

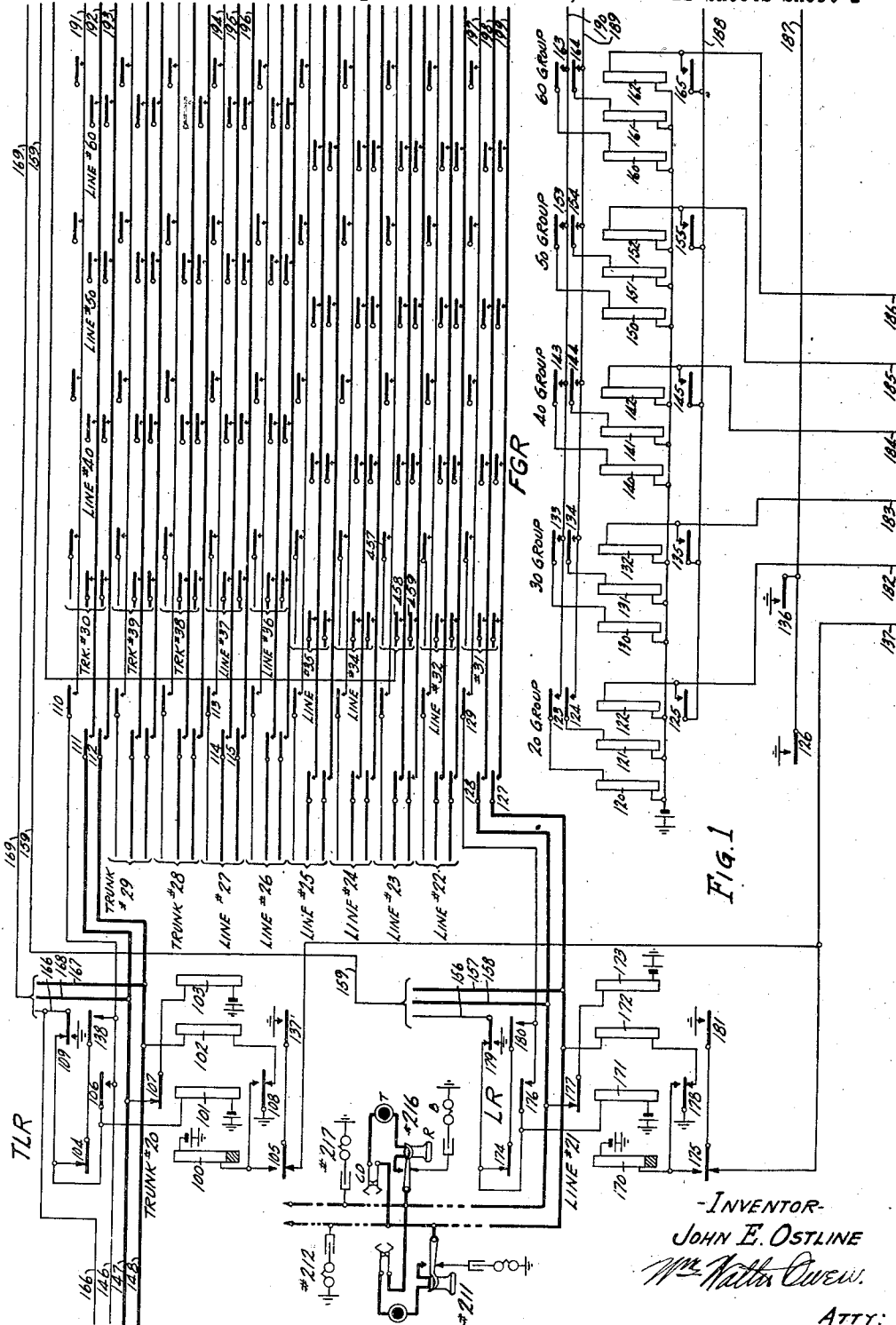
Dec. 3, 1935.

J. E. OSTLINE

2,023,239

AUTOMATIC TELEPHONE SYSTEM

Original Filed Dec. 14, 1933 11 Sheets-Sheet 1



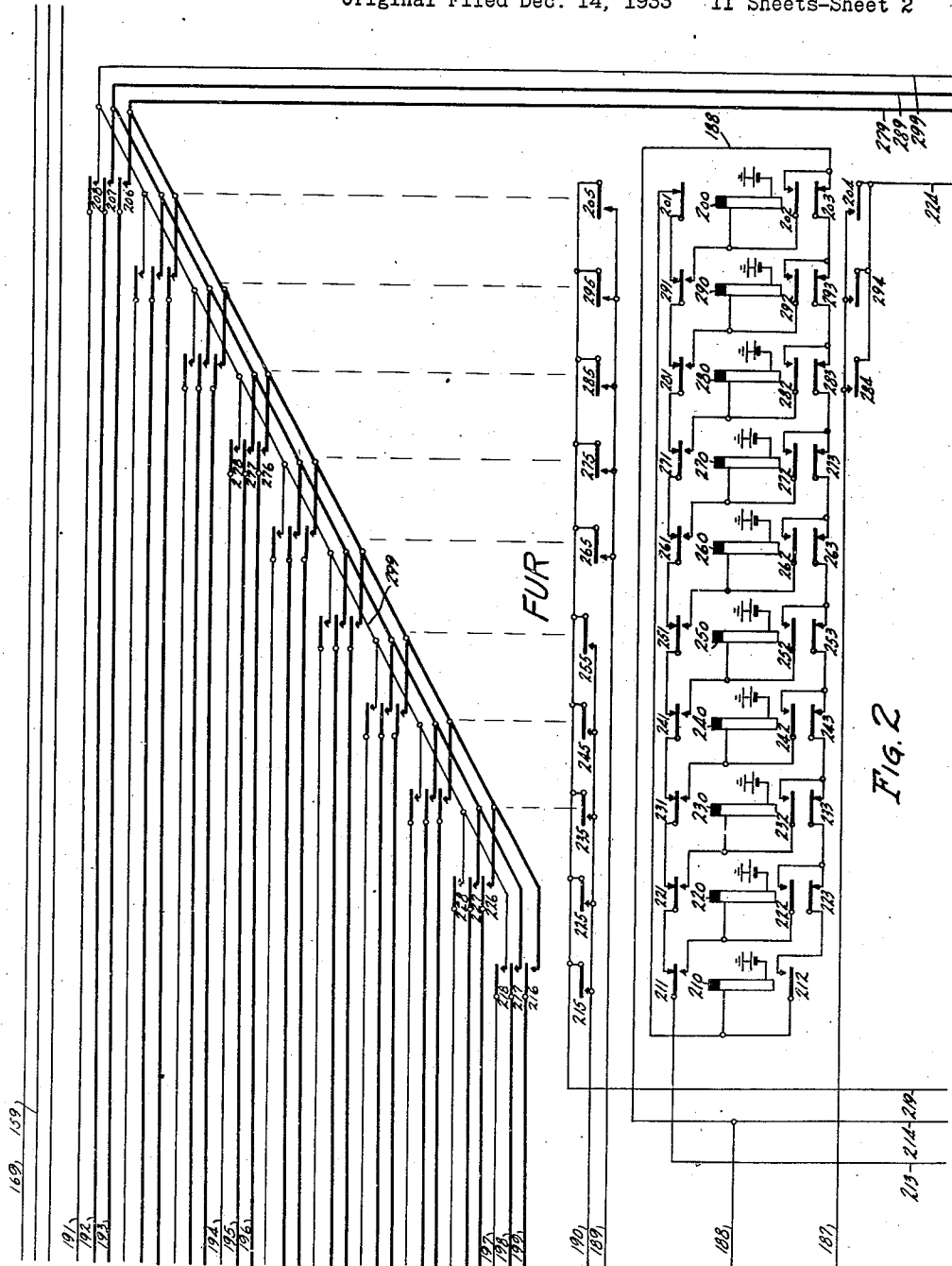
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AUTOMATIC TELEPHONE SYSTEM

