

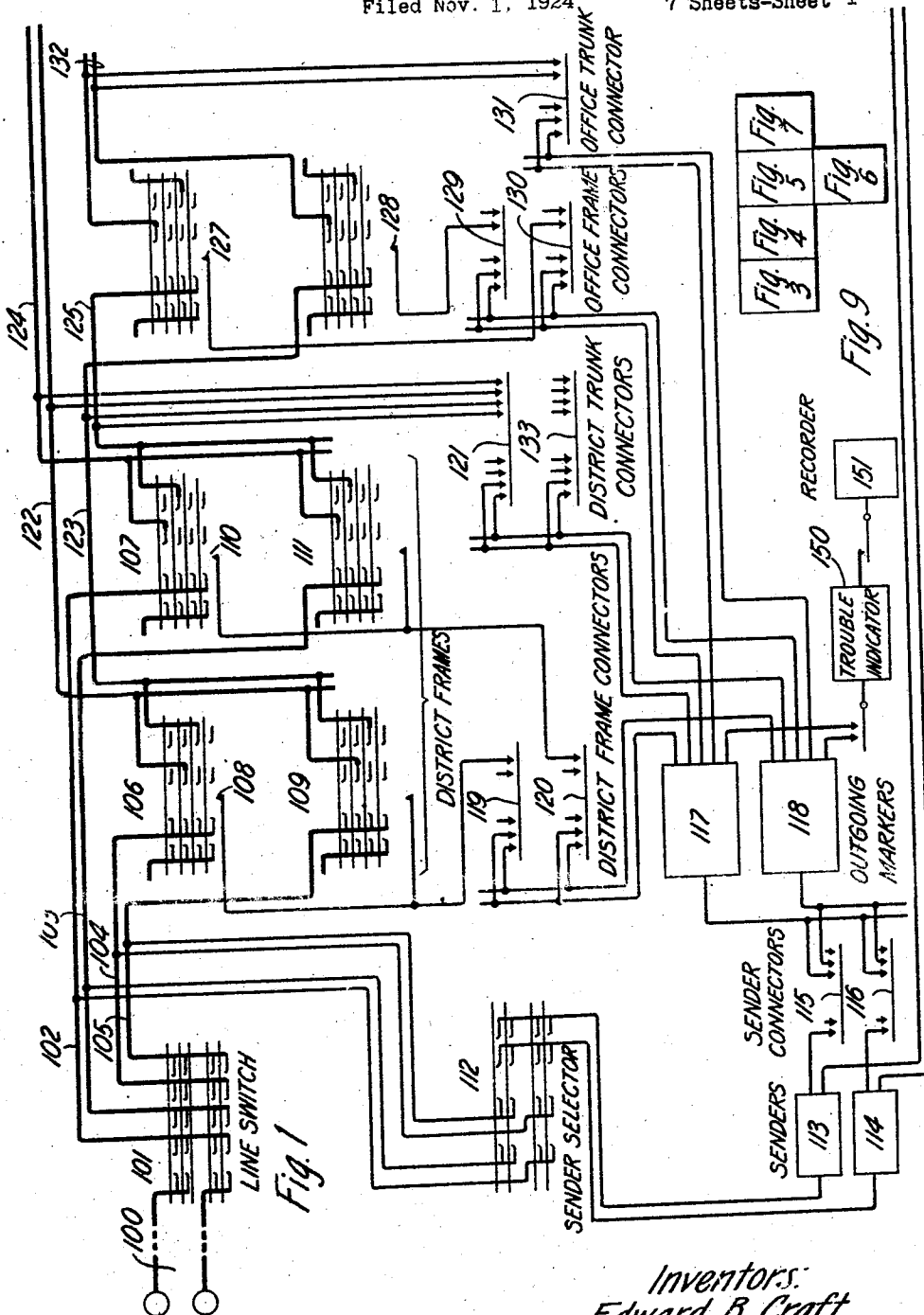
Jan. 11, 1927.

E. B. CRAFT ET AL
TROUBLE INDICATING SYSTEM

1,614,285

Filed Nov. 1, 1924

7 Sheets-Sheet 1



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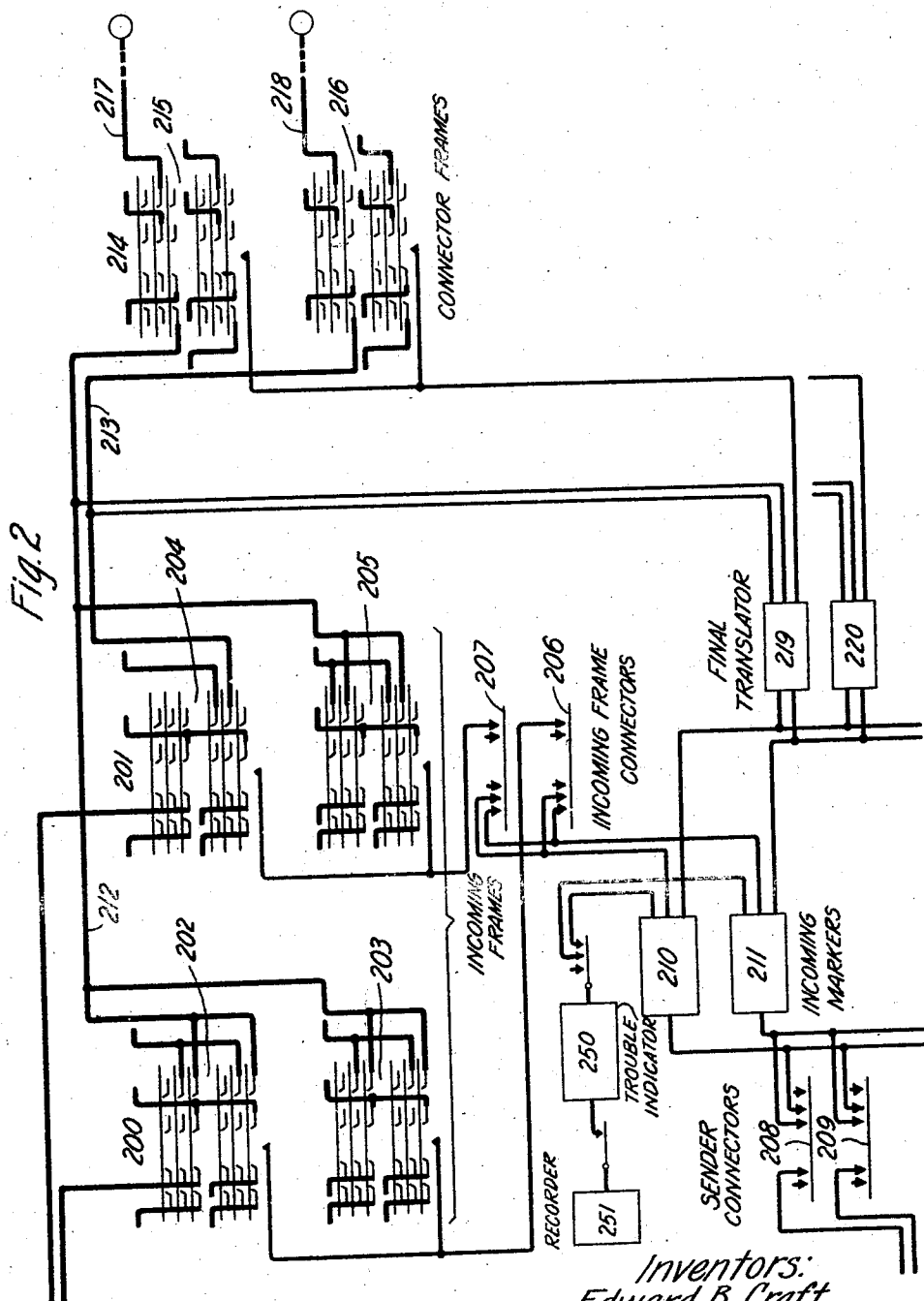
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7 Sheets-Sheet 2

