Aug. 21, 1928. 1,681,510

S. B. WILLIAMS

TELEPHONE SYSTEM

Filed Oct. 22, 1926 6 Sheets-Sheet 1

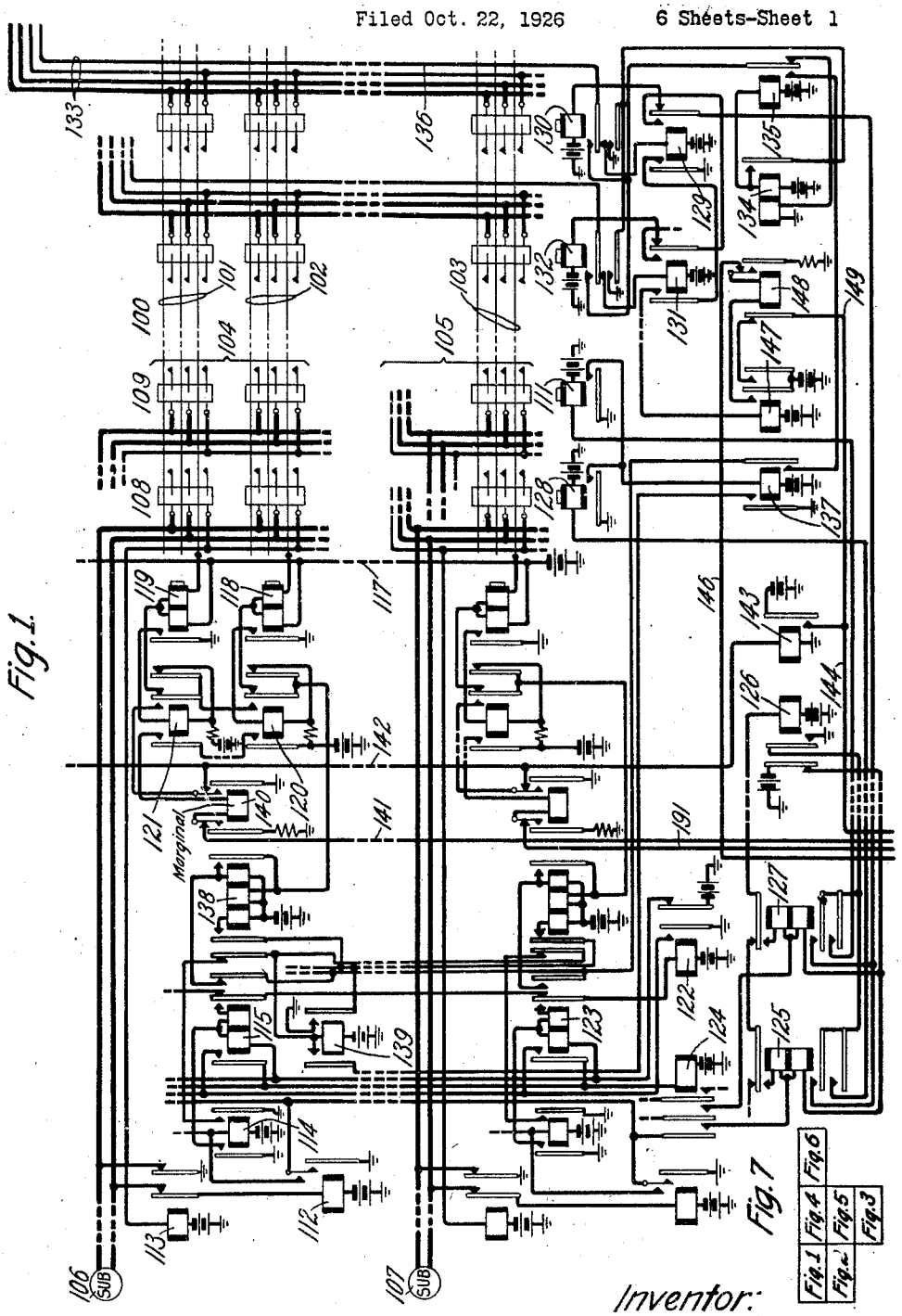


Fig. 1.

Fig. 7

Fig. 6		
Fig. 4	Fig. 5	Fig. 3
Fig. 1	Fig. 2	

Inventor:
Samuel B. Williams.
by Paul C. Palmer Att'y.