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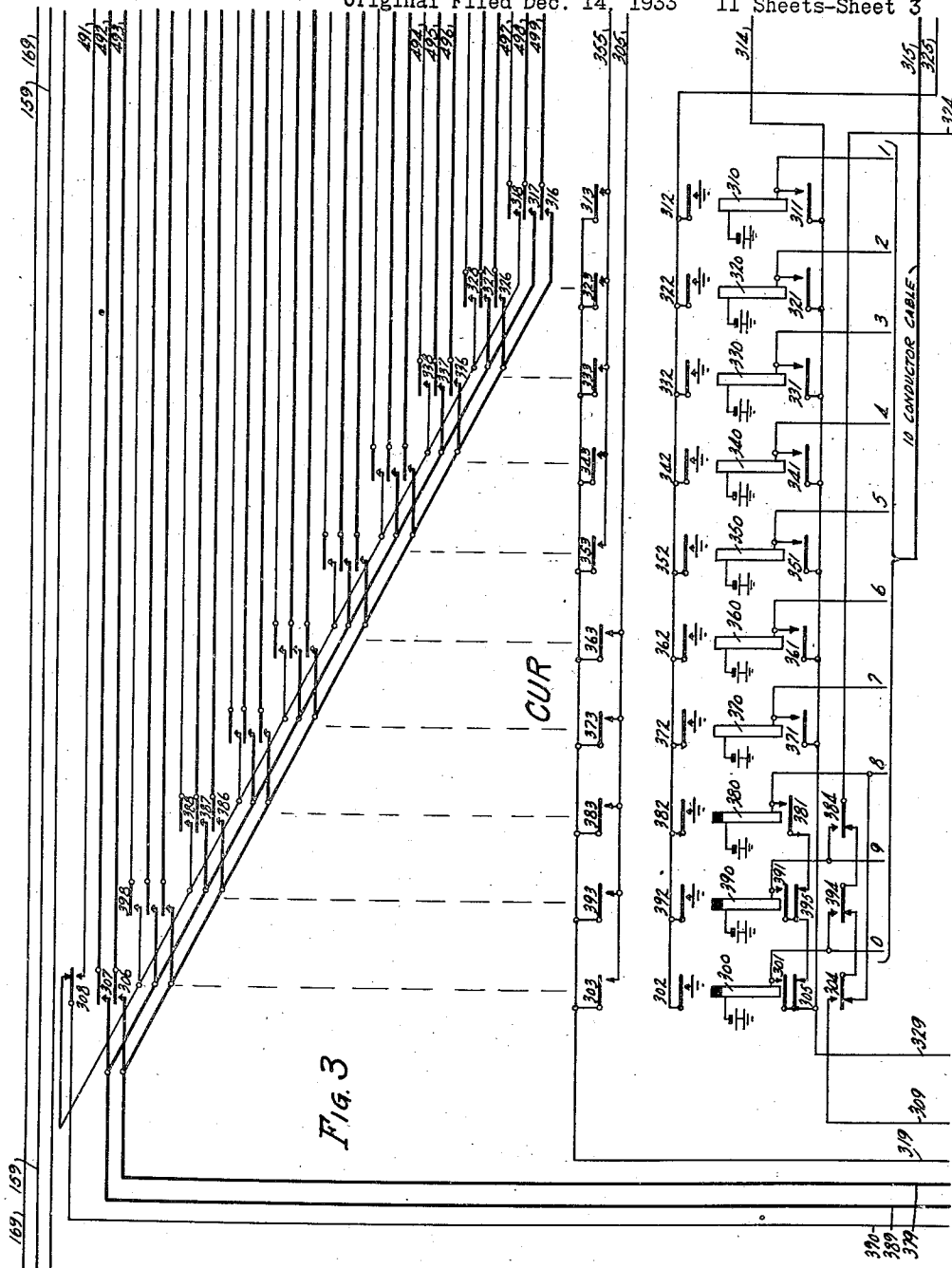
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11 Sheets-Sheet 3