1,614,285



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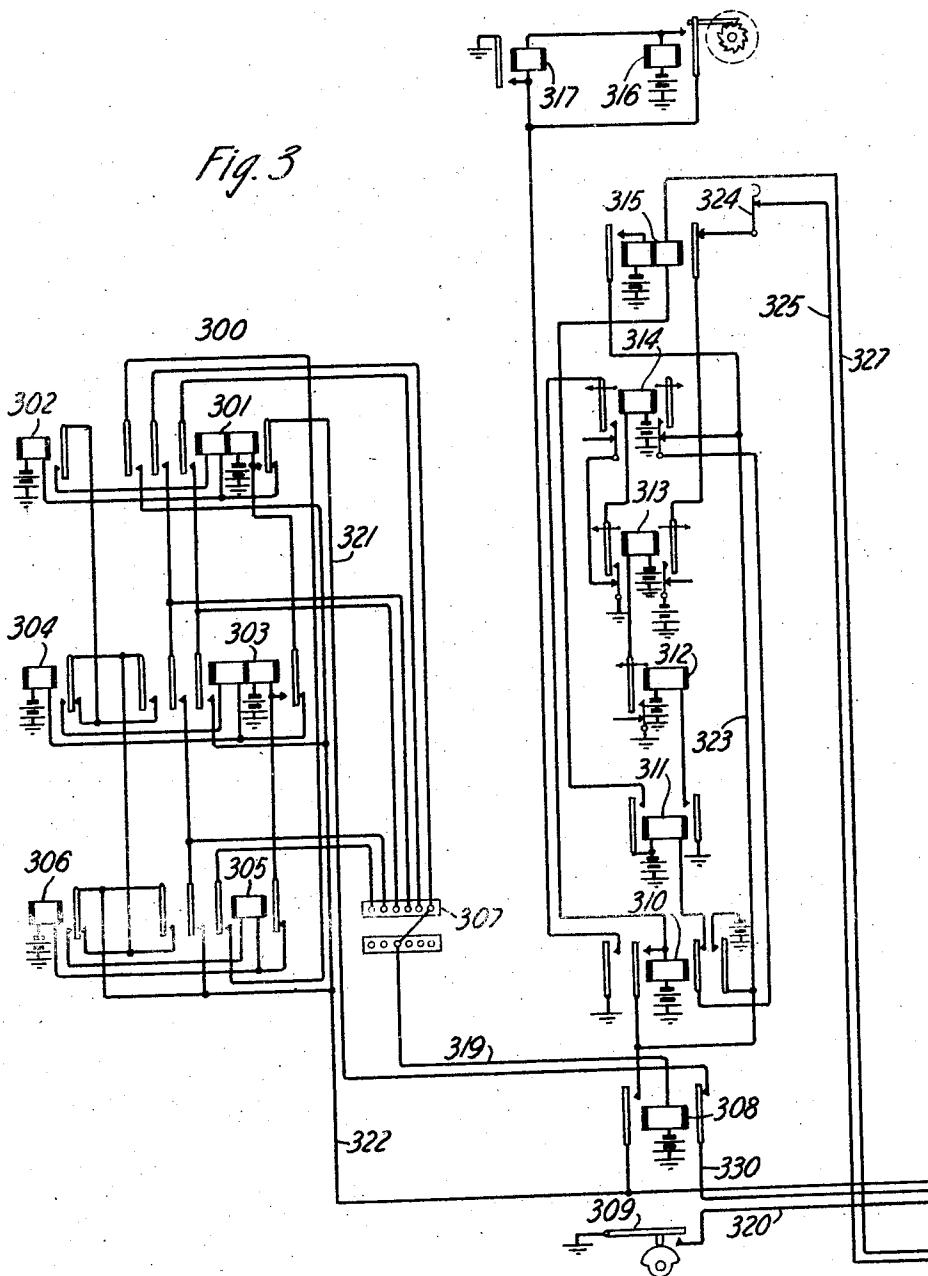
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7 Sheets-Sheet 3



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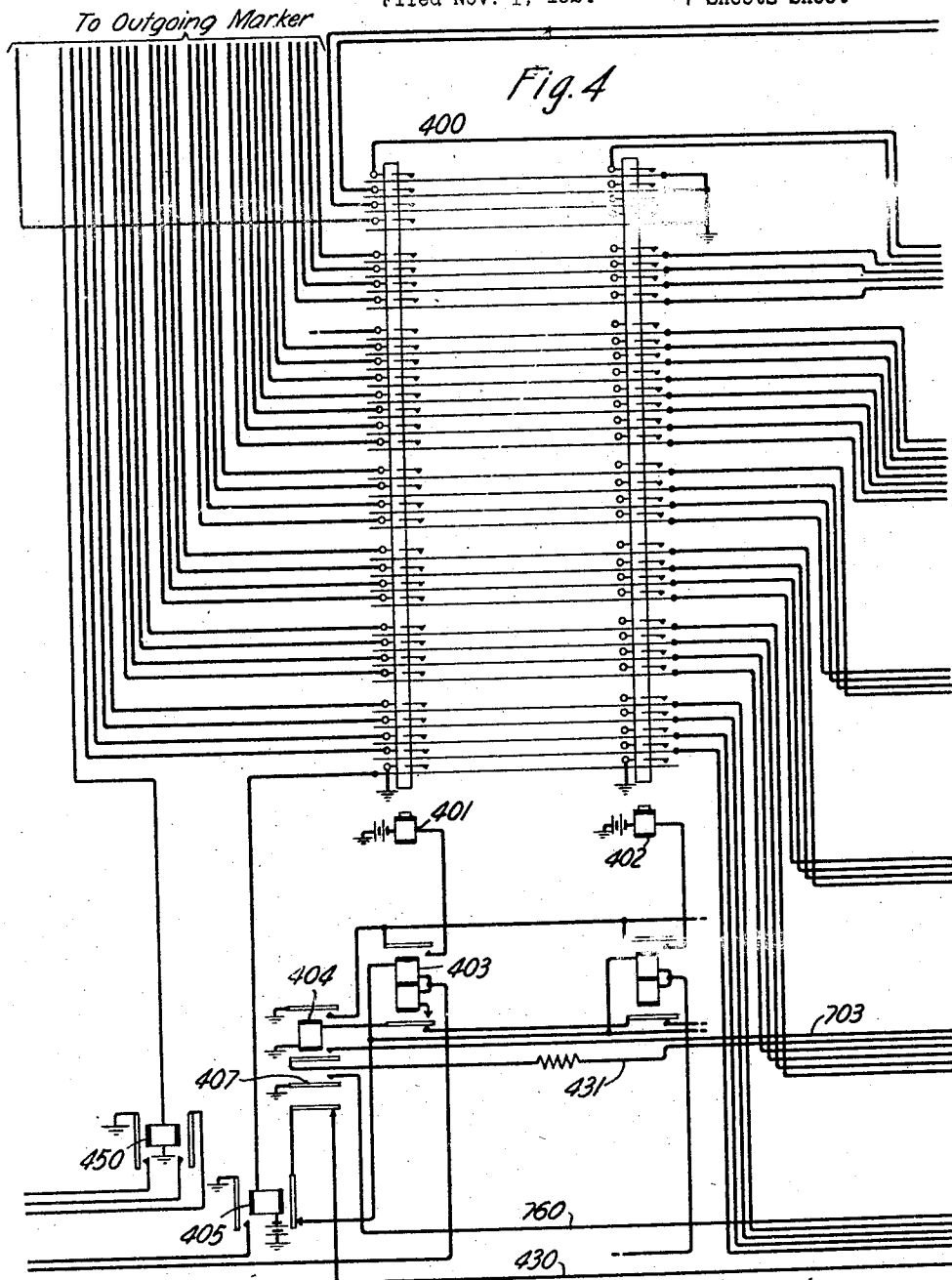
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7 Sheets-Sheet 4