Aug. 21, 1928. 1,681,510

S. B. WILLIAMS

TELEPHONE SYSTEM

Filed Oct. 22, 1926 6 Sheets-Sheet 2

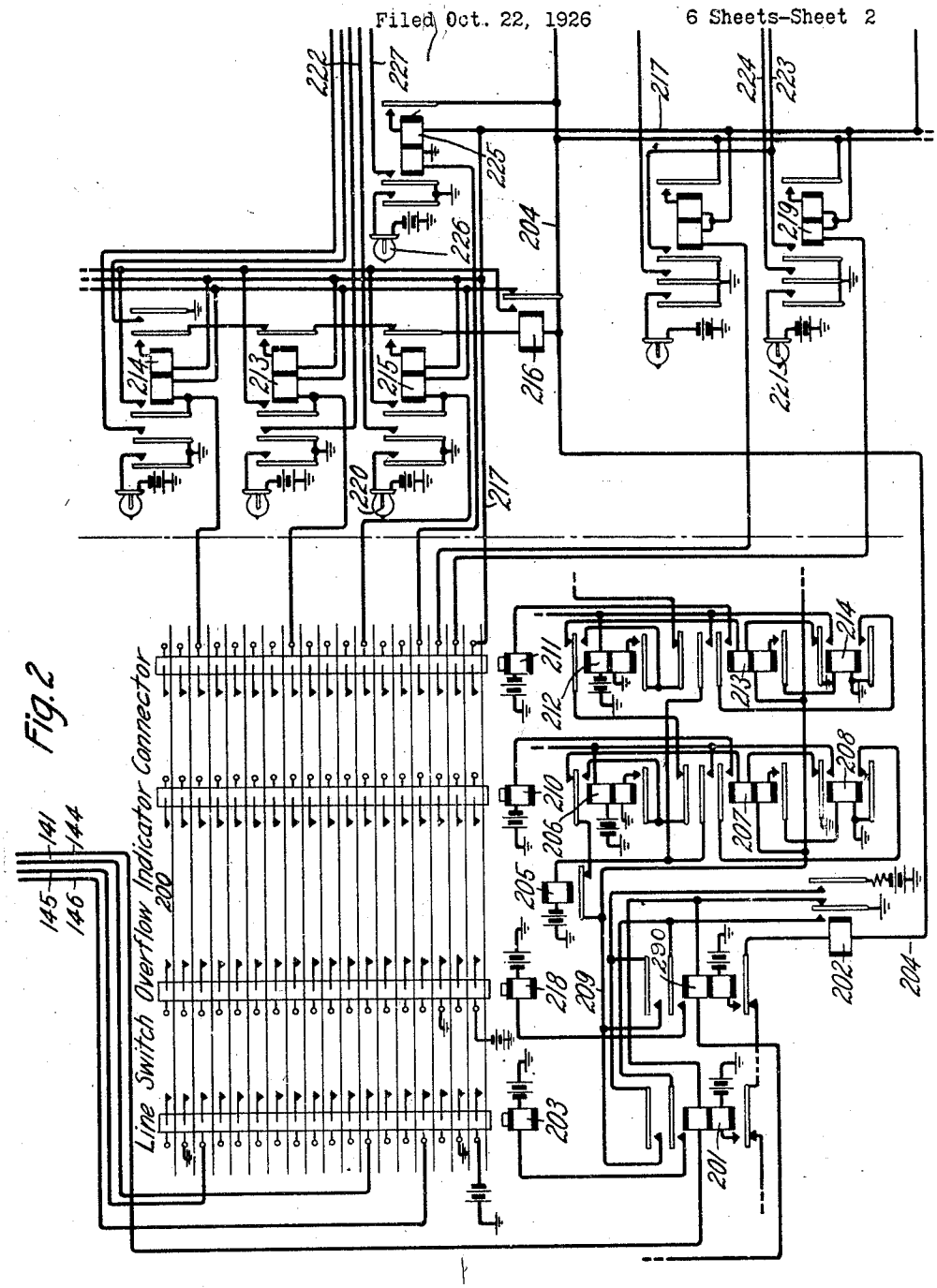


Fig. 2

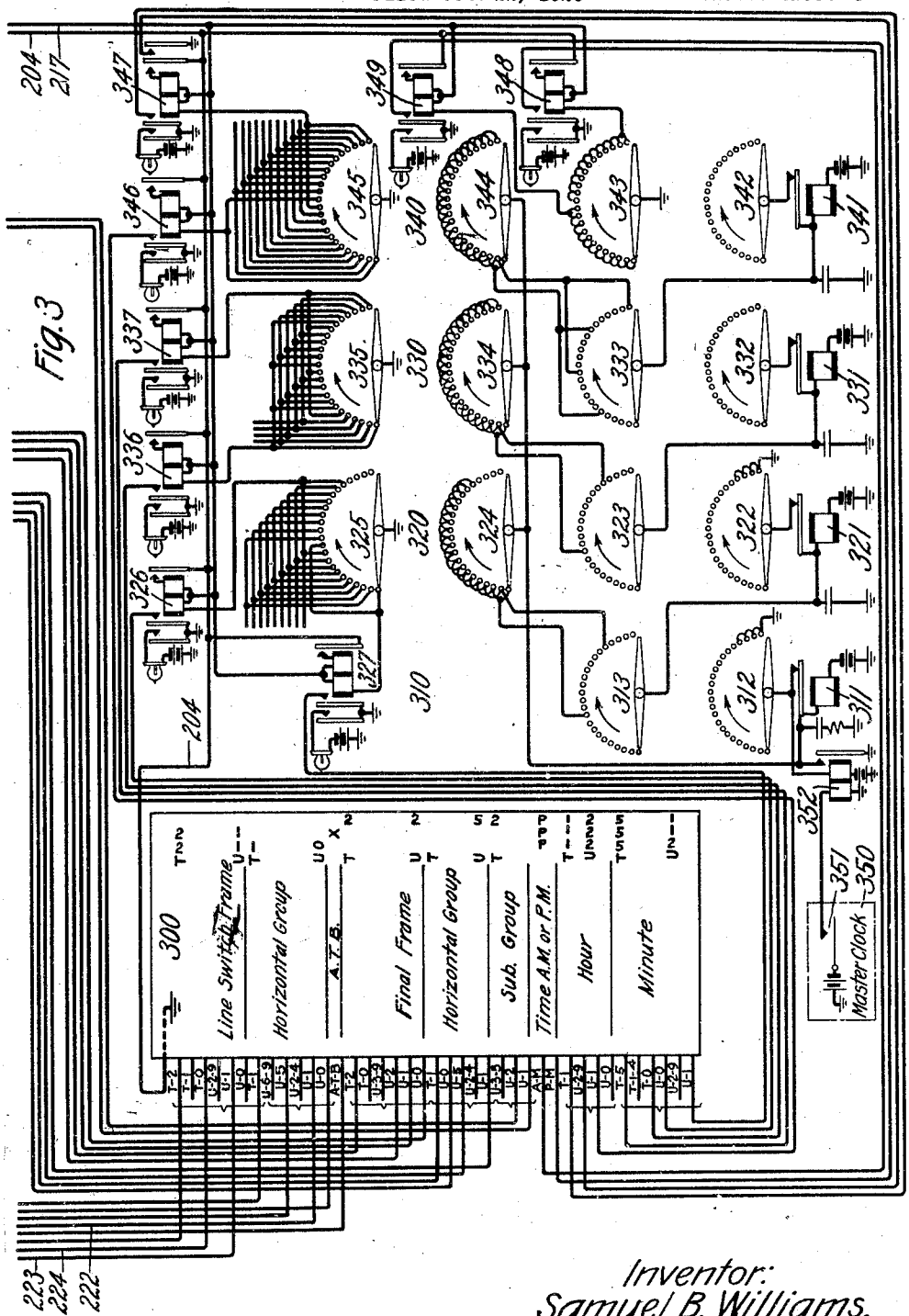
Inventor:
Samuel B. Williams.
by Jas. R. Palmer Atty.

Aug. 21, 1928. 1,681,510

S. B. WILLIAMS

TELEPHONE SYSTEM

Filed Oct. 22, 1926 6 Sheets-Sheet 3



Inventor:
Samuel B. Williams.
by Jael R. Palmer Att'y.