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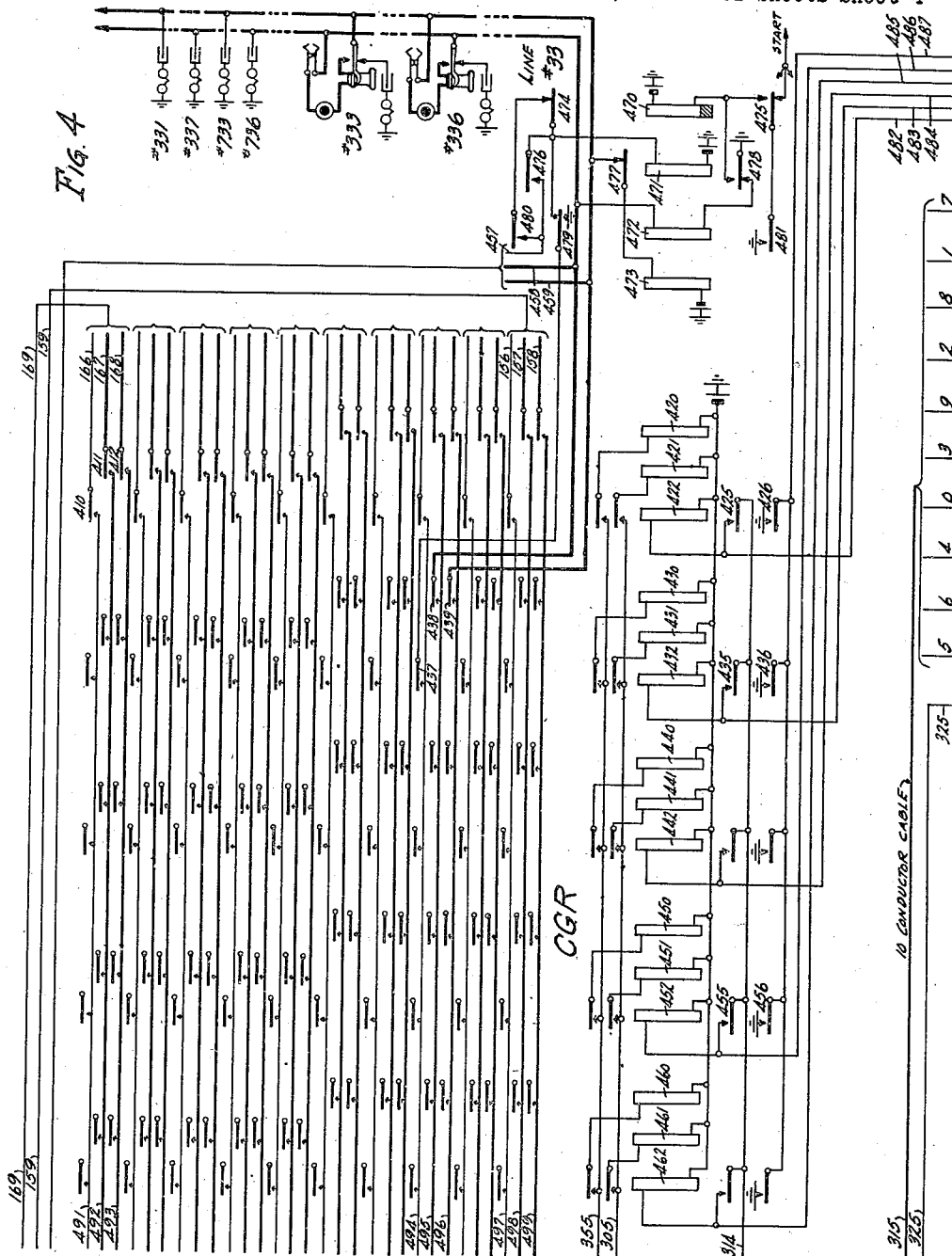
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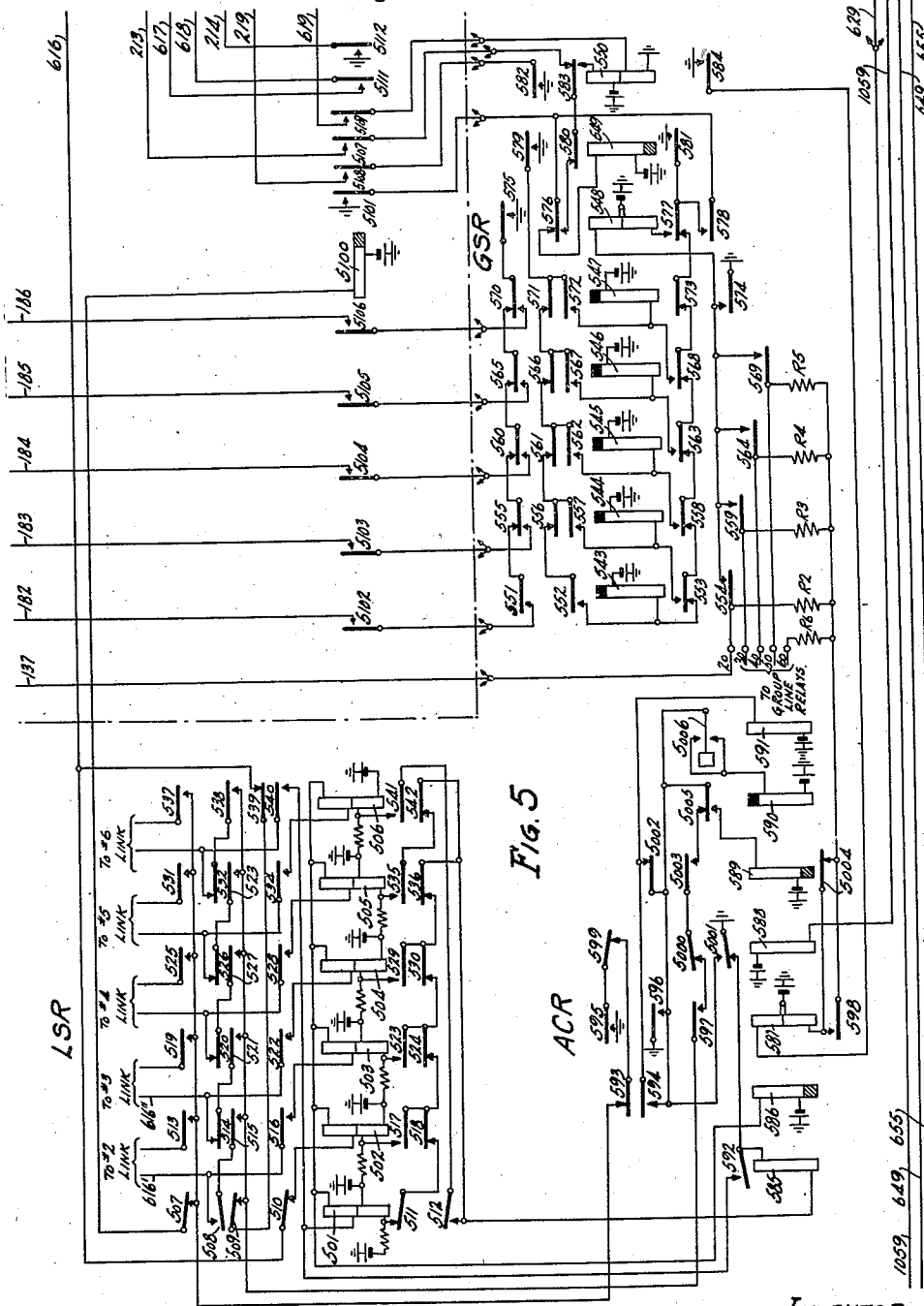
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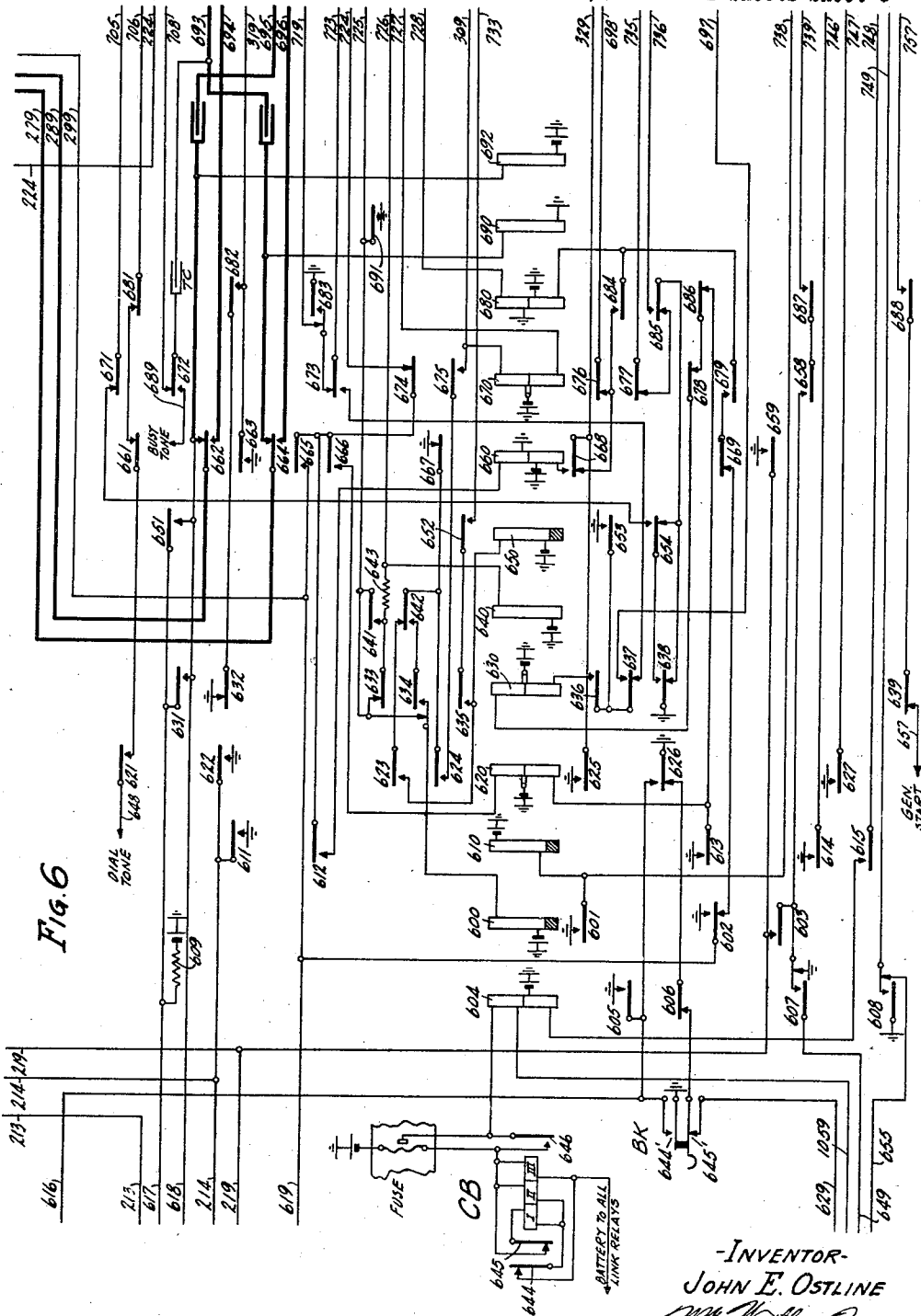
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11 Sheets-Sheet 6