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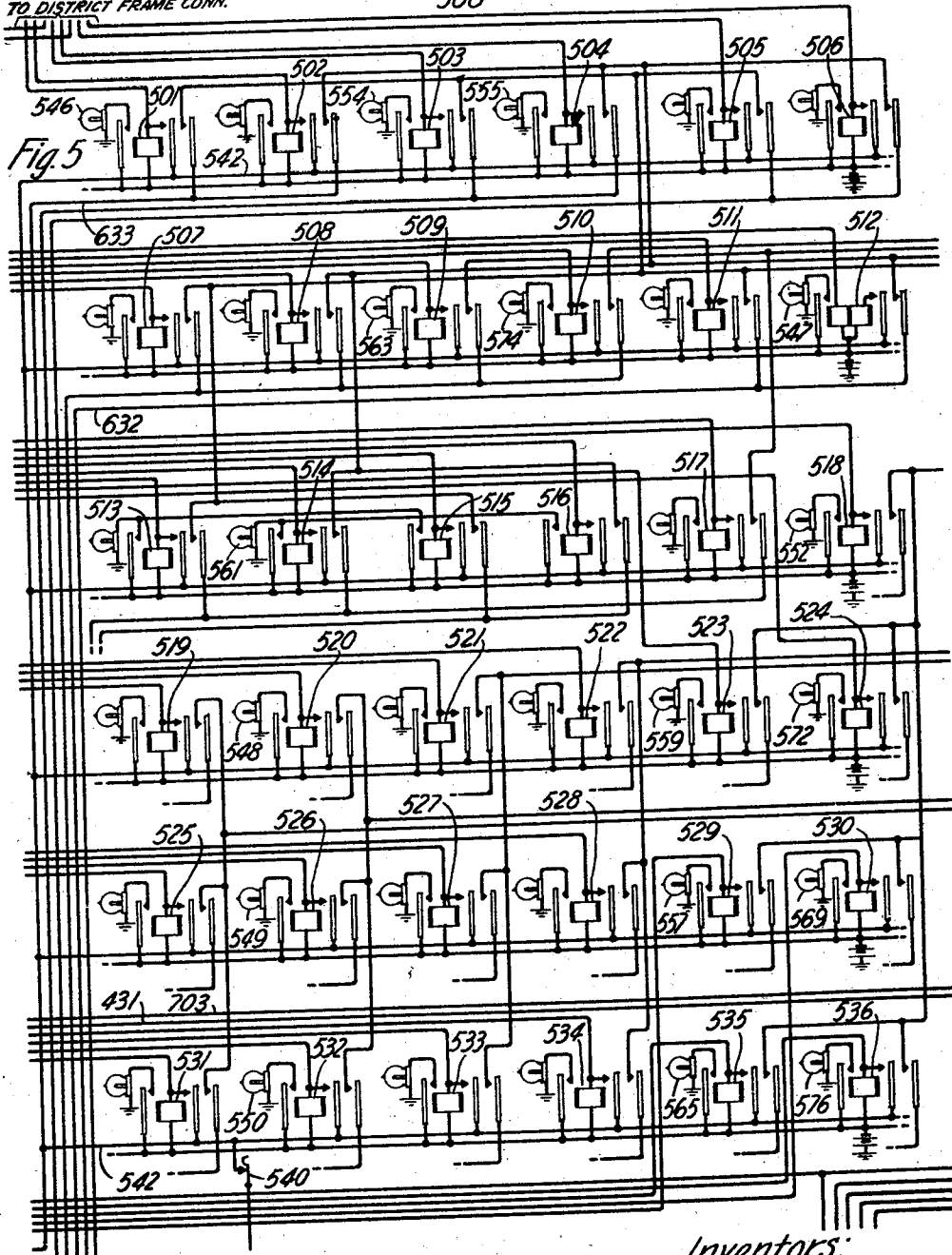
E. B. CRAFT ET AL
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1,614,285

Filed Nov. 1, 1924

7 Sheets-Sheet 5

TO DISTRICT FRAME CONN.



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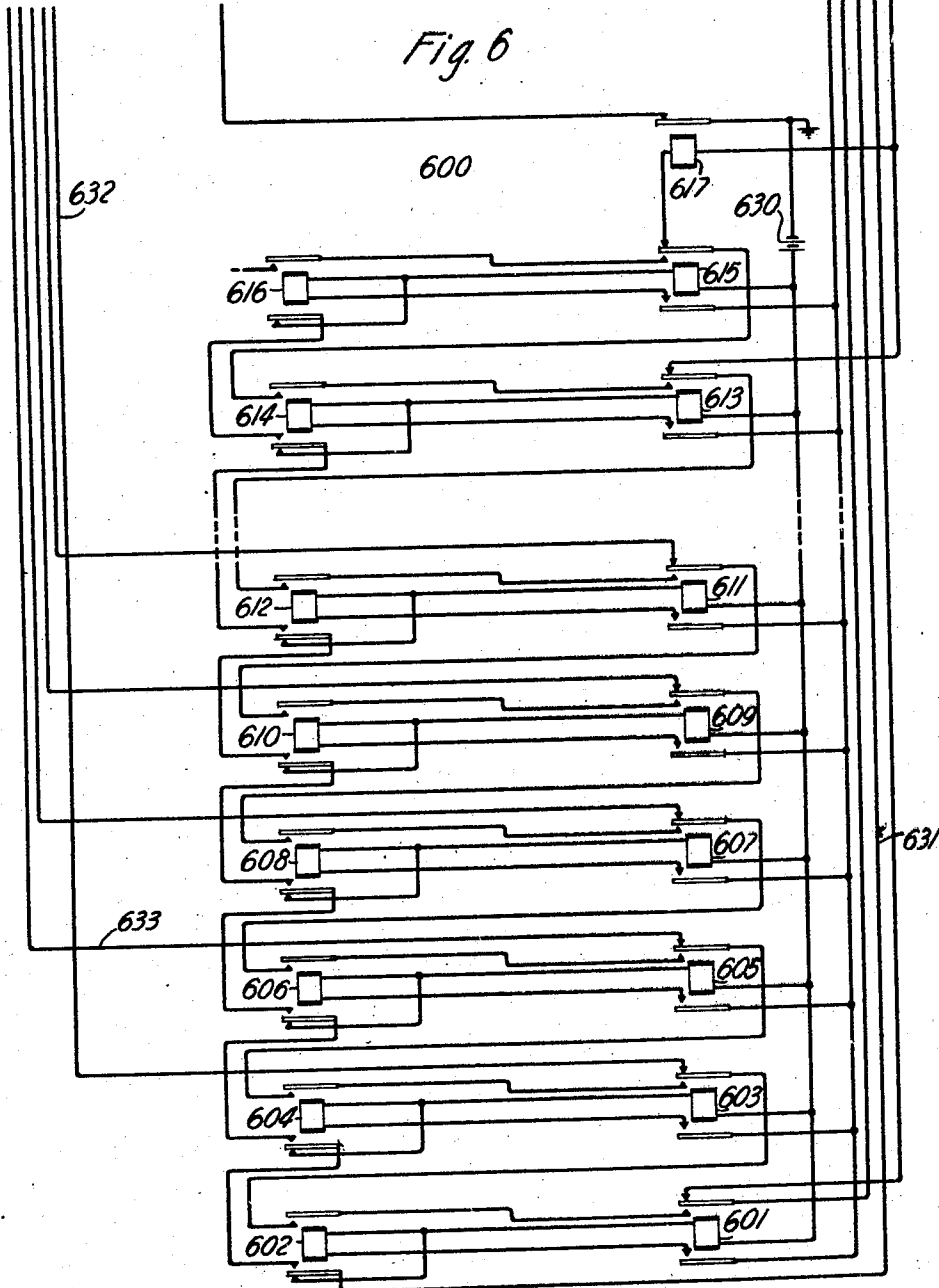
Jan. 11, 1927.