Aug. 21, 1928. 1,681,510

S. B. WILLIAMS

TELEPHONE SYSTEM

Filed Oct. 22, 1926 6 Sheets-Sheet 4

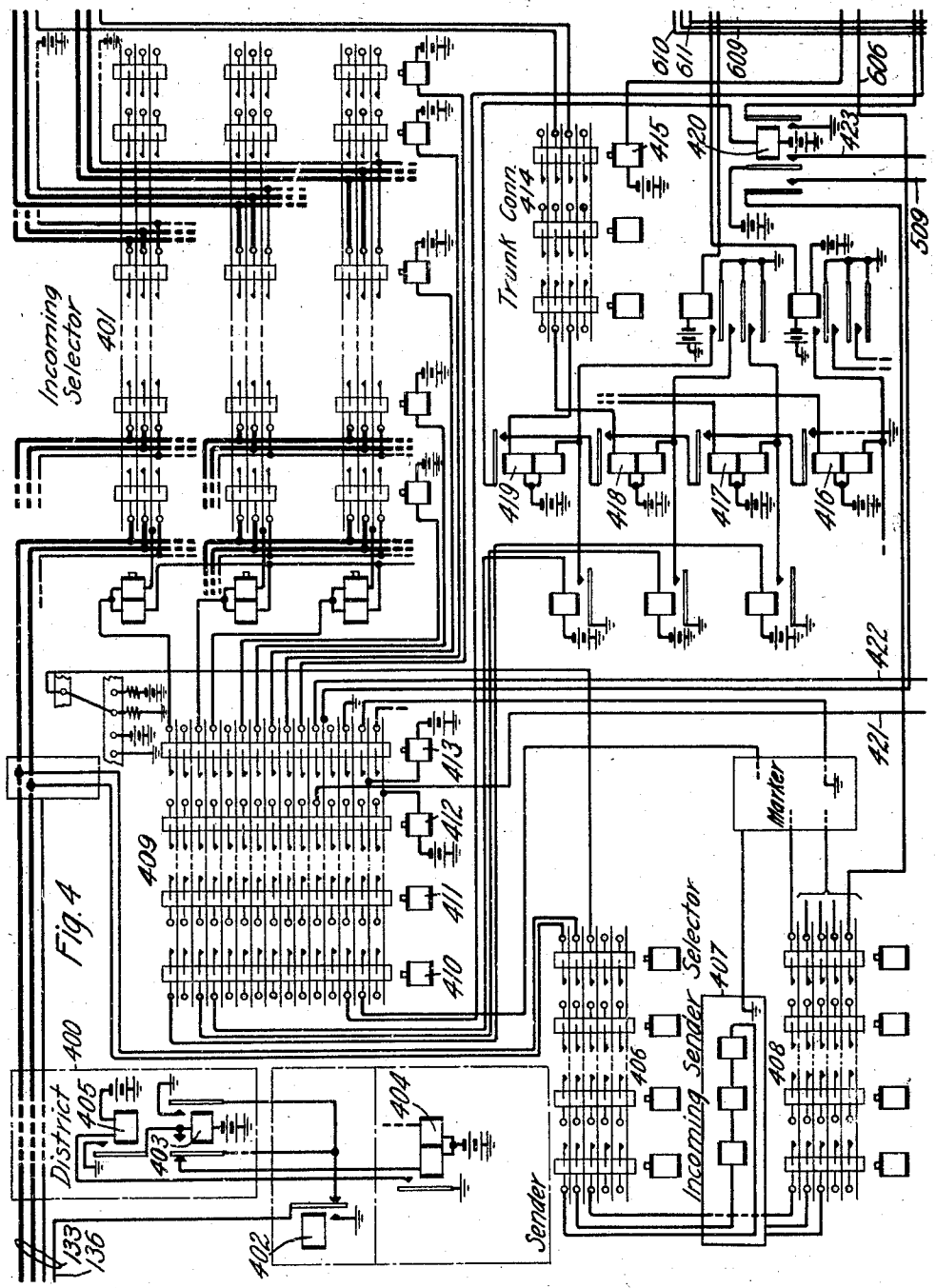


Fig. 4

Inventor:
Samuel B. Williams
by Jas. C. Lawrence, Atty.

Aug. 21, 1928. 1,681,510

S. B. WILLIAMS

TELEPHONE SYSTEM

Filed Oct. 22, 1926 6 Sheets-Sheet 5

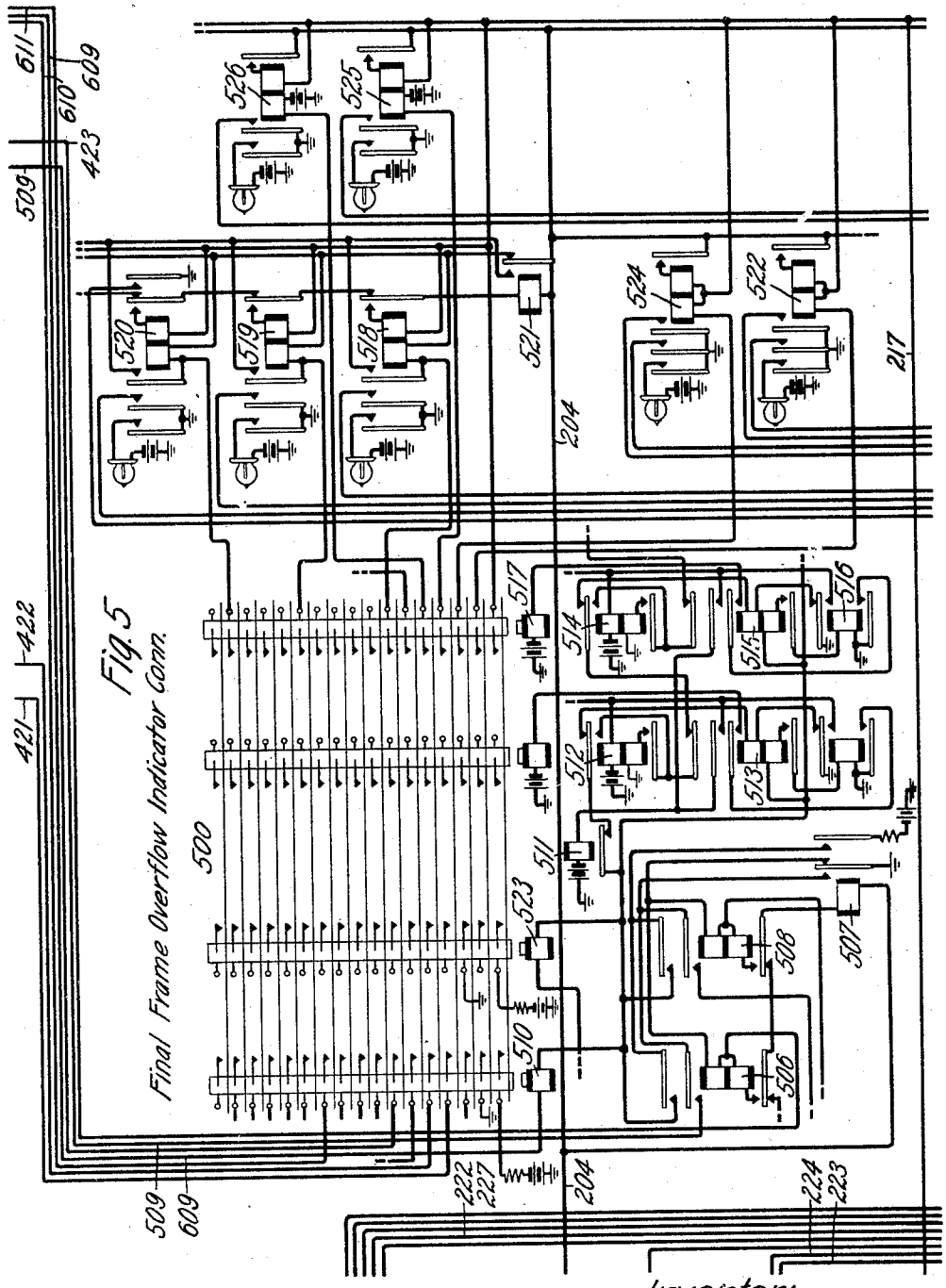


Fig. 5

Final Frame Overflow Indicator Conn.