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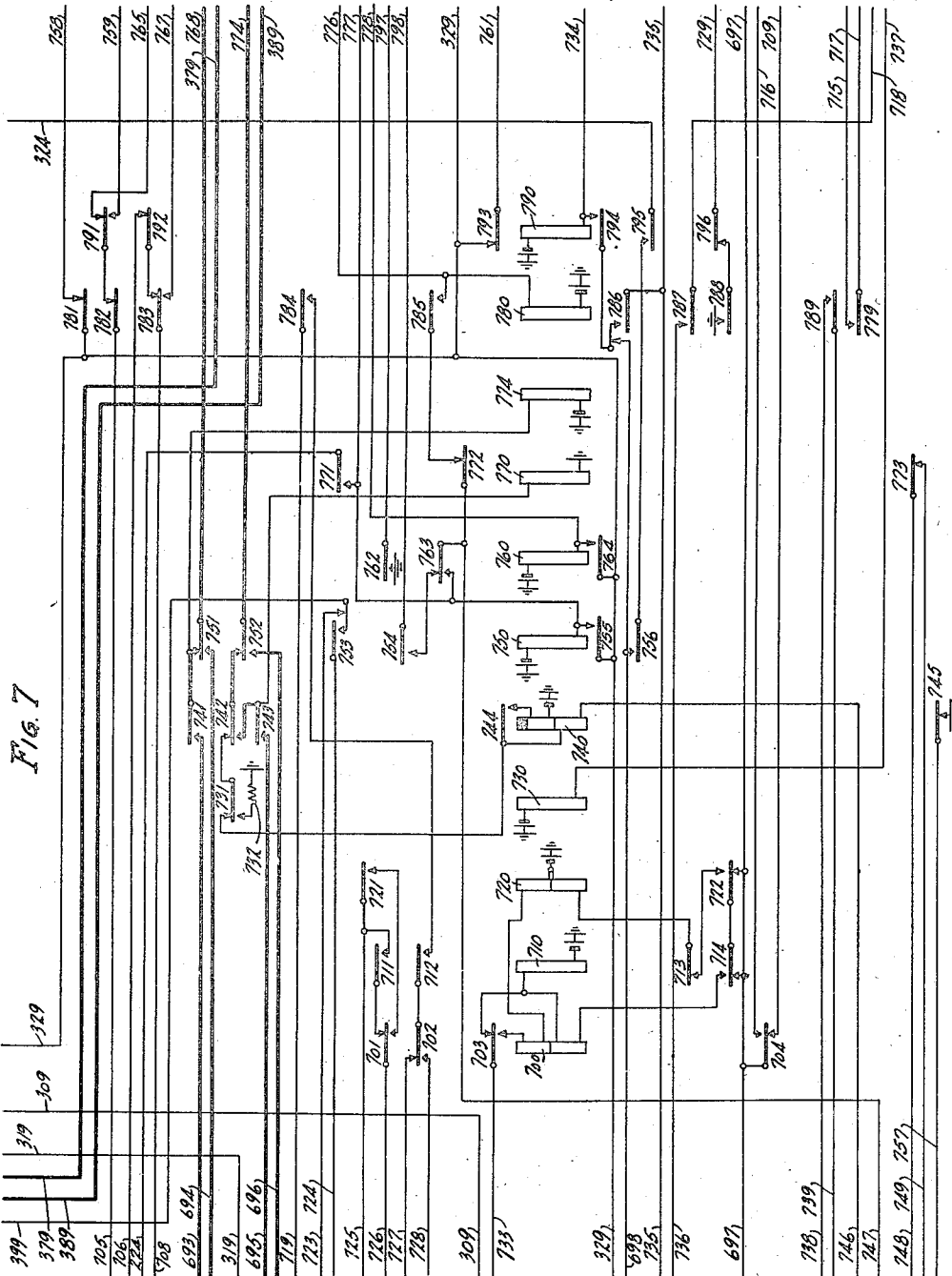
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11 Sheets-Sheet 7