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E. B. CRAFT ET AL
TROUBLE INDICATING SYSTEM

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7 Sheets-Sheet 6



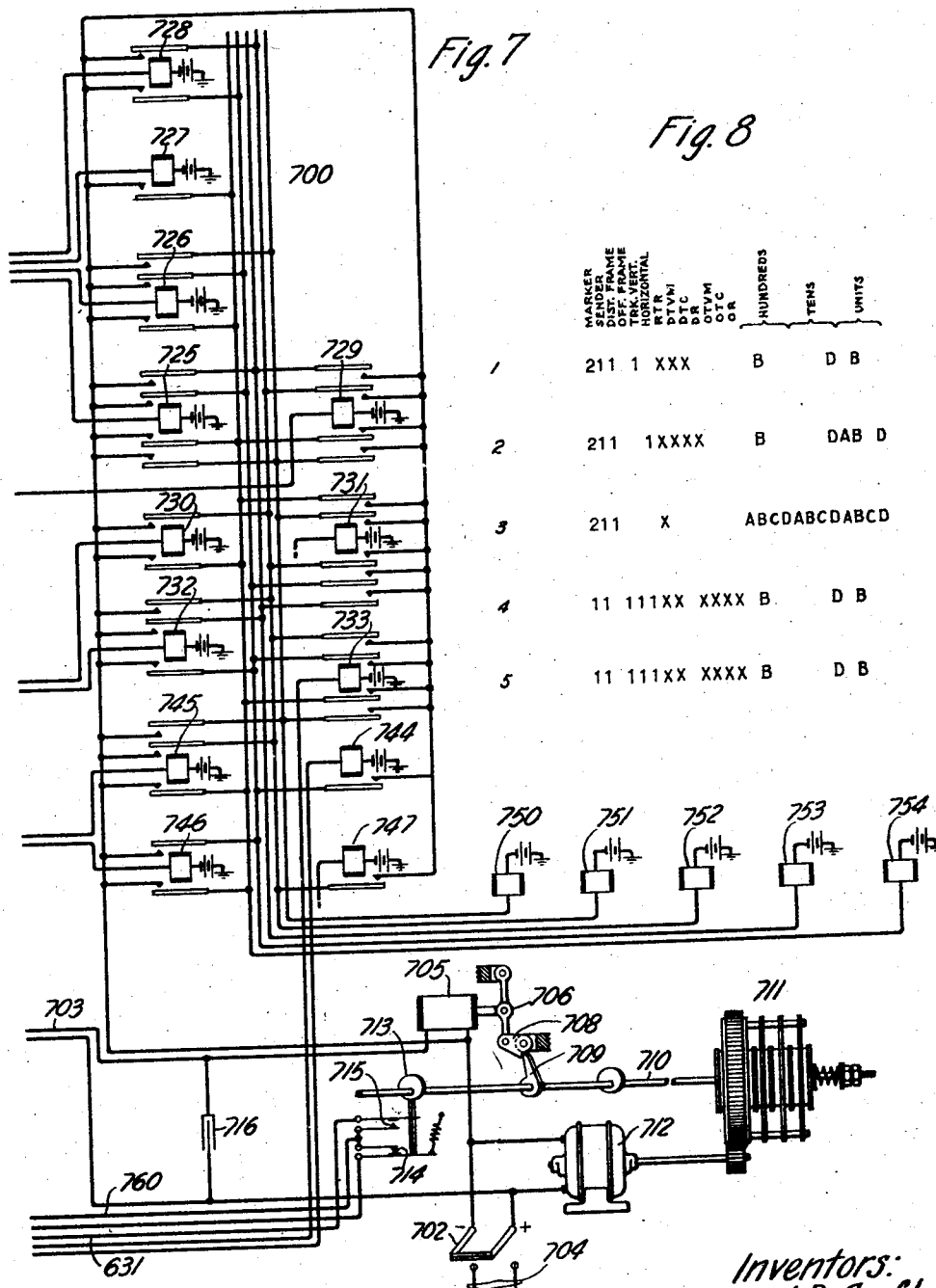
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1,614,285

TROUBLE INDICATING SYSTEM

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7 Sheets-Sheet 7



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UNITED STATES PATENT OFFICE.

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TROUBLE-INDICATING SYSTEM.

Application filed November 1, 1924. Serial No. 747,174.

This invention relates to telephone exchange systems and more particularly it pertains to recording apparatus especially adapted to telephone systems employing automatic switching apparatus for the establishment of desired conversational connections.

In telephone systems where automatic selecting apparatus is employed for establishing conversational connections in response to predetermined impulses transmitted by a calling subscriber, it is found that the efficiency of operation of the system may be materially increased by providing switching mechanism operative immediately that the apparatus encounters trouble for indicating and recording the apparatus involved in establishing the desired connection and the point to which the call progressed when trouble was encountered.

The principal object of the invention is, therefore, to obtain information concerning the apparatus involved in the establishment of a connection and the point to which the call progressed when trouble occurred.

A feature of the invention relates to a recording mechanism common to a number of switching mechanisms which becomes associated with the mechanism which has encountered trouble and which operates to record in a permanent form information from which the apparatus involved in the connection and the point to which the call progressed when trouble occurred may be quickly ascertained.

This invention is in the nature of an improvement on the system shown and described in Patent No. 1,594,003, issued July 27, 1926, to W. W. Carpenter, and a general reference is hereby made to that patent for an understanding of the manner in which the mechanisms of the present system are arranged and the details of operation whenever such arrangements and details are hereinafter mentioned but are not particularly illustrated or described.

For the purpose of this case it has been considered sufficient to show only such part of the apparatus or mechanism as is necessary for a clear understanding of the present invention and to confine the detailed description to apparatus involved in the recording of information from which the nature and source of the trouble can be easily

ascertained in accordance with the invention.

Referring now to the drawings, Figs. 1 and 2 when taken together end for end with Fig. 2 arranged on the right of Fig. 1 shows the general location of the apparatus for a complete system to which the invention is particularly adapted. Figs. 3 to 7, when arranged in the manner illustrated in Fig. 9 disclose circuits and apparatus involved in indicating and recording the nature and source of trouble. Fig. 3 shows the time measuring mechanism for controlling the operation of the relays of the marker. Fig. 4 illustrates a connector for connecting the control relays of the indicating mechanism to the markers. Fig. 5 shows a part of the trouble indicator. Fig. 6 illustrates a counting relay distributor for successively associating the trouble indicator with the recorder which responds in accordance with the operation of the indicator for making a permanent record of the nature and source of the trouble encountered. Fig. 7 illustrates diagrammatically the circuits and apparatus for the recorder. Fig. 8 shows a sample of the record produced when the apparatus encountered several different kinds of trouble.

General description of the system and apparatus.

Referring now for the moment to Figs. 1 and 2, descriptions will be given of the general plan of the system. The lines 100 enter the office and terminate in a number of line switches, such as switch 101. Outgoing from these switches are a number of trunks which extend to district selector switches. For certain reasons it is desirable that the district selector switches be divided into a number of groups, two of which groups 106 and 107 are illustrated. The group 106 comprises a number of district selector switches, two of which 108 and 109 are shown and trunks such as trunks 104 and 105 leading from the line switches are distributed among these district selector switches. In like manner the trunks 102 and 103 extend to the district selector switches 110 and 111 of the second group 107. It is, of course, obvious that other similar groups may be provided.

The trunks outgoing from the district selector switches lead in different directions. For example, some of the trunks 123 and

125 extend to office selector switches. The office selector switches may be arranged in groups similar to the district selector switches, the selector 127 being of one group and the selector 128 being of a second group of office selectors. The trunks 132 leading from the office selectors extend to distant offices to take care of interoffice communications.

10 Other trunks leading from the district selector switches, such as the trunks 122 and 124, extend to incoming switches located in the same central office.

These incoming switches are similarly divided into two groups, group 200 comprising switches 202 and 203 and the group 201 comprising the switches 204 and 205. The trunks outgoing from the incoming switches, such as trunks 212 and 213 lead to the various connector switches of the several groups. Only one group of connector switches 214, which includes the switches 215 and 216, is illustrated in the drawing. The connector switches have access to the called lines as 217 and 218.

The trunks which lead from the line switch to the district selectors also appear in the sender selector switches 112, which operate to extend these trunks to the register senders. Two of these senders 113 and 114 are shown. The sender connector may comprise a plurality of sections 115, 116, etc. which serve to connect the senders to the outgoing markers 117 and 118. While only two of the markers are illustrated any suitable number may be provided for handling the required traffic.