Inventor:
Samuel B. Williams.
by Jul C.R. Palmer Att'y.

Aug. 21, 1928. 1,681,510

S. B. WILLIAMS

TELEPHONE SYSTEM

Filed Oct. 22, 1926 6 Sheets-Sheet 6

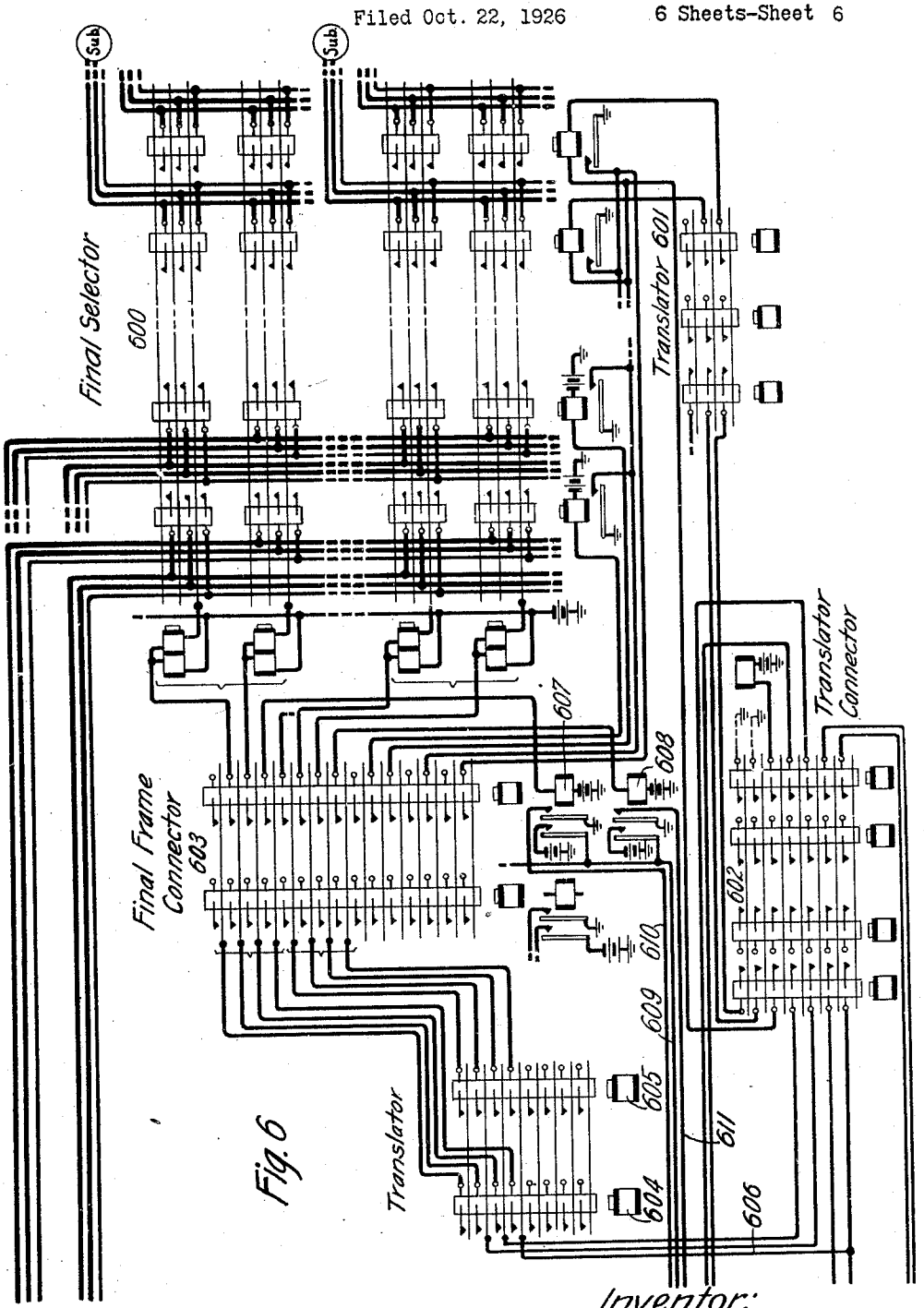


Fig. 6

Inventor:
Samuel B. Williams.
by Joel CR. Palmer Att'y.

Patented Aug. 21, 1928. 1,681,510

UNITED STATES PATENT OFFICE.

SAMUEL B. WILLIAMS, OF BROOKLYN, NEW YORK, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE SYSTEM.

Application filed October 22, 1926. Serial No. 143,352.

This invention relates to telephone systems and more particularly to recording apparatus common to a plurality of groups of switching elements for obtaining a record when all of the elements of any group are in use simultaneously.

According to one aspect of the invention, a recording means is arranged to be associated with any group whenever all the elements of that group are taken into use and operates to indicate the identity of the group and the time at which the group became busy. Moreover, duplicate indications for the same condition are prevented.

Switches and trunks, employed in telephonic connections, as well as control apparatus such as senders, translators and markers are usually arranged in large groups, in accordance with the frame or panel on which they are located and in smaller groups or subgroups determined by their use or other considerations. In general the organization is such that the elements of only one subgroup are available for use at any one time in connection with any one call. Therefore if all the elements of a particular subgroup are taken for use, no more connections may be established by the aid of that subgroup. Such a condition is usually termed an overflow condition.

In accordance with the present invention a series circuit is provided controlled by a relay individual to each member of a subgroup of elements such as line switches. When all the line switches of the subgroup are in use simultaneously, this series circuit is completed to initiate the operation of a connector switch which associates a common recorder with the subgroup. Relays in the recording mechanism are then operated and locked to register the number of the group or frame on which the busy subgroup is located, and the number of the subgroup. A printing device is provided in the recorder of the type employed in printing telegraphy, whereby the selection of a letter or figure is determined by the operation of one or more of five selecting magnets. Associated with the printer are control relays which cause the printer to print the number of the group and subgroup in the space individual to the kind of apparatus, say line switches. In addition an organization of step-by-step switches controlled by a master clock causes the operation of other control relays which cause the printer to print the time at which the overflow condition occurred.

The recorder may be arranged to operate from as many or as few groups of elements as seems desirable. For example, in the present disclosure it records overflow on line switches, final selectors and trunks outgoing from line switches. A study of the printed record will show whether groups of apparatus are overloaded and when, and will thus suggest reassignment of groups to overcome such overloading.

The scope and features of the invention will be more clearly understood from a consideration of the following description in connection with the accompanying drawings, in which,

Fig. 1 shows a line switch comprising a plurality of groups of horizontal links, together with subscriber's lines;

Fig. 2 shows the connector for associating the recorder with line switches, as well as a portion of the recorder;

Fig. 3 shows the printer schematically, and also the switches for controlling the printing of the time;

Fig. 4 shows an incoming selector together with a sender and portions of a marker;

Fig. 5 shows the connector for associating the recorder with the final selector and control apparatus;

Fig. 6 shows a final selector and other portions of the marker.