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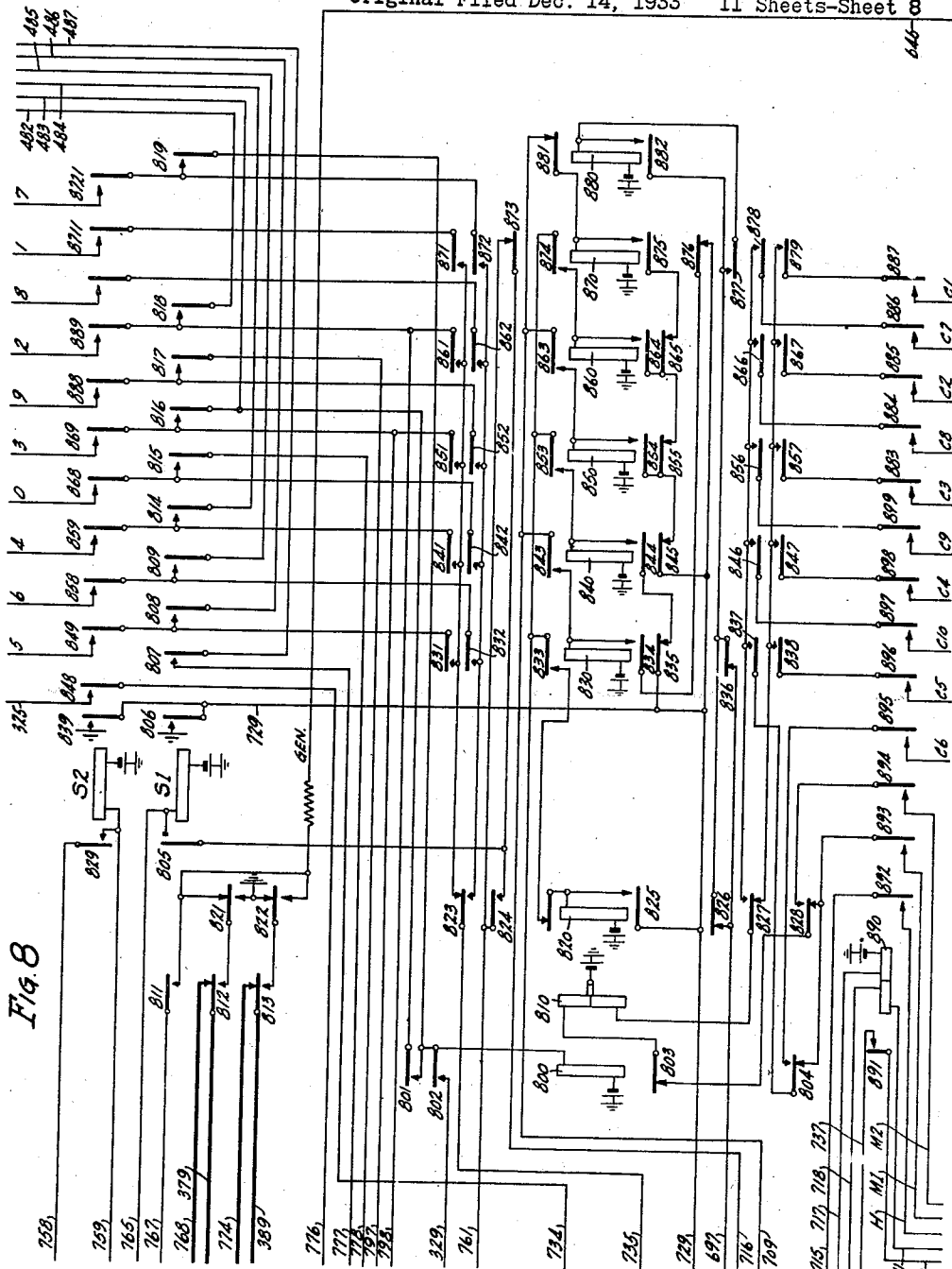
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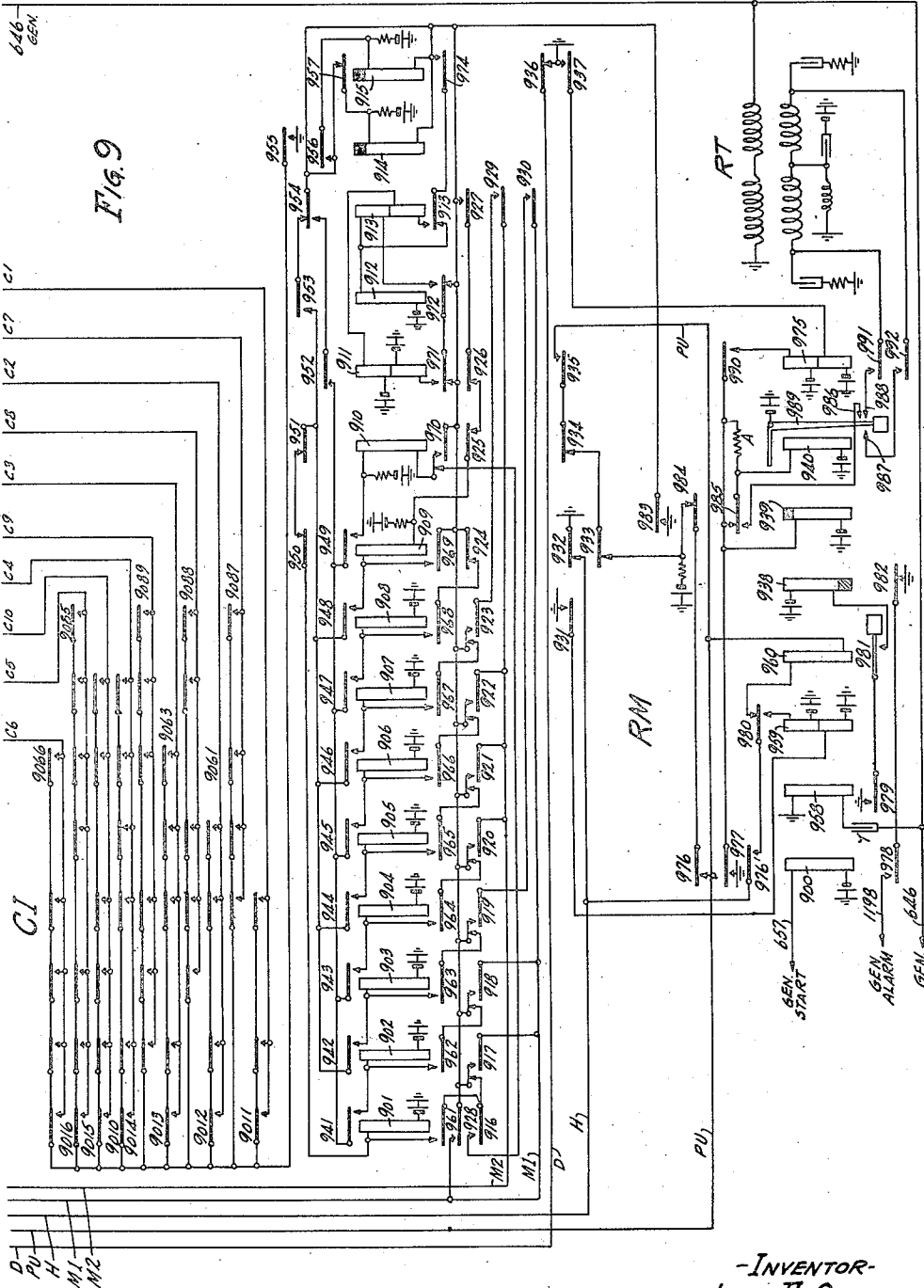
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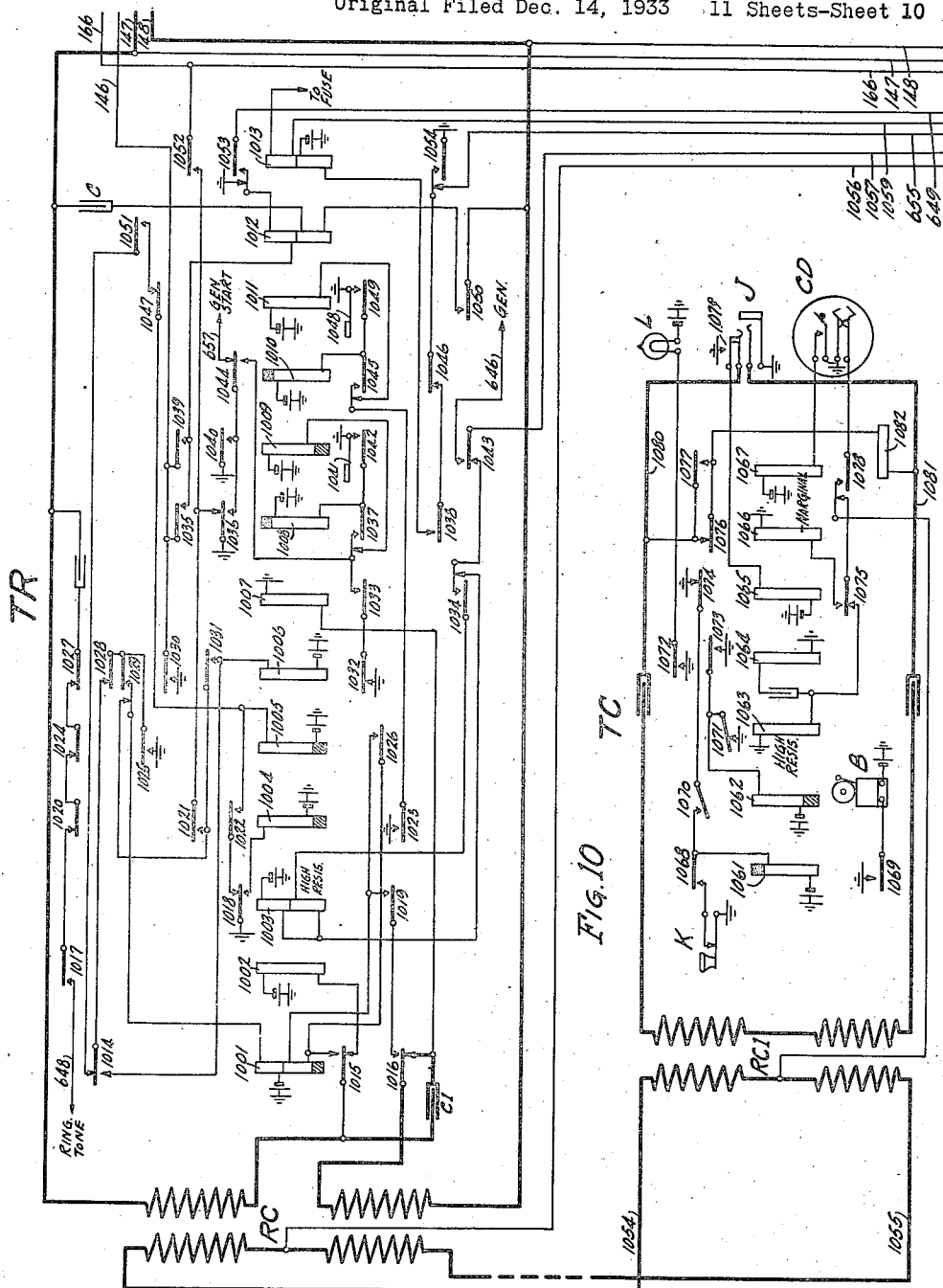
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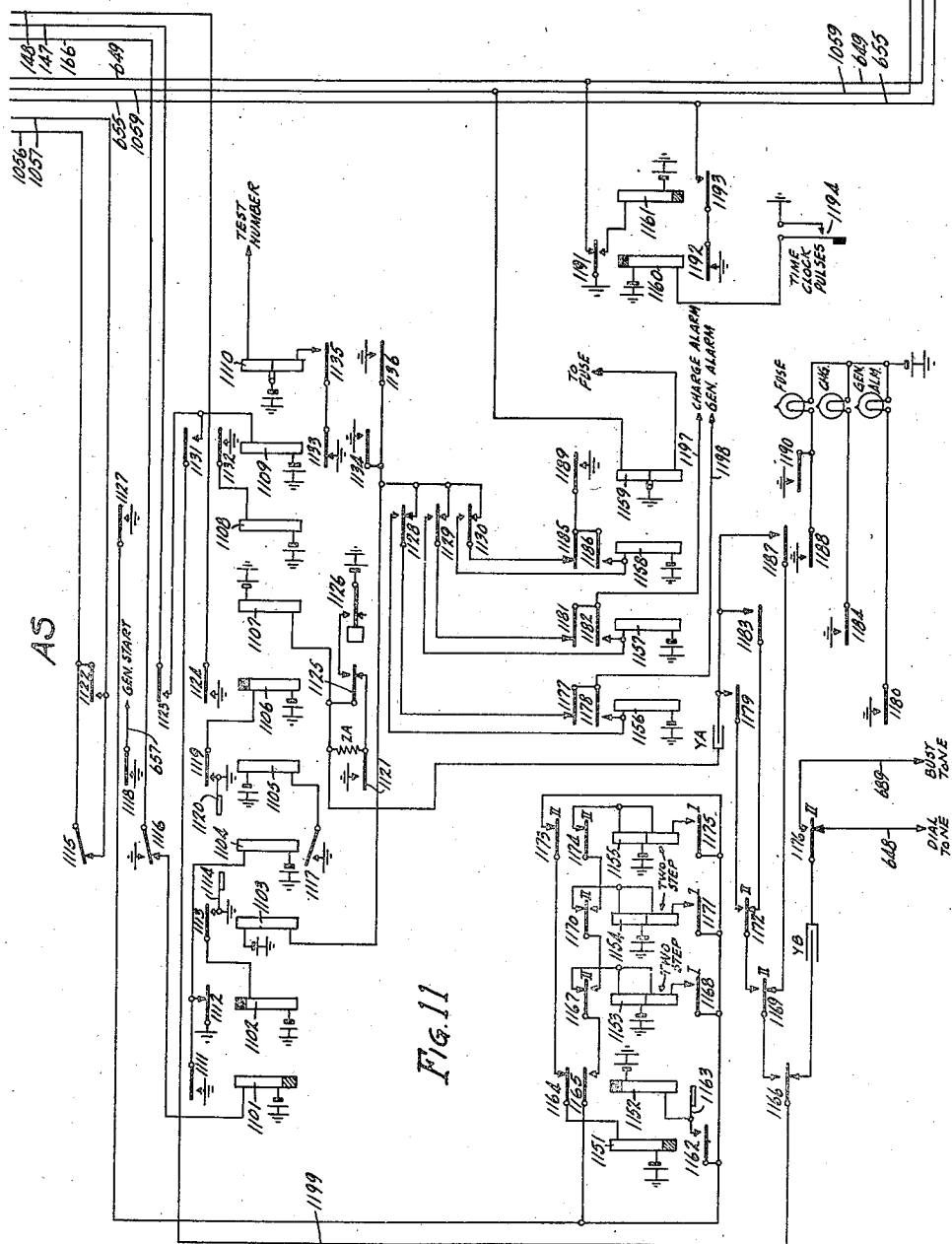
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AUTOMATIC TELEPHONE SYSTEM