In order to connect the markers to the district frames there are provided a number of frame connectors, one for each group of district selector frames. Frame connector 119, for instance, serves to connect any of the markers to any of the frames in the selective group 106, while frame connector 120 serves to connect any of the markers to any of the frames in the district selector group 107.

The outgoing markers are connected to the trunks outgoing from the district selector switches by means of district trunk connectors 121 and 123, etc.

Likewise, frame connectors 129 and 130 are provided for associating the outgoing markers, respectively, with the office selector switches of the two corresponding groups, while trunk connectors such as the trunk connector 131 are provided for associating the outgoing markers with the two groups of trunks leading from the office selector switches.

A sender connector device which may comprise a plurality of sections 208 and 209 serves to connect the senders with any one of a plurality of incoming markers, two of which, 210 and 211, are shown. These in-

coming markers are associable with frame connectors 206 and 207, respectively, with the groups of incoming selector frames 200 and 201.

A number of final translators 219 and 220 are provided. There may be any number of these translators depending on the number of called subscribers' lines, there being one pertaining exclusively to a different portion of the subscribers' lines. Any of the final translators may be associated with the incoming markers.

The final translator 219, for example, is arranged to make connection with any of the final connector switches of the group 214 and serves to control any of these switches to make a connection to the called subscribers' lines. In a similar manner the final translator 220 is associable with the connector switches of a different group and governs the same to extend connections to other called subscribers' lines.

A trouble indicator 150 is provided in common to all outgoing markers 117 and 118, etc. and may be associated with any one of the markers in case of trouble. Connectible with the trouble indicator 150 is recorder 151, which responds to the operation of the trouble indicator 150 to record the information given by the trouble indicator to provide a permanent record of the nature and source of the trouble. Similarly, a trouble indicator 250 is provided for the incoming markers 210 and 211. Likewise, a recorder 251 is associable with the trouble indicator 250 for recording the nature and source of the trouble encountered through the operation of the incoming markers 210 and 211, in a manner similar to that described in connection with the trouble indicator 150.

Referring now to Figs. 1 and 2 a more detailed explanation will be given of the general arrangement of the switches and control mechanism and the apparatus involved in the establishment of a desired conversational connection. Assume that the subscriber of line 100 desires to hold a conversation with a subscriber of line 217 located in the same office. Assume further that the code of the office designation of the local office is represented by a certain abbreviation which in terms of dial impulses is represented by three digits. Assume also that the numerical designation of line 217 is represented by certain other digits.

The calling subscriber upon removing his receiver from the switchhook causes the operation of line switch 101 thereby extending the line 100 to an idle trunk 104. The initiation of the call also causes the operation of the sender selector 112 to select an idler sender such as 113 and 114.

The calling subscriber now operates his dial to send the series of impulses represent-

ing the office code which are recorded on the office registers immediately followed by the impulses representing the digits of the called subscriber's line. The designations of the office and the called for subscriber's line represented by the operation of the calling dial are transferred, for example, to sender 113. Following this operation the sender connector 115 is operated for associating this sender with any one of a plurality of outgoing markers, such as 117 and 118. Following the operation of the outgoing marker and the transfer of the designations thereto, one of the district frame connectors 119 or 120 is selected for extending the connection to the district frame 108. Inasmuch as line 100 was extended to the district frame 108 upon the initiation of the call by the subscriber, the connection is now extended over line 122 to the incoming frame 200.

The next step in the establishment of the connection is to connect the sender through the sender connector 208 to an idle incoming marker for controlling the selective operation of the incoming selector switches and the completion of the desired connection. Before this operation, however, the outgoing marker has been released and is in readiness for use in the establishment of other desired connections. The designations recorded on the sender are now transferred to the selected incoming marker, for example 210, in turn causing the operation of the incoming frame connectors and the selection of the proper one of the final translators which serves the group of called lines containing the line wanted for this particular call. When the incoming marker is connected to the final translator the connector frames respond to the operation of the final translator for operating the vertical row of contacts associated with the line 217 extending to the called for subscriber. Following this operation the horizontal row of contacts in the incoming and connector frames are operated for establishing the connection through from the calling subscriber to the called subscriber and in turn releasing any mechanism which is not required during the conversational period.

An outgoing marker encounters trouble.

In the establishment of conversational connections, both the outgoing marker and the incoming marker functioned normally and, therefore, completed their control over the associated mechanism within the predetermined interval of time allotted for this purpose. The markers may, however, find it impossible to complete a connection due either to a fault within the marker itself or to a fault within the frames, frame or trunk connectors or the wiring involved in the progress of establishing a connection. In order to illustrate the manner in which the trouble indicator shown in Figs. 5, 6 and 7 operates, it will next be assumed that the outgoing marker encounters trouble at any one of several of its different stages of operation. For this purpose it may be assumed that the connection being established is one which requires the use of both a district and an office selector switch.

At the instant the outgoing marker is seized by a sender through the sender connector, relay 450 operates as described in W. W. Carpenter Patent No. 1,594,003, issued July 27, 1926, and in W. W. Carpenter application, Serial No. 703,362, filed April 1, 1924. This relay initiates the operation of the time measuring device shown in Fig. 3, which counts an interval of time sufficient for the marker, if functioning normally, to control the district and office selector switches and to release in the regular manner. The time measuring device includes a series of counting relays 300, which operate successively under the control of the constantly driven interrupter 309. These relays apply ground potential at definite intervals of time to the various conductors leading to the distributing frame 307. By strapping conductor 319 to various ones of these conductors the time interval measured may be adjusted, as desired.

As soon following the operation of relay 450 as the interrupter 309 closes, relay 302 is operated in a circuit from ground through interrupter 309, conductor 320, outer left contact of relay 450, conductor 330, right contact of relay 308, conductor 321, right contact of relay 301 and winding of relay 302 to battery. Relay 302 operates and prepares a circuit from battery, through its winding, left winding of relay 301, contact of relay 302, back contact of relay 304, back contact of relay 306, conductor 322, and thence to ground at the left front contact of relay 450. When the interrupter 309 opens its contacts, its shunt is removed and relay 301 operates in series with relay 302. On the next closure of the interrupter grounded conductor 321 is extended through the right front contact of relay 301, right back contact of relay 303, winding of relay 304 to battery. Relay 304 operates and opens the circuit for relay 302 and relay 302 releases. Relay 304 prepares a locking circuit through its own winding and left winding of relay 303, front contact of relay 304, thence to the grounded conductor 322, as previously traced. On the next opening of the interrupter, relay 301 releases and the shunt being removed, relay 303 operates in series with relay 304.

On the next closure of the interrupter grounded conductor 321 is again extended to the winding of relay 302. This relay operates and prepares the circuit for relay 301, which operates the next time the interrupter opens. On the next closure of the

interrupter the grounded conductor 321 is extended through the right front contacts of relays 301 and 303 and the right back contact of relay 305 to the winding of relay 306. The operation of relay 306 opens the holding circuit of relays 302 and 304, which thereupon release. Following this operation the interrupter opens and releases relays 301 and 303 and permits relay 305 to operate in series with relay 306. Thus, the counting relays 300 are associated in different combinations under the control of the interrupter 309. From inspection it will be found that grounded potential is placed on the various conductors leading to the distributor frame 307 at succeeding and definite intervals of time. With the distributing frame cross-connected as illustrated, relay 308 is not operated until relays 301, 303 and 305 are operated simultaneously. The circuit for relay 308 may be traced from battery, through its winding distributing frame 307, middle front contact of relays 301, 303 and 305, to the grounded conductor 322.

If the marker encounters trouble immediately the relay 450 operates, the interval of time is counted and relay 311 becomes energized in a circuit from battery through the winding of relay 311, inner right contact of relay 310, right normal contact of slow-release relay 314, conductor 323, left contact of relay 308 to grounded conductor 322. Relay 311 operates slow release 312, which in turn operates the slow-release relay 313, which thereby operates the slow-release relay 314.

When relay 313 operates, it initiates the operation of the connecting device 400 for the purpose of connecting the marker to the trouble indicator. The peg count register magnet 316 also operates the register to record the occurrence of the trouble.