The invention has been set forth in connection with a coordinate switching system such as disclosed in the United States application of W. W. Carpenter, Serial No. 703,362, filed April 1, 1924, Patent No. 1,600,399, issued September 21, 1926. The printing mechanism may preferably be of the type disclosed in the application of H. Pfannenstiehl, Serial No. 397,903, filed July 21, 1920, Patent No. 1,623,809, issued April 5, 1927, and may be controlled in the manner disclosed in the application of L. M. Potts, Serial No. 752,080, filed November 25, 1924, Patent No. 1,620,286, issued March 8, 1927. A general reference is made to these patents for an understanding of the manner in which the various parts of the present system are arranged when the details are hereinafter mentioned but are not particularly illustrated or described.

Referring first to Fig. 1 the line switch 100 is of the coordinate type and is one of a plurality of line switches each comprising a frame on which is located a plurality of links 101, 102, 103 which are divided into groups 104, 105. The subscribers' lines 106, 107 appear in vertical rows at one end of the switch and the trunks leading to the district selector appear on the opposite side of the switch. Each line has access to the links of a single group, for example line 106 has access to links of group 104, while each trunk may be reached through any link of the frame. The lines each appear in a vertical row such as 108 and 109 and are controlled by the corresponding vertical magnets 128 and 111, to connect the line with the links in the group. Each line has a line relay 112 and a cut-off relay 113; each group of links has a start relay 114 and group relay 115, a busy relay 138 and a busy record relay 140; and each link has an operating magnet 118 and 119 and a holding relay 120, 121.

When a subscriber such as the subscriber at sub-station 106 initiates a call, the removal of the receiver from the switch hook operates line relay 112. The operation of relay 112 closes an obvious circuit for group start relay 114. Relay 114 closes a circuit from battery, back contact of relay 122, which is common to the frame, left winding of relay 115, to ground at the left front contact of relay 114. Relay 115 closes a holding circuit for itself extending from ground at the contact of relay 114 through its right winding over a chain circuit extending over the front contact of relay 115 and the back contacts of other group relays in the same frame such as relay 123 to battery through the winding of relay 122. Relay 122 operates and opens the energizing circuit of relay 115 as well as the energizing circuit for other group relays on the frame and closes a circuit from ground at its front contact over the left front contact of relay 115 to battery through the winding of relay 124. Relay 124 is provided with a plurality of armatures one for each horizontal group on the frame and in operating now extends a circuit from ground on the outer contact of relay 112, over a front contact of relay 124 through the lower winding of relay 125, which is individual to the vertical group in which line 106 appears, to battery at the left back contact of relay 126 which is common to all vertical groups. Relay 125 closes a holding circuit for itself from ground at the front contact of relay 112 through the upper winding of relay 125 and its front contact over the back contact of the other vertical group relays 127, etc., to battery through the winding of relay 126. Relay 126 operates opening the energizing circuit for all vertical group relays of frame 100, preventing the operation of any other vertical group relay until line 106 has been served. It also closes a circuit from ground at its front contact over the lower contacts of relay 125 to the winding of vertical magnet 128 and battery and also to the armature of relay 129. If the first outgoing trunk of the group is idle, this second circuit will be extended over the back contact of relay 129 to battery through the winding of trunk vertical magnet 130. If the trunk controlled by magnet 130 is busy, a circuit will have been completed for relay 129 and the circuit traced to magnet 130 will be extended over the front contact of relay 129 and the back contact of relay 131 to the winding of vertical magnet 132.

Assuming the trunk 133, controlled by magnet 130 is idle, the operation of magnets 128 and 130 will rotate the vertical bars to prepare for extension of line 106 to trunk 133. The operation of magnet 130 closes a circuit from ground through the left winding of relay 134, left back contact of relay 135, front contact of magnet 130 over conductor 136, to the corresponding district selector where it extends over back contact of relay 402, back contact of relay 403, to battery through the winding of pulsing relay 404 in the sender. Relay 404 operates and closes an obvious circuit for relay 405 which in turn closes an obvious circuit for relay 403. The operation of relay 403 connects ground to conductor 136 in place of battery. Relay 134 also operates in circuit as first traced and closes a locking circuit for itself from battery through its right winding and right front contact to ground at the front contact of magnet 130. It also closes an obvious circuit for relay 135. Relay 135 in operating disconnects conductor 136 from the winding of relay 134 and extends it to the front contact of relay 137.

Magnet 128 in operating closes an obvious circuit for relay 137 so that a circuit is now extended from conductor 136 as above traced over the front contact of relay 137, outer right front contact of relay 115, right winding of relay 138 to battery. As soon as ground is connected to conductor 136 from the district selector, relay 138 operates.

When relay 114 operated as previously described, it closed a circuit from ground over its right front contact, left back contact of relay 138 to battery through the winding of lock-out relay 139. When relay 137 operated it closed a locking circuit for relay 139. Therefore, the operation of relay 138, opening the energizing circuit for relay 139, does not cause that relay to release. Relay 139 provides a locking ground for relay 138 over the left front contact and left winding of relay 138. The operation of relay 138 closes a circuit from battery through the left winding of horizontal magnet 118, inner back contact of relay 120, front contact of relay 138, and thence over the energizing circuit for relay 138 to ground on conductor 136. Magnet 118 operates to cause the engagement of

the contacts of line 106 and trunk 133 with the horizontal conductors of link 102 thus extending line 106 to the district selector. The operation of link 102 extends a circuit from battery through the winding of relay 113 over the sleeve conductor of link 102 and trunk 133 to ground in the district selector. Relay 113 operates and opens the circuit of relay 112, in turn releasing relays 114, 115, 122, 124, 125, 126, magnets 128 and 130, and relays 134 and 135. The release of magnet 130 extends grounded conductor 136 to the winding of relay 129 and battery. This relay operates and extends the vertical magnet operating circuit over the front contact of relay 139 as previously described to the winding of magnet 132 individual to the next district selector. The release of magnet 128 opens the circuit of relay 137 and that relay releases in turn releasing relays 139 and 138. The horizontal magnet 118 in operating, closed a circuit from ground at its front contact, through the winding of relay 120 to battery, but relay 120 was not able to operate since it was shunted by the energizing circuit of magnet 118. When the energizing circuit of magnet 118 is opened by the release of relay 138, relay 120 operates further opening the energizing circuit of magnet 118. However, magnet 118 is held operated in a circuit from battery through both windings over the sleeve conductor of link 102 and trunk 133 to ground at the district selector.

If link 102 had been in use with another call at the time the call was initiated at substation 106, the operated condition of relay 120 would have extended the horizontal magnet operating circuit over its inner right front contact and the inner right back contact of a subsequent relay of the group to the winding of the corresponding horizontal magnet to employ that link for the extension of the connection.