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UNITED STATES PATENT OFFICE

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AUTOMATIC TELEPHONE SYSTEM

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Application December 14, 1933, Serial No. 702,298
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25 Claims. (Cl. 179—17)

This invention relates in general to automatic telephone systems, but more in particular to small systems suited for installation in towns or villages. An automatic telephone system of this type is generally known as a Community Automatic Exchange or C. A. X., and may have a capacity of about fifty lines, more or less. Usually the lines are party lines having either bridged or grounded ringing circuits over which such subscribers are signalled by means of code ringing. Provision is also made for trunking calls to and from distant exchanges.

The object of the present invention is to provide a novel and improved all-relay community automatic exchange of the foregoing character.

One of the features of the invention relates to the all-relay finder-conductor links for interconnecting the various lines in this system.

Another feature of the invention relates to the manner in which both the trunk lines and subscribers' lines are connected to a finder-conductor link, especially the line and trunk hunting operations of the finder and connector units relays.

Another feature of the invention relates to an all-relay allotter which preselects idle finder-conductor links and in which common relay testing equipment is provided for causing a calling line to be connected to the preselected idle link.

Another feature of the invention relates to an improved lock pulsing arrangement for repeating the pulses received from a calling line.

Another feature of the invention relates to circuit arrangements whereby the finder-conductor link switches straight through cutting off the local talking bridges on both incoming and outgoing trunk calls.

Another feature of the invention relates to a common all-relay code interrupter and the circuit arrangements for selecting and connecting various code rings to called subscribers' lines.

A further feature of the invention relates to an alarm sender which seizes a trunk line to the distant exchange when a case of trouble arises, and which transmits a series of tones over the trunk line to identify the particular trouble.

These and other features of the invention will be apparent from the following detailed description of the invention.

Referring now to the drawings, comprising Figs. 1 to 11, inclusive, there is shown by means of the usual circuit diagrams sufficient of the apparatus in an automatic telephone system to enable the invention to be readily understood.

Fig. 1 shows a group of finder group relays FGR for connecting the line conductors and test

conductors of the various groups of lines and trunk lines to one of the finder-conductor all-relay links. The link shown is capable of interconnecting fifty lines. The groups of lines are divided into five groups of ten lines each and are designated as the 20, 30, 40, 50 and 60 groups. Relays 122, 132, 142, 152 and 162 are call finder group control relays and operatively connect the test conductors of their respective groups to the link circuit shown. Relays such as relays 120—121, 130—131, 140—141, 150—151 and 160—161 are for connecting the line conductors of their respective groups to the link circuit. In the lower left-hand corner of Fig. 1 is shown the line circuit LR of the first line in the 20-group. A plurality of substations such as 211, 212, 216, and 217 are diagrammatically shown connected to this line. As will be seen, the line conductors of this line, or line 21, terminate in armatures 127 and 128 of relay 120 in the 20-group, while the test conductor of this line terminates in armature 129 of relay 122 in the 20-group. The line conductors and the called test conductor extend by way of a three-conductor cable 150 to the outgoing end of the link wherein these conductors terminate in armatures on the connector group relay in the 20-group. In the upper left-hand corner of Fig. 1 is shown the trunk line circuit TLR for the trunk line TR shown in Fig. 10. As will be seen, this trunk line terminates in armature springs 110, 111 and 112 of the finder group relays 121 and 122. The trunk line conductors are also connected to the outgoing end of the link circuit in a manner similar to that described for line 21. Lines 22, 23, 24, 25, 26 and 27, and trunk lines 28 and 29, indicated by the brackets, terminate in armatures controlled by the finder group relays in the 20-group for connecting such lines to the link circuit. In a similar manner the trunk lines and subscribers' lines in the 30-group and other groups are connected in a similar manner.

Fig. 2 shows a group of finder units relays FUR for connecting the line of any selected group to the control circuits in the link.

Fig. 3 shows a group of connector units relays CUR for connecting the link circuit to any particular called line in any called group as determined by the operated connector group relays.

Fig. 4 shows a group of connector group relays CGR for connecting the outgoing end of the link to any line in any group. In the right-hand end of Fig. 4 is shown the line circuit of line 33 and a plurality of substations thereon. Line 33 is connected to the incoming end of the link as

shown diagrammatically by the three-conductor cable extending to armatures 457, 458 and 459, in Fig. 1. All of the trunk lines and all of the subscribers' lines in all of the groups terminate in the outgoing end of the link in the manner illustrated by line 33.