In case the marker had progressed to a point where it was associated either with the district or office switches the operation of certain relays as described in pending application, Serial No. 723,140, filed June 30, 1924, referred to above, would bring about the release in the manner explained in the referred to application. The release of the marker would in turn cause the release of the operating relays of the time measuring device.

During the time the trouble indicator is associated with the marker certain of the relays 501 to 536 inclusive, are operated to record certain information regarding the apparatus involved and the point of progress which has been made up to the time when trouble was encountered. The manner of effecting the connection of the indicator relays with the marker is fully described hereinafter. Relay 501 is operated in a circuit extending through the selected marker to the

sender. Since relay 501 is individual to the particular sender illustrated, the indicator operates to record the fact that this particular sender is the one involved in the establishment of the present connection. Had another sender, such as the sender represented by another relay, been the one concerned, relay 502 in the indicator would have been operated. Relay 501 immediately locks through its right contact, over conductor 542 to ground, through key 540.

The operation of the relay 501, in addition to completing a circuit for causing the illumination of lamp 546 and the establishment of its own locking circuit, also conditions an energizing circuit for one of a series of code relays 700. These code relays function to cause the energization of selecting magnets 750 to 754 of a receiving printer in various combinations whereby a permanent record of the trouble encountered may be made. The operation of the code relays 700 is, however, dependent upon the energization of a plurality of counting relays 600, which operate successively under the control of an interrupter 713 which is driven only when the printer is recording the failures in the operation of the several switches. These relays apply ground potential at regular intervals of time to the various conductors extending through the contacts of the relays of the indicating mechanism 500 to the code relays 700. The operation of the parts just referred to will be described more in detail hereinafter.

Relay 512 is operated in a circuit from battery, through its left winding, thence through the contacts of the relay 401 individual to the particular marker that is in trouble. To this end relay 403 individual to the marker is operated in circuit from battery, through the right front contact of relay 313, right contact of relay 314, key 324, conductor 325, upper winding of 403, right contact of relay 405, lower contact of relay 404 to ground, through key 540. Relay 403 locks through its lower winding and front contact, winding of relay 404, to ground. Relay 403 operates and causes the operation of multi-contact relay 401 in a circuit traceable from battery, through the winding of relay 401, upper contact of relay 403 to ground at the upper contact of relay 404. Relay 401 operates and connects the various leads from the trouble indicator shown in Fig. 5, through to the marker.

When relay 314 operates it opens the circuit of relay 311, which relay releases, in turn releasing relay 312, which likewise releases relay 313, thereby releasing relay 314. Relays 312, 313 and 314 being slow to release, provide an appreciable interval of time for the apparatus to function. As soon as relay 313 releases, it removes battery from conductor 325, causing the release of relay 401 and

the disconnection of the trouble indicator from the marker.

Upon the release of relay 313 and while relay 314 is still operated, relay 310 is operated in a circuit from battery through its winding, left contacts of relay 314 and 313 to ground. Relay 310 immediately locks through its inner left contacts, left contact of relay 308 to conductor 322. Relay 310 opens the circuit of relay 311 to prevent a repetition of the operation. Relay 310 at its outer left contact closes a circuit to relay 317 and ground. Since relay 401 is individual to the particular marker which has encountered trouble, the operation of relay 512 records the identity of this particular marker. Had another marker been involved, such as the marker represented by relays 402, then relay 511 would have been operated. Relay 512 locks to the conductor 542.

Thus, it will be seen that the trouble indicator shown in Fig. 5 may be associated with any one of the several markers in response to the time measuring device associated with the marker, provided such marker has encountered trouble at any of the various stages of its operation, dependent upon the particular point at which the trouble occurred. The indicator will give various signs of information which are of assistance in determining the nature of the trouble and in locating the exact point in the system where it occurred. While only the important items have been taken into account in the disclosure, it will be evident that the trouble indicator may be extended to secure an indication of various other operative conditions in the marker in order to enable the tracing of the trouble more minutely to the exact point of its occurrence.

Inasmuch as the trouble indicator is common, as shown in Fig. 1, to all the outgoing markers, it may happen that at the time the particular marker finds trouble and attempts to appropriate the indicator, said indicator is already engaged in a connection with another marker. The circuits are so arranged, however, that the connection of the trouble indicator to the marker is prevented and the marker is released for service and the record of the occurrence of trouble therein is lost. The details of this particular part of the mechanism have been described quite fully in the applications referred to above.

Immediately after relay 404 is operated, a circuit is completed for relay 705 which constitutes the release relay of the receiving printer. A printer especially adapted for the purpose of recording the information relative to the occurrence of trouble is shown and described in pending application to Harry Pfannenstiehl, Serial No. 397,903, filed July 21, 1920. Inasmuch as the printer mechanism itself does not form a part of the present invention only, so much of the

mechanism as is necessary for a clear and concise understanding of the invention has been illustrated. A general reference to the Harry Pfannenstiehl application is hereby made for an understanding of the manner in which the various parts of the present system, so far as the printer mechanism and circuits are concerned operated, and the details of operation wherever such arrangements and details are hereinafter mentioned, but are not particularly illustrated or described. The circuit for relay 705 may be traced from the negative pole of the power source 704, winding of magnet 705, conductor 703, middle front contact of magnet 404, conductor 431 to the positive pole of the power supply 704. The operating winding of the driving motor 712 is directly connected in the power circuit 704, when the switch 702 is closed and under these conditions the motor is recording continuously. The motor 712 communicates power to a shaft 710, through a friction clutch 711. Mounted on the shaft 710 is a stop arm 709, which is normally in engagement with a stop 708. Operatively associated with the armature of the magnet 705 is a toggle joint 706, arranged so that upon the energization of this magnet the stop 708 will be moved out of the path of the arm 709 and since power is continuously applied to the shaft 701 from the motor 712 through friction clutch 711, the shaft 710 will rotate until the arm 709 again engages stop 708. Also mounted on the shaft 710 is a cam 713 which for each revolution opens and closes contacts 714 and 715, serving to control the energization of the counting relays 600. The interrupter 713 is so arranged with respect to contacts 714 and 715 that the former contact is closed when the printer shaft 710 is stopped. Contact 714 opens before the selecting mechanism of the printer returns to normal and contact 715 opens after this mechanism is returned to normal. In this way the proper sequence of operation takes place.

In order that the receiving printer will be in the proper position for recording numerals the following operations take place. Code relay 733 is operated upon the energization of relay 404 but before the opening of contact 714. The circuit of this relay 733 is traceable from grounded battery, winding of relay 733, conductor 760, upper armature and back contact of relay 601, contact 714, to ground at armature 407 of relay 404. Code relay 733 operates to close circuits extending to the selecting magnets 750, 751, 753, and 754 of the receiving printer. Accordingly the printer is operated for causing the operation of the shift mechanism which places the printer in a position for printing numerals. Immediately that the interrupter 713 closes contact 715, relay