If all of the horizontal links except link 101 had been in use when the call was initiated, the operation of relay 138 would have extended the horizontal magnet operating circuit over the front contacts of all such relays as relay 120 over the back contact of relay 121 to the winding of magnet 119. The operation of magnet 119 would in turn have caused the operation of relay 121. With relay 121 operated a chain circuit is completed over the left front contacts of all the horizontal relays such as relays 120 and 121 through the winding and left normal contact of relay 140 to conductor 141. A second chain circuit would be extended from battery through the middle winding of relay 138 over the inner right front contacts of the horizontal relays and the back contact of relay 140 individual to the horizontal group 104 to conductor 142 and the winding of relay 143 to ground. Relay 143 in operating closes a circuit from battery over its front contact, conductor 144, upper winding of relay 201 at the overflow indicator connector, back contact of relay 202, to ground. Relay 201 locks in a circuit from battery through its lower winding and lower front contact, back contacts of other relays such as relays 290, through winding of relay 202 to conductor 204 which is grounded in the printer shown diagrammatically in Fig. 3. Relay 202 operates disconnecting ground from the windings of relays 201, 290, etc., and closing a circuit from ground at its inner right front contact over the inner upper contact of relay 201 to the winding of multi-contact relay 203. The operation of this relay extends conductors 141, 144, 145, 146 to the grid wires of the overflow connector 200. At the same time, relay 202 closes a circuit from battery over its outer right contact, uppermost contact of relay 201, back contact of relay 205 and thence, assuming that the first indicator is busy, over the upper front contact of relay 206, upper back contact of relay 207, upper back contact of relay 212, upper winding of relay 213, to ground at the upper back contact of relay 214. Relay 213 operates and extends a circuit from battery over conductor 209, lower winding and front contact of relay 213 to ground through winding of relay 214. Relay 214 in operating closes a circuit from ground over its lower front contact, inner upper front contact of relay 213 to the winding of multi-contact relay 211. Relay 211 extends the grid wires of overflow connector 200 to the recording relays associated with the second overflow indicator.

Relay 214 in operating also closes a circuit from battery through the upper winding of relay 212, to ground at the upper front contact of relay 214, and in parallel therewith over the middle upper contact of relay 213, winding of relay 205. Relay 205 operates opening the energizing circuit of relay 213 but relay 213 is held operated as above described.

With both relays 203 and 211 operated, the chain circuit previously traced to conductor 141 is extended over contacts of relays 203 and 211 to the winding of relay 215, back contact of relay 216, to grounded conductor 204. Relay 215 in operating closes a locking circuit for itself from grounded conductor 204 through the winding of relay 216, right front contact and winding of relay 215, conductor 217, contacts of relays 211 and 203 to battery. Relay 216 operates in this circuit extending ground from conductor 204 over the front contact of relay 216, left front contact of relay 215, contacts of relays 211 and 203, conductor 141, to the winding of relay 140. Relay 140 is marginal and did not operate in series with relay 215 but now operates and locks over the chain circuit to ground at its left front contact. It also closes ground over its right front contact and the second chain circuit to the middle winding of relay

138 and battery holding relay 138 operated until the overflow condition indicated by the closure of the chain circuit ceases, so that each overflow condition will be recorded but once.

From a consideration of Fig. 1, it will be seen that relay 140 and the chain circuit closed thereover is individual to horizontal group 104. Therefore, the operation of relay 215 serves to identify group 104 as that on which the overflow condition arose. Relay 143 is individual to the line switch frame 100 and in turn operates relay 201 which is also individual to line switch 100. The frame is therefore identified by means of relay 219, the circuit for which may be traced from battery over the contacts of relays 203 and 211, conductor 217, left winding of relay 219, to ground at the contacts of relays 211 and 203. The operation of any frame relay such as relay 203 or 218 connects battery to conductor 217. The grounded contact of each frame relay is connected only with the indicator relay corresponding to the frame to be identified. Relay 219 locks from battery on conductor 217 through its right winding and right front contact to grounded conductor 204. Relays 215 and 219 light lamps 220 and 221 respectively to give a visual signal of the frame and group number. Relay 215 also connects ground to conductor 222 which completes a circuit for the No. 1 units relay among those identifying the horizontal group to the printer 300. In turn relay 219 connects ground to conductors 223 and 224. Conductor 224 extends to the winding of the No. 0 tens relay and conductor 223 extends to the No. 1 units relay among those identifying line switch frames.

As above indicated, the printer 300 may be of the type disclosed in the Pfannenstiehl patent and may be controlled in the manner shown in the Potts patent. There will be a group of relays for each indication desired, that is, a group for the line switch frame number, a group for horizontal group identification, etc. If there are more than 10 units of any kind to be identified, there will be a series of units relays and a series of tens relays for each indication. Each relay will have contacts to control the code setting of the printer magnets and means will be provided for progressively associating the relays of each group with the printer and for advancing the control from group to group. Only those groups in which relays have been operated will be effective. When the complete indication has been printed, ground will be removed from conductor 204 and all of the relays of the overflow indicator and connector will be released.

In addition to indicating the group of apparatus involved, it is also desirable to know the time of day at which the condition arose and for that purpose the timing arrangement shown in Fig. 3 has been provided. This timing arrangement is under the control of a master clock 350 having a contact 351 which closes at 6-second intervals. When this contact is closed, an obvious circuit is completed through the left winding of relay 352 and that relay operates. Relay 352 closes a holding circuit for itself from battery through the right winding of relay 352, back contact of magnet 311 to ground at the front contact of relay 352. This ground also completes a circuit through the winding of magnet 311. This magnet operates opening the holding circuit of relay 352 and permitting that relay to release, in turn releasing magnet 311 and stepping switch 310 to its first terminal. At the end of 6 seconds the circuit of relay 352 is again closed and switch 310 stepped to its second terminal. When contact 352 closes, stepping switch 310 from its tenth terminal which will occur at the end of 60 seconds, the operation of relay 352 closes a circuit from ground over its front contact, brush 324 of switch 320 and its first terminal, tenth terminal of brush 313, winding of magnet 321 to battery. The release of relay 352 permits magnets 311 and 321 to step their brushes simultaneously to the next terminals. When switch 310 reaches its twentieth terminal, a circuit is again closed over brush 324 and its second terminal, twentieth terminal of brush 313 to winding of magnet 321, and switches 310 and 320 are simultaneously stepped to their twenty-first and third terminals respectively. An obvious self-interrupting circuit is now closed for magnet 311 to bring switch 310 back to terminal 1. When relay 352 is operated to step switch 321 to its tenth terminal, a circuit is closed from ground over the front contact of relay 352, brush 334 of switch 330 and its first terminal, tenth terminal of brush 323 to the winding of magnet 331. When relay 352 releases, magnet 331 steps switch 330 to its second terminal. When switch 320 is stepped to its twentieth terminal, a circuit is closed for magnet 331 over the second terminal of brush 334 and the twentieth terminal of brush 323. Switch 320 is then returned to its first terminal by a self-interrupting circuit for magnet 321. When the circuit is closed for stepping switch 331 to its sixth terminal, a circuit is closed from battery through the winding of magnet 341 of switch 340, brush 333 and its sixth terminal, brush 344 and its first terminal to ground at the front contact of relay 352. When switch 331 is stepped to its twelfth terminal, the circuit of magnet 341 extends over the twelfth terminal of brush 333 and the second terminal of brush 344. From a consideration of the above description and the drawing it will be apparent that switch 310 makes one step every six seconds, switch 320 makes one step per minute, switch 330 every ten minutes, and switch 340 every hour. These switches are simple step-by-step switches having 24

terminals. Switch 320 in each position prepares a circuit for one of relays such as relays 326, 327 etc., which correspond to the units digit of the minute. Switch 330 prepares a circuit for one of the relays 336, 337 etc., corresponding to the tens digit of the minute. Switch 340 prepares a circuit for relays 346, 347 etc., corresponding to the hour. It likewise prepares a circuit from ground through brush 343 to relay 348 or relay 349 depending upon whether the hour is a morning hour or an afternoon hour.