Fig. 5 shows an all-relay allotter for preselecting an idle link. In the upper left-hand corner of Fig. 5 are shown the link selecting relays LSR which control the selection of an idle link and which control the operation of the link connecting relay, such as 5100, for connecting such link to the group selecting relays GSR in the common allotter. The group selecting relays GSR are operated to find the calling group while relay 550 is operated when the calling line is found by the finder units relay. In the lower left-hand corner of Fig. 5 is shown the allotter control relays ACR, which control different functions to be described hereinafter. Each group of lines has a start conductor, such as start conductor 137, extending from each group of line circuits to a terminal such as terminal 20 shown in the lower part of Fig. 5. The start conductor, corresponding to start conductor 137, of the 30-group would terminate in the terminal 30, and the remaining start conductors of the other groups would terminate in the correspondingly numbered terminals. In the upper-right-hand corner of Fig. 5 is shown the connecting relay 5100 of one of the link circuits. This relay connects the group selecting relays GSR to the finder group relays FGR of the selected link, and also connects circuits for controlling the line hunting operations of the link.

Fig. 6 shows a group of relays in the control circuit of the link.

Fig. 7 shows another group of relays in the control circuit of the same link.

Fig. 8 shows a further group of relays in the control circuit of the same link. Relay S1 in Fig. 8 is provided for connecting the counting relays 820 to 880, inclusive, to the connector group relays CGR, in Fig. 4. Relay S2 is provided for connecting the counting relays to the connector units relays CUR, in Fig. 3. Relay 890 is provided for connecting the common code interrupter CI to the counting relays.

Fig. 9 shows an all-relay code interrupter CI, and a ringing machine RM.

Fig. 10 in its upper portion shows the trunk line TR which terminates in position 20' of the 20-line group of the link. This trunk line is connected by way of repeating coils RC and RC1 and conductors 1054 and 1055 to the trunk circuit TC at a distant exchange. This particular trunk circuit TR is connected to an alarm sender AS shown in Fig. 11.

Fig. 11 shows an alarm sender AS for transmitting a series of tones over the trunk line TR to the distant exchange when some trouble arises.

Throughout the drawings numerous types of relays, well known in automatic telephone art, are shown. Slow-to-operate relays are shown having a full-black upper section. Slow-to-release relays are shown having a cross-hatched section. The weighted armature springs of vibrating relays are shown with a rectangular weight on their movable ends.

Although only substations having their ringers grounded for divided or grounded ringing have been illustrated in the drawings, it will be understood that substations having their ringers bridged across the line conductors may also be operated over the circuits shown.

Briefly the operation of the system is as follows:

When a calling subscriber initiates a call the test conductor of the calling line is marked with calling potential and the calling group is marked in the common all relay allotter which operates to find the calling group. When the calling group is found the allotter completes a circuit for energizing the proper finder group control relay in an idle link previously preselected by the allotter. The operation of the finder group control relay connects all of the test conductors of all the lines in the calling group to the finder units relays which now operate successively until the marked calling line is found.

When the calling line is found the allotter is operated to preselect another idle link and the calling line is connected to the control circuits of the link in use. The first digit transmitted by the calling subscriber operates counting relays to operate the corresponding connector group control relay which connects all of the test conductors of the called group to the connector units relays of the link. The second digit reoperates the counting relays to operate the corresponding connector units relay to connect the test conductor of the called line to the link control circuits. The third digit reoperates the counting relays to select the ringing code. If the called line is idle an all relay code interrupter controls a ringing relay in the link over the selected code ringing conductor to transmit the selected ringing code to the called line.

In incoming trunk calls the operation is the same as just described with the exception that the local talking bridges in the link are disconnected to connect the trunk line straight through to the called subscriber.

In outgoing trunk calls the calling line is found in the same manner as just described and in response to dialling a single digit designating a trunk call the corresponding connector group control relay connects the test conductors of this line group to the connector unit relays and the connector unit relays corresponding to the trunk lines in this group are successively operated to hunt for an idle trunk in this group. When an idle trunk line is found the link switches through cutting off the local talking bridges.

It will now be assumed that subscriber 216 desires to call subscriber 331. When the subscriber at substation 216 removes his receiver a circuit is completed for energizing line relay 172 over the following circuit: from ground by way of armature 178 and resting contact, through the winding of relay 172, over the lower talking conductor of line 21 through the subscriber's substation loop comprising the receiver R, transmitter T, calling device CD, and over the upper heavy talking conductor of line 21, armature 177, and through the winding of relay 173 to battery. Relay 172 at armature 179 disconnects conductor 156 from the cut-off relay 171 at its resting contact and at its working contact grounds conductor 156 which extends by way of the three-conductor cable 159 of Fig. 4 to busy the calling line at the called terminals, at armature 180 connects the cut-off relay 171 to armature 129 by way of armature 174 to mark line 21 as a calling line in the finder group of relays. At armature 181 relay 172 grounds start conductor 137 by way of armature 175 and resting contact, thereby marking the group in which the calling line is associated in the relay allotter. Responsive to relay 172 grounding the start conductor 137 a circuit may

be traced for energizing relay 587 from grounded armature 181, armature 175 and resting contact, conductor 137, terminal 20, resistance R2, armature 5004, and through the lower winding of relay 587 to battery.

At the time this call is initiated the link selecting relays LSR in Fig. 5 have preselected the first relay link. Since one or more links are idle, the all link busy relay 588 is energized over the common all link busy conductor 629 from ground at the idle link circuits. One of these circuits may be traced from armature 626 and resting contact, armature 606, springs 645 of busy key BK, common to all link busy conductor 629, and through the winding of all link busy relay 588 to battery. Relay 588 is maintained energized from ground from the idle link circuits and therefore only deenergizes at a time when all of the links are busy. Relay 588 at armature 599 prepares a circuit for the link connecting relays, at armature 5000 prepares a point in the circuit to the link selecting relays LSR, and at armature 5001 completes a circuit for energizing relay 585 as follows: grounded armature 5001 and working contact, through the winding of relay 585, through armatures 536, 530, 524, 518, and 511, and through the lower winding of relay 501 to battery and in multiple therewith through the associated resistance to battery. Relay 501 is also maintained energized over this circuit as long as the first link is preselected. Link selecting relay 501 at armature 507 prepares a point in the circuit for operating the link connecting relay 5100, at armature 509 prepares a point in the circuit extending to the guard conductor 616, at armature 510 prepares a circuit for the second link selecting relay 502, and at armature 512 opens a point in the circuit of link selecting relay 506.

Since the first link is the link preselected, due to link selecting relay 501 being in energized position, the energization of start relay 587 completes, in this case, the circuit for energizing the link connecting relay 5100 as follows: from ground by way of armatures 595, 599, 593, and 507, and through the winding of relay 5100 to battery. At armature 596 relay 587 completes a circuit by way of armature 5002 for energizing relay 591, at armature 597 prepares a point in the circuit for grounding the guard conductor 616 so as to transfer the call to the next idle link if the calling line is not found within a predetermined time, and at armature 598 completes a circuit through its lower winding independent of armature 5004. Relay 591 operates and closes the circuit to relay 590. Relay 590, after an interval, energizes and at armature 5005 completes the circuit for energizing relay 589 as follows: from ground by way of armature 596, armature 5005 and working contact, and through the winding of relay 589 to battery. At armature 5002 relay 589 opens the circuit of relay 591 which deenergizes; at armature 5003 prepares a point in the circuit for the guard lead 616, and at armature 5004 opens the original energizing circuit of relay 587. Relay 591, upon restoring, causes its weighted spring 5006 to vibrate alternately opening and closing the circuit of relay 590. Due to its slow release action, relay 590 remains operated during the vibrations of spring 5006. Relay 5100, upon energizing over the above traced circuit, at armatures 5102, 5103, 5105 and 5106 prepares circuits for operating the finder group control relays shown in Fig. 1. At armature 5101 relay 5100 completes a circuit for energizing relay 549 as follows: from ground by way of armature 5101, armature 576

and resting contact, and through the winding of relay 549 to battery. At armature 5108 relay 5100 prepares a circuit for one of the finder group line relays of the finder group FGR, shown in Fig. 1, at armature 5107 prepares a circuit for starting the hunting operation of the finder units relays FUR, shown in Fig. 2; at armature 5109 prepares a point in the circuit for the common line test relay 550, and at armature 5112 connects ground to conductors 214 and 188 in order to provide locking ground for the finder group control relays and for the finder unit relays.