601 is operated in a circuit from grounded battery 630, winding of relay 601, lower back contact of relay 602, conductor 631, contact 715, conductor 760, contact and armature 407 of relay 404 to ground. Relay 601 operates and prepares a circuit from battery through its winding and the winding of relay 602, through the lower front contact of relay 601 to ground at the armature 407 of relay 404. The energization of relay 602 is effected upon the opening of contact 715. Now relays 601 and 602 are held energized over a circuit extending from battery 630, windings of relays 601 and 602 in series, lower contact and armature of relay 601, conductor 760 to ground at the armature 407 of relay 404. When the interrupter 713 again closes contact 715, relay 603 is operated over a circuit similar to that traced for relay 601 and which in turn causes the energization of relay 604. The operation of relays 601 and 602 connects ground to conductor 632, which is connected to the extreme right hand armature of relays 511 and 512 of the indicating mechanism. These relays are allotted to the markers 117 and 118 and since but one marker is involved in the establishment of a conversational connection, but one of these relays will be operated in the case of trouble. Assume, for example, that marker 117 was involved in the connection previously described and has encountered trouble. This information will be recorded through the operation of relay 511, which conditions a circuit for code relay 725. The circuit for the code relay 725 is completed upon the energization of relays 601 and 602, which applies ground to conductor 632 upon the closure of contact 714. Code relay 725 is thereupon operated for completing energizing circuits for selecting magnets 750, 751, 752 and 754 of the receiving printer. These selecting magnets are thus operated for setting the selecting mechanism of the printer to effect the recordation of information relative to the location and nature of the trouble encountered in the marker 117. Had the marker 118 been involved in the connection and had trouble been encountered, relay 512 would have been operated and in turn code relay 726 energized. The energization of this particular code relay would have caused the energization of selecting magnets 750, 751, and 754, which would cause the setting of the selecting mechanism of the printer in a manner such as to cause the recordation of information designating the marker 118 as the one in which trouble has been encountered. On the next closure of the contacts 714 and 715 by the cam 713, relays 603 and 604 will be energized in a manner similar to that described in connection with relays 601 and 602. On the operation of these relays and the closure of contact 714 ground is connected to conductor 633, extending to the right hand armatures of relays 501, and 502. These relays designate the senders, only one of which will be operated for any given trouble. Several of the indicator relays may be operated simultaneously and circuits conditioned through their contacts to the same code relay but as previously described, ground is applied to operate the counting relays. Therefore, but one of the indicator relays of each group will be effective to cause the energization of the particular code relay for recording the information in the proper column. Assume for the purpose of illustration that the sender 1 is involved in the connection and that trouble is encountered. The conductor 633 which extends to the extreme right hand armature of relay 501 being grounded, code relay 725 is energized for causing the energization of selecting magnets 750, 751, 752 and 754 of the receiving printer. The selecting mechanism of the receiving printer will then be set in a manner to record in column 1 the numeral 1, which indicates the particular sender involved in the establishment of the connection.

Now in the case of the district frames, but one of these frames is utilized at a time, which makes it possible to connect the armatures controlling the code relays to the same conductor which is grounded through the contacts of relays 603 and 604. Upon the energization of the relay 503 which is allotted to the district frame number 1, a circuit is also completed for causing the energization of the code relay 725, which records information designating the district frame number 1 as the one involved in the establishment of the connection.

Following the recording operation and for each rotation of the shaft 710 mechanism is operated for causing the relative movement between the platen and the type carriage to bring the next column of the record in a printing position. This particular operation is fully described in the Pfannenstiehl application previously referred to and is one which is also well understood by those skilled in the art. The details of the operation have, therefore, been omitted. Simultaneously with the relative movement between the platen and type carriage, ground is successively connected through the counting relays to the various groups of indicator relays.

Immediately that the recording operation for the horizontal operate relay has taken place, which occurs upon the operation of the second set of counting relays following the set designated by the numerals 611 and 612, code relay 747 is energized. This relay upon closing its contact causes the energization of selecting magnet 751 of the receiving printer. The selecting mechanism

of the receiving printer is thus operated for causing the mechanism thereof to be restored to its unshifted position, for from this point in the recording operation letters are recorded on the record blank, it being recalled that the receiving printer upon the operation of relay 404 was placed in its shifted position. The receiving printer is so constructed that upon the operation of the un-shift mechanism the spacing mechanism is rendered ineffective for causing the relative movement between the platen and the type carriage. Therefore, no space appears between the record for the horizontal operate relay and the RTR relay. When the last letter of the office designation has been recorded, the counting relays have progressed to a point whereby the circuit of code relay 731 is completed. The operation of relay 731 causes the energization of certain ones of the selecting magnets 750 to 754 of the receiving printer so as to cause the operation of the carriage return mechanism. The carriage which may be either the platen or the type basket is moved under the action of a spring so that upon the operation of the carriage return mechanism the carriage is returned to its left hand position for the beginning of a new line of printing. The operation of the code relay 731 occurs immediately preceding the operation of code relay 744, which causes the operation of the line-feed mechanism.

After the record of the apparatus involved in a connection and the point to which the call progressed when trouble occurred, has been made code relay 744 is energized over a circuit extending to the upper back contact and armature of relay 613. The energization of this particular code relay causes the energization of the selecting magnet 753 of the receiving printer so that the mechanism of the printer is selected to cause the paper to be advanced to bring an unprinted area in a printing position.

All the operations just described are fundamentally the same as in many receiving printers in which a record is made in page form and since the receiving printer itself does not form a part of the present invention, a detailed description thereof is believed unnecessary here.

After relays 613 and 614 operate, and contact 714 is closed, relay 617 is energized over an obvious circuit, which includes relay 744 for causing an additional line feed operation. Relay 617 removes the ground from conductor 542, whereupon the indicating relays 504 to 536 which happen to be energized are deenergized. This operation causes the extinction of the associated lamps and the opening of the circuits extending to the code relays 700. Subsequently with this operation the locking circuit of relay

403 is opened. This relay, as well as relays 401, 404, and 405 release, thus restoring the system to normal in readiness for connection when another case of trouble occurs either with same marker or another marker.

These same operations may be brought out through the opening of key 540, which has its contacts connected in the locking circuit of the specified relays and which may be operated manually to cause the release of the several relays and the restoration of the system to normal.

A sample record showing the apparatus involved in a connection and the point of progress made at the time trouble was encountered is illustrated in Fig. 8. The meaning of the various designations appearing on the illustrated record will now be described.

Assume, first, that the sheet upon which the record is printed bears a number of columnar spaces, each of which has a definite and predetermined position on the sheet and which bears certain designations representing the various mechanisms employed in the establishment of a conversational connection. Assume further that the sheet is arranged in the receiving printer in a manner to bring the designated columns in their proper position so that the record of the apparatus involved in a given connection will appear in the proper column. In other words, there is a column allotted to each particular operation of the system which is apt to encounter trouble and which is arranged so that designations will appear in the proper columns, according to the point of progress of the call. An examination of this record shows that column 1 is allotted to the markers, column 2 to the senders, column 3 to the district frame, etc. and with numerical designations in these columns or other symbolic designations representing the apparatus employed in a given connection the nature and source of the trouble can be quickly ascertained. Also, the permanent record of the occurrence of trouble makes it possible to compare the records of other failures to determine whether it is the same apparatus causing the trouble.

With the thus arranged record sheet properly inserted in the receiving printer, a record of any failures occurring in the operation of the apparatus will be automatically recorded. Assumed now for the purpose of illustration that a call is desired to be completed and the office dialed is number 252 BLack, and that trouble is encountered in attempting to establish the desired connection. The record of the apparatus involved will be recorded on the sheet in the columns designating the respective mechanisms. In the record shown in Fig. 8, line 1, the circuit to operate the horizontal operate relay of

marker number 2 failed. This fact is detected by the absence of a designation in the column allotted to this particular operation or the one labeled "horizontal." From this record it is seen that the connection involved marker number 2; sender number 1, district frame number 1 and district trunk vertical number 1 and since the failure occurred in setting up the connection at the district frame no office frame was selected, no designation appears in office frame column. The X designation indicates that all the apparatus up to and including the relay designated at the top of the column has functioned properly. The last three letters B D B appearing in line number 1 represents BLAck the office code dialed in an arbitrary code. Had another marker or sender been involved in establishing the connection just described, other designations would appear in the columnar spaces allotted to these particular mechanisms. For the sake of brevity a further detailed description of the manner in which the various designations are recorded will not be described here, since the operation was fully discussed in connection with the operation of the indicating mechanism 500 and the code relays 700.

Record number 2 shows that marker number 2 failed to release when used in connection with sender number 1 on a call to 258 BLUe, whose trunks are located on a district frame. This particular trouble is indicated by the appearance of the numerals and the X's, indicating that the conversational connection has been correctly set up but the marker failed to release.

Record number 3 shows that the translator check circuit of marker number 2 in connection with sender number 1 failed to function properly. This fact is shown by the appearance of all the code letters which shows that the unselected office code relays of the marker failed to release.

Records 4 and 5 show that the marker number 1 failed to release when used in connection with sender number 1 on two successive calls to 252 BLAck, whose trunks are located on office frame number 1.