When the overflow indicator connector 200 operates, connecting battery to conductor 217, the circuits prepared by the timing mechanism at that moment are completed and the corresponding relays operate to light lamps giving a visual indication of the time and to operate relays in the printer control mechanism to print the hour, minute and whether before or after noon.

If instead of the horizontal links being busy all the trunks outgoing to the district selector had been busy, relays 129, 131, etc., corresponding to the trunks would have been operated as above described and a chain circuit closed from ground over the left front contact of relay 129, left front contact of relay 131 and other trunk relays to the winding of relay 147 and battery. Relay 147 connects battery over its outer front contact and the back contact of relay 148 to conductor 149 and thus to conductor 144 operating relay 201 in the same manner as did relay 143. The operation of relay 201 causes the connection of the conductors 141, 144, 145 and 146 to the overflow indicator in the same manner as before. Relay 147 also closes a circuit from battery over its inner front contact, winding and normal contact of relay 148, to conductor 146. With relays 203 and 211 operated, this circuit will be extended over the contacts of these relays to the left winding of "all trunks busy" relay 225 and ground. Relay 225 locks in a circuit from battery on conductor 217, through its right winding and right front contact to ground on conductor 204. The operation of relay 225 lights all-trunks-busy lamp 226 and grounds conductor 227 to operate the all-trunks-busy relay in the printer control circuit. As before, relay 201 operates indicator relay 219 to identify the frame.

Referring now to Figs. 4, 5 and 6, a skeletonized showing has been made of an incoming selector and a final selector together with a part of the control apparatus. Reference is made to the above identified patent of W. W. Carpenter for a complete showing and description of the means for extending a connection from a district selector to a called subscriber's line. Briefly, when a connection is extended to an incoming selector such as 401, the tip and ring conductors are extended to a sender selector switch such as 406 and a sender 407. Here a registration is made of the number of the wanted line and the sender is connected with a marker by means of a connector switch 408. In accordance with the registration set up on the sender 407, a particular translator 601 is selected and associated with the marker by means of translator connector 602. The translator 601 serves to identify the vertical group in which the called subscriber's line appears.

It is then necessary to find a connecting unit including a horizontal link in both the incoming selector and the final selector and a trunk connecting these links all of which are idle before the connection can be established. The horizontal operating magnets of the incoming selector are associated with the marker by means of incoming selector frame connector 409. The multi-contact relays 410 and 411 of connector 409 are individual to the marker taken for use, while the relays 412 and 413 are individual to the incoming frame and one of them is operated by means of a circuit extending through the marker and controlled by an identifying potential on the incoming frame itself.

The trunks extending between the incoming selector and the final selector are connected with the marker for test by means of trunk connector 414, and a trunk group connecting a particular incoming selector with a particular final selector appears in the contacts of a particular relay such as relay 415 in the trunk connector. The identity of this relay is determined by the joint action of the incoming frame connector 409 and the translator connector 602.

The horizontal operating magnets for the horizontal group, in which the called subscriber's line is located on the final selector, are connected with the marker by means of final frame connector 603. The frame connector serves to extend the circuits of all horizontal magnets and discrimination between the groups is brought about by multi-contact relays 604, 605, etc., which form a part of the translator.

In order to extend a connection there must be an idle path comprising an incoming link, a trunk and a final link. Since each trunk has access to only one link in each of the incoming selector groups and final selector groups, a three-way test is performed to select the path to be used in completing the connection. For this purpose a circuit is extended from the sleeve grid wire of each link in the incoming selector group through the winding of the corresponding operating magnet, through the incoming frame connector 409 to battery through the winding of a relay in the marker. Similar circuits are closed from sleeve grid wires of the final selector group through the winding of the operating magnets, through the final frame connector 603 and the translator relays 604 or 605 depending on the group, through the translator con-

nector 602, to battery through the windings of another set of relays. In addition, circuits are closed from the sleeve conductors of the trunks, through the trunk connector to battery through the windings of a third set of relays. A busy link or trunk is characterized by ground at its sleeve wire or conductor and the corresponding relay in the marker is operated.

The test relays for the trunks are provided with secondary operating circuits through the front contacts of the test relays of the links. Since there are 35 trunks to a group connecting an incoming selector with a final selector and only 14 links in the final selector, each final link is accessible from three trunks and therefore each final link test relay is arranged to operate three trunk test relays. Therefore it is possible that there may be no idle connecting path between the incoming selector and particular final selector although there may be idle links in either selector and idle trunks provided that these do not have access to one another. If this is the case, all of the trunk test relays 416, 417, 418 and 419, etc., will be operated and a chain circuit will be closed from ground over the front contacts of these relays through the winding of relay 420 to battery.

Relay 420 in operating closes a circuit from battery at its inner right front contact to conductor 423, upper winding of relay 506 of the final frame overflow connector, to ground at the back contact of relay 507. Relay 506 operates and locks in a circuit from battery on conductor 423, lower winding and front contact of relay 506, thence over the back contacts of relays such as relays 508 corresponding to other final frames through the winding of relay 507 to grounded conductor 204. The operation of relay 507 closes a circuit from ground at its inner front contact, inner upper front contact of relay 506, conductor 509, front contact of relay 420, marker connector 408 to the sender to indicate to the sender that it has been impossible to complete the connection and to cause the sender to signal the calling subscriber and to release the apparatus. Relay 507 also closes a circuit from battery over its outer front contact, upper front contact of relay 506, winding of multi-contact relay 510, conductor 609 to ground at the outer left front contact of relays 607, 608 or other relays corresponding to the group in which the called subscriber's line was located. Relay 510 operates and extends the indicating conductors to the grid wires of the incoming connector 500. A circuit is also closed in parallel with relay 510 extending over the back contact of relay 511, upper front contact of relay 512, assuming that the corresponding indicator is busy, upper back contact of relay 513, upper back contact of relay 514, upper winding of relay 515, upper back contact of relay 516 to ground. The operation of relays 515, 516, 514, and 511 is the same as described in connection with the line finder overflow indicator connector and results in the operation of multi-contact relay 517, to extend the grid conductors through to the indicator relays.

