registration of a directory number in said control equipment to connect said control equipment with the cor-

responding number terminal, means operated over said conductor to indicate in said control equipment whether the associated line is busy or idle and the type of said line, first sources of alternating current individual to each of said choices, means to transmit current from the associated first source over said conductor, receiving means in said control equipment, means responsive to the operation of said indicating means if said line is idle to connect said receiving means to said conductor, means selectively operated by said receiving means in response to current from said first source to establish an auxiliary connection between said control equipment and the corresponding choice, other sources of alternating current individual to said control equipment, matching circuits in said control equipment individual to each level in a choice, means in said control equipment responsive to the establishment of said auxiliary connection to connect the corresponding one of said other sources to said conductor and to said matching circuits, means to transmit the current from said other source over said auxiliary connection to the matching circuit associated with the level on which said line terminals are located, and means controlled by said matching circuit to operate said switches to complete a telephone connection with said line.

10. In a telephone system, subscribers' lines of a plurality of types identified by directory numbers, automatic switches arranged in choices, each choice comprising a plurality of frames and each frame comprising a plurality of levels, control equipment common to said lines and said switches, a set of terminals individual to each directory number, a set of terminals individual to each line in said switches, each set of line terminals including a test terminal, means to

individualize one of said number terminals with one of said sets of line terminals by connecting one of said number terminals with the test terminal of said set of line terminals by a single conductor, means responsive to the registration of a directory number in said control equipment to connect said control equipment with the corresponding number terminal, means operated over said conductor to indicate in said control equipment whether the associated line is busy or idle and the type of said line, first sources of alternating current individual to each of said choices, a transformer for each level having a winding for each line connected to the associated test terminal and a common winding for transmitting current from the associated first source over said conductor, receiving means in said control equipment, means responsive to the operation of said indicating means if said line is idle to connect said receiving means to said conductor, means selectively operated by said receiving means in response to current from said first source to establish an auxiliary connection between said control equipment and the corresponding choice, other sources of alternating current individual to said control equipment, matching circuits in said control equipment individual to each level in a choice, means in said control equipment responsive to the establishment of said auxiliary connection to connect the corresponding one of said other sources to said conductor and to said matching circuits, means to connect said common winding over said auxiliary connection to the associated matching circuit to transmit the current from said other source thereto, and means controlled by said matching circuit to operate said switches to complete a telephone connection with said line.

BERNARD D. HOLBROOK.