The previous description was with reference to trouble encountered in the outgoing marker of the system. Had the call progressed sufficiently far to involve an incoming marker, such as, for example, 210 of Fig. 2, and if the trouble occurred at this point in the connection trouble indicator 250 and recorder 251 would be associated in a manner similar to that described in connection with trouble in the outgoing marker. The apparatus associated with the incoming markers is identical to that common to the outgoing markers. Therefore, a similar record would be made of trouble encountered in this particular part of the system.

It will also be obvious that the trouble

indicating mechanisms may serve in connection with the markers whether the call being handled is a local one or one involving interoffice trunks. For the purpose of brevity, it is considered unnecessary to describe the operation incident to the establishment of an interoffice connection and the occurrence of trouble therein, but the functions of the marker and the associated apparatus in handling such connection are fundamentally the same.

What is claimed is:

1. In combination, a plurality of selectively operable switches for establishing various connections, means operated in accordance with failures in the operation of said switches, circuit connections controlled by said means, a page recording mechanism for recording information giving a designation of the switches involved in a connection, and means to successively associate groups of said circuit connections with the recording mechanism so that the same group will invariably cause the occurrence of the record in the same position.

2. The combination in a telephone system of switching apparatus for extending connections, a switch controlling mechanism for governing the operation of said apparatus, a recording device, and means for associating said device with said mechanism and for operating said device to produce a permanent record giving information of the different degrees of progress made by such mechanism.

3. The combination in a telephone system of switching apparatus for extending connections, a switch controlling mechanism for governing the operation of said apparatus, a control device, means for connecting said device with said mechanism if said mechanism fails to function properly, and means responsive to the operation of the control device for producing a permanent record giving information of the different degrees of progress made by such mechanism.

4. The combination in a telephone system of switching apparatus for extending connections, a switch controlling mechanism for governing the operation of said apparatus, a control device, means for connecting said device with said mechanism when an unstandard condition is encountered by said mechanism, and means responsive to the operation of the control device for recording information in different columnar spaces designating the particular mechanism involved in a connection and the point of progress of such connection.

5. A switching system comprising a plurality of selectively operative apparatus for establishing predetermined connections, switch controlling mechanisms for governing the operation of said apparatus, a con-

control device, means operated when said mechanism fails to function properly for connecting said device to said switching mechanism, said control device operating in accordance with the failures of said mechanism to proceed with the connection, and means responsive to said control device for recording in a permanent form information of the progress and the apparatus involved in the connection.

6. The combination in a telephone system of switching apparatus for extending connections, a switch controlling mechanism for governing the operation of said apparatus, a control device, means responsive to the failure of said mechanism to function properly to connect said control device to said mechanism, a recording mechanism, and means controlled by said device for effecting the operation of said recording mechanism to record information concerning the apparatus involved and the point of progress made at the time of failure of the apparatus.

7. The combination in a telephone system of selective switches for extending connections, a controlling mechanism associable with said switches for governing their operations, a device operated in accordance with various degrees of progress of the connections, switching means for associating said device with said mechanism in response to the occurrence of trouble in said mechanism, a recording printer, relay means controlled by said devices for governing the operation of said recording printer to record information concerning the operation of the switches involved and the point of progress made when the trouble was encountered, and periodically operated means for successively causing the operation of said relay means in accordance with the operation of said device.

8. The combination in a telephone system of selective switches for extending connections, a controlling mechanism associable with said switches for governing their operations, a device operated in accordance with various degrees of progress of the connections, switching means for associating said device with said mechanism upon the occurrence of trouble in said mechanism, a recording printer, normally ineffective, means responsive to said switching means for releasing said printer, a plurality of relays controlled by said device, and means associated with said printer and controlled by said relays for selectively operating said printer to record information relative to the nature and source of the trouble encountered in the operation of said switches.

9. The combination in a telephone system of selective switches for extending connections, a controlling mechanism associable with said switches for governing their operations, a device operated in accordance with various degrees of progress of the connections, switching means for associating said device with said mechanism in response to the occurrence of trouble therein, a plurality of code relays controlled by the relays of said device for setting up predetermined circuits, means for successively completing the circuits extending to said code relays as determined by the relays of said device, and means operated by said code relays for producing a permanent record of information giving the apparatus involved and the point of progress made at the time trouble was encountered.

10. The combination in a telephone system of selective switches for extending connections, a controlling mechanism associable with said switches for governing their operations, a device including a plurality of relays operated in accordance with the various degrees of progress of the connection, switching means for associating said relays with said mechanism in response to the occurrence of trouble therein, a plurality of code relays controlled by the relays of said device for setting up predetermined circuits, means for successively completing the circuits extending to said code relays as determined by the relays of said device, and means operated by said code relays for producing a permanent record of information giving the apparatus involved and the point of progress made at the time trouble was encountered.

11. The combination in a telephone system of selective switches for extending connections, a controlling mechanism associable with said switches for controlling the same, a device for producing a permanent record showing the different degrees of progress made by said mechanism comprising relay means operated in accordance with switches involved and the nature of the trouble encountered, and a receiving printer selectively operated depending upon the operation of said relays to record in different columns information giving the switches involved and the point at which the connection had progressed when trouble occurred.

12. The combination in a telephone system of selective switches for extending connections, a controlling mechanism associable with said switches for controlling the same, a device for producing a permanent record showing different degrees of progress made in the establishment of a connection by said mechanism comprising relay means operated in accordance with the switches involved and the nature of the trouble encountered, a plurality of electro-magnetic devices operated successively in accordance with said relay means, and a receiving printer rendered effective as determined by said electro-

magnetic devices for recording in different columns information from which the switches involved and the point at which the connection had progressed when trouble occurred can be quickly deduced.

13. The combination in a telephone system of selective switches for extending connections, a controlling mechanism associable with said switches for controlling the same, a device for producing a permanent record showing different degrees of progress made in the establishment of a connection by said mechanism comprising relay means operated in accordance with the switches involved and the nature of the trouble encountered, a plurality of electro-magnetic devices conditioned for operation by said relay means, successively operated means for completing the operation of said electro-magnetic devices, and a receiving printer rendered effective as determined by said electro-magnetic devices for recording in different columns information from which the switches involved and the point at which the connection had progressed when trouble occurred can be quickly deduced.

14. The combination in a telephone system of selective switches for extending connections, a controlling mechanism associable with said switches for controlling the same, a device for producing a permanent record showing different degrees of progress made in the establishment of a connection by said mechanism comprising relay means operated in accordance with the switches involved and the nature of the trouble encountered, a plurality of electro-magnetic devices conditioned for operation by said relay means, a series of counting relays for completing the operation of said electro-magnetic devices, and a receiving printer rendered effective as determined by said electro-magnetic devices for recording in different columns information from which the switches involved and the point to which the connection had progressed when trouble occurred can be quickly deduced.

15. The combination in a telephone sys-

tem of selective switches for extending connections, a controlling mechanism associable with said switches for controlling the same, a device for producing a permanent record showing the different degrees of progress made in the establishment of a connection by said mechanism comprising relay means operated in accordance with the switches involved and the nature of the trouble encountered, a plurality of electro-magnetic devices conditioned for operation by said relay means, a series of counting relays for completing the operation of said electro-magnetic devices a receiving printer rendered effective as determined by said electro-magnetic devices for recording in different columns information from which the switches involved and the point at which the connection had progressed when trouble occurred can be quickly deduced, and means effective when said counting relays have progressed to a certain point for causing the operation of said printer to bring an unprinted area in a printing position.

16. In a telephone system, a machine switching exchange including automatic switches for extending connections, a permanent record producing device common to said switches, and means to operate said device to record the nature and location of trouble in response to the failure of any of said switches to function properly.

17. In a telephone system, a machine switching exchange including automatic switches and associated apparatus for extending connections, a permanent record producing device common to said switches and apparatus, and means to operate said device to record the nature and location of trouble in response to the failure of any of said switches or apparatus to function properly.

In witness whereof, we hereunto subscribe our names this 28th day of October, A. D., 1924.

EDWARD B. CRAFT.
LEO KELLER.