Although it is possible to record all the frames, groups, etc., over which a connection was attempted, in practice all of the incoming links could not be busy since there are more links than there are incoming trunks of the incoming circuit. Each group of trunks outgoing from an incoming selector terminates on a particular final selector and therefore may usually be identified by the final frame. Where it is necessary to employ more than one group of trunks for a particular group of final lines, more than one incoming frame will be used and a group of trunks from each frame will be terminated on the final frame having access to the particular group of subscribers. It is therefore desirable to know the number of the final frame and the horizontal group of that frame where the overflow occurred together with the number of the trunk group, provided more than one group of trunks is used. To this end a circuit is provided from ground at the right front contact of relay 420 through the translator connector to conductor 606. Conductor 606 extends to a part of the translator and likewise to incoming frame connector 409. The circuit of conductor 606 extends as previously described to relays 607, 608, etc., the circuit for relay 607 being completed to contacts of relay 604 individual to a particular horizontal group and relay 608 to contacts of relay 605 which likewise identifies a particular horizontal group. Relays 607 and 608 connect battery to conductors 610 and 611 respectively, which completes circuits extending through indicator connector 500 to the left winding of relays such as 518, 519 and 520, back contact of relay 521 to grounded conductor 204. These relays identify the horizontal group on which the overflow occurred.

Since relays 607 and 608 are both individual to the same final selector and the operation of either one causes the operation of relay 510, the circuit completed from ground over the contacts of relays 510 and 517 through the left winding of relay 522 to battery over contacts of relays 517 and 510 serves to identify the final frame on which the group is located. Another final frame would cause the operation of relay 523 which would in turn cause the operation of relay 524 to indicate the identity of that other final frame. In order to identify the group of trunks among a plurality of groups of trunks having access to a given final selector, a circuit is likewise extended from grounded conductor 606 through the incoming frame connector to conductors 421 or 422 etc., according to

which frame has been employed. Connecting ground to conductors 421 or 422 serves to operate one of relays 525, 526, etc. to identify the sub-group.

As in the case of the line finder indication, any of these indicating relays upon operating locks and displays a lamp to give a visual indication of the apparatus involved. It likewise extends circuits to the control circuit of the printer 300 to operate corresponding relays to identify the final frame and horizontal group on that frame and the sub-group of trunks. Relay 510 in opreating also connects battery to conductor 217 to complete the circuit of the time indicator relays.

At the right of the rectangle representing the printer are shown three typical records. The first record shows that no connecting paths were available to reach a subscriber's line appearing in group 5 on final frame 22, over the trunks of sub-group 2, at 12:51 p. m. The second record shows that all the trunks outgoing from line switch frame 21 were busy at 12:52 p. m. The third record shows that all the links of group 10 on line switch frame 21 were busy at 12:51 p. m.

It will be apparent from the foregoing description that by means of the apparatus of the present disclosure, a printed record may be obtained of every occurrence of a failure to complete a connection because all of the apparatus available was busy, whereby it is possible to study traffic conditions and to determine remedies at leisure.

What is claimed is:

1. In a telephone system, a plurality of connective elements divided into groups, means to operate said elements, means common to said groups of elements for recording the simultaneous operation of all elements of a group, and means for selectively associating the recording means with said groups.

2. In a telephone exchange system, a plurality of connective elements divided into groups, means for operating said connective elements, a printer for printing a record identifying said groups, and means effective in response to the simultaneous busy condition of the elements of any group to associate the printer with that group.

3. In a telephone exchange system, a plurality of connective elements divided into groups and sub-groups, means for operating said connective elements, a printer device common to said connective elements, and means to operate said printer to record the simultaneous operation of all of the elements of a sub-group in any group and to control said printer to record the identity of said group and sub-group.

4. In a telephone exchange system, a plurality of connective elements divided into groups and sub-groups, means to operate said elements, means common to said groups of connective elements for recording the failure to establish a connection by means of any sub-group in any group of elements because of the operated condition of all the elements of said sub-group, means to identify said group and sub-group, and means to record the time at which the failure occurs.

5. In a telephone exchange system, a plurality of connective elements having different functions, said elements being divided into groups and sub-groups, means for operating said connective elements, a printing mechanism common to said connective elements, and means to operate said mechanism to record the simultaneous operation of the elements of any sub-group in any group and to cause said printer to record the function, group and sub-group of said connective elements.

6. In a telephone exchange system, a plurality of connective elements divided into groups, means for operating said connective elements, a printer device common to said connective elements, means to operate said device to record the simultaneous operation of all the elements of any group and to control said printer to record the identity of the group, a timing device, and means controlled by said timing device to cause said printer to record the time of day at which said simultaneous operation occurred.

7. In a telephone exchange system, a plurality of connective elements having different functions, said elements being divided into groups and sub-groups, means for operating said connective elements, a printing mechanism common to said connective elements, means to operate said mechanism to record the simultaneous operation of the elements of any sub-group in any group and to cause said printer to record the function, group and sub-group of said connective elements, a timing device, and means controlled by said timing device to cause said printer to record the time at which said simultaneous operation occurred.

8. In a telephone exchange system, a plurality of line switches, each comprising a plurality of groups of switching elements, means for operating each switching element, a printing mechanism, means responsive to the simultaneous operation of all of said switching elements in any group to associate said printer with the line switch in which said group is located, and means to operate said printer to record the identity of said switch and said group.

9. In a telephone exchange system, line switches, final selectors, each comprising a plurality of groups of switching elements, a timing device, a printer mechanism common to said line switches and said final selectors, means responsive to the simultaneous operation of all of the switching elements of a group in either said line switches or said final selectors to cause the association of said printer with the line switch or final selector upon

which said group appears, means to cause said printer to identify said group and to make a printed record thereof, and means controlled by said timing device to cause said printer to record the time.

10. In a telephone exchange system, a plurality of connective elements divided into groups and sub-groups, means to operate said elements, means common to said groups of elements to record the simultaneous operation of the elements of any sub-group of any group and to record the identity of said group and sub-group, and means responsive to the operation of said recording means to prevent duplicate recording of any one simultaneous operation.

11. In a telephone exchange system, a plurality of connective elements divided into groups and sub-groups, means to operate said elements, a recording device common to said groups of connective elements, means individual to each sub-group in each group responsive to the simultaneous operation of all elements in said sub-group to initiate the operation of said recording means to record the identity of the group and sub-group, and means responsive to the operation of said recording means to prevent the reoperation of said individual means, until one of said connective elements has released.

12. In a telephone exchange system, a plurality of connective elements divided into groups and sub-groups, means to operate said connective elements, a chain circuit closed by said operating means when all of said elements are simultaneously operated, a printing device common to said elements, means individual to each sub-group controlled by said chain circuits to initiate the operation of said printer and to control said printer to record the identity of the group and sub-group, and means responsive to the operation of said recording means to prevent the reoperation of said individual means as long as said chain circuits are maintained.

In witness whereof, I hereunto subscribe my name this 18th day of October, A. D. 1926.

SAMUEL B. WILLIAMS.