Relay 549, upon energizing, at armature 579 prepares a locking circuit for the group selecting relays GSR, at armature 580 opens a point in the circuit for operating the finder units relays, and at armature 581 closes the starting circuit for energizing the group selecting relays, and in this case closes a circuit for energizing the first group selecting relay 543 as follows: ground by way of armature 581, armature 577 and resting contact, armatures 573, 568, 563, 558, and 553 and their resting contacts through the winding of relay 543 to battery. Relay 543 at armature 551 prepares a point in the circuit for energizing finder group control relay 122; at armature 552 completes a locking circuit for itself, at armature 553 opens a point in its original energizing circuit and closes the circuit for relay 544; and at armature 554 connects battery through the upper winding of group test relay 548 to the finder start conductor 137 which is grounded in response to a call from any subscriber in the 20-line group.

The group selecting relays 543 to 547, inclusive, are slow to operate relays which only operate after a short interval and close their own locking circuits through their inner upper armatures before operating their remaining armatures. Assuming for the time being that some other subscriber in another line group is calling and therefore the finder start lead 137 will not be grounded and therefore the group test relay 548 will not be operated. In case conductor 137 is not grounded relay 544 energizes after an interval over the following circuit: from ground by way of armature 581, armatures 577, 573, 568, 563, 558, and their resting contacts, armature 553 and working contact, and through the winding of the second group selecting relay 544 to battery. Relay 544 at armature 555 prepares a circuit for energizing the finder group control relay 132, at armature 556 opens the locking circuit of the first group selecting relay 543 which will be energized after an interval, at armature 557 completes a locking circuit for itself from grounded armature 579 by way of armatures 571, 566, and 561; at armature 558 opens its original energizing circuit at its resting contact and at its working contact closes the circuit for the third group selecting relay 545; and at armature 559 connects the group test relay 548 to the finder start lead common to the 30-line group subscribers. In the same manner as just described relays 545, 546 and 547 operate in sequence each unlocking the preceding group selecting relay and connecting the finder start lead of the group with which they are associated to the upper winding of relay 548 until the calling line group is found or the last group is reached.

When the calling line group is found ground over the start lead, such as lead 137, completes the circuit for energizing the group test relay 548 through its upper winding. Relay 548, upon energizing, at armature 577 opens the energizing circuit to the next succeeding group selecting re-

lay before such group selecting relay operates and closes its locking circuit; at armature 576 opens the circuit to the slow to release relay 549, and at armature 578 completes its locking circuit from grounded armature 5101, armature 578, armature 577 and its working contact, and through the lower winding of group test relay 548 to battery. At armature 575 group test relay 548 completes the circuit for energizing the selected finder group control relay, in this case relay 122, as follows: from grounded armature 575, armature 570, 565, 560, and 555 and their resting contacts, armature 551, armature 5102, group cut-in conductor 182, and through the winding of finder group control relay 122 to battery. Relay 122, at armature 125 completes its own locking circuit from grounded conductors 188 and 214 and at armatures 123 and 124 connects the finder group line connecting relays 120 and 121 to conductors 190 and 189. At its upper armatures, such as armatures 110, 113, and 129, relay 122 connects all of the test conductors of the twenty-line group to the test armatures associated with the finder units relays shown in Fig. 2 in order to connect the marked calling line in the finder units relay group. In this case, since the line 21 is the calling line, armature 129 connects battery to armature 218 by way of conductor 197, armatures 129, 180 and 174, and through the winding of cut-off relay 171 to battery.

In the allotter in Fig. 5 relay 549 deenergizes after an interval and at armature 579 opens the locking circuit of the energized group selecting relay, in this case relay 543, at armature 580 completes a circuit for operating the finder units relays of Fig. 2 in their hunting operation, and at armature 581 removes one of the multiple locking grounds from the lower winding of relay 548, which, however, is maintained energized from grounded armature 5101. Group selecting relay 543 deenergizes, and at armature 551 opens the original energizing circuit of relay 122 and at armature 554 opens the original energizing circuit of relay 548. It should be noted that due to the slow to operate action of the group selecting relays, relay 544 did not have sufficient time to operate and close its locking circuit before the group test relay 548, upon finding the calling group, energizes and at armature 577 opens the circuit to relay 544. The group test relay 548, therefore, energizes when the group in which the calling line is located is found, and at armature 577 opens the energizing circuit to the succeeding group selecting relay before such group selecting relay is fully energized.

As soon as relay 549 deenergizes the circuit for energizing the first finder units relay 210 may be traced as follows: from ground by way of armature 5101, armature 576 and working contact, armature 580, armature 583 and resting contact, armature 5107, conductor 213 by way of armatures 211, 221, 231, 241, 251, 261, 271, 281, 291, and 201 and their resting contacts, and through the winding of relay 210 to battery. The finder units relays are also slow to operate relays and operate in a manner similar to that described for the group selecting relays in the allotter. At armature 212 relay 210 completes its locking circuit from grounded conductor 188 by way of armatures 203, 293, 283, 273, 263, 253, 243, 233, and 223. At armature 211 relay 210 opens its original energizing circuit after its locking circuit is closed, and connects the grounded start conductor 213 to the second finder units relay 220. At armature 215 relay

210 prepares a point in the circuit for operating the finder group line relay having its circuit prepared by its associated energized finder control relay, and at armature 218 prepares a circuit for the common line test relay 550 in the allotter. In case the calling line is 21, 31, 41, 51, or 61 the operation of armature 218 completes a circuit for energizing the line test relay 550 in the allotter. However, in order to describe the hunting operation of the finder units relay 10 it will be assumed for the time being that some line other than the line mentioned is calling. In this case the second finder units relay 220 is operated from grounded conductor 213 by way of armature 211 and its working contact. At armature 222 relay 220 completes its own locking circuit by way of armatures 233, 243, 253, 263, 273, 283, 293, and 203 to grounded conductor 188. At armature 223 relay 220 opens the locking circuit of the first finder units relay 210 to cause its deenergization; at armature 221 and its working contact prepares the energizing circuit for the third finder units relay 230 which circuit, however, is only completed upon the deenergization of the first finder units relay 210 at armature 211 and its resting contact. At armature 225 relay 220 prepares the circuit to the finder group line relay having its circuit prepared by its associated finder group control relay, and at armature 228 prepares a circuit for the common line test relay 550 in the allotter. The first finder units relay 210 after an interval deenergizes and at armature 218 opens the previously prepared circuit for the common line test relay 550, and at armature 211 completes the circuit for energizing the third finder units relay 230. In the same manner as just described the remaining finder units relays operate in sequence each preparing a circuit to the preceding finder units relay and extending the test lead of the line with which they are associated to the winding of the common line test relay 550 until the calling line is found.

When the calling line is found battery through the winding of cut-off relay of the calling line 45 will be connected to conductor 299 for energizing the common line test relay 550 and the subscriber's cut-off relay in series. Since line 21 in this case is the calling line it will be remembered that finder group control relay 122 has been energized and locked in energized position to prepare the circuit for the finder group line relay 120 and to connect battery from the winding of cut-off relay 171 to conductor 197 by way of armature 129. Therefore, when the first finder unit relay 210 energizes and operates its armature 218 the circuit for energizing the common line test relay 550 in series with the subscriber's cut-off relay 171 is completed. This circuit may be traced as follows: From ground through the lower winding of relay 550, armature 5109, conductor 619 to conductor 299, armature 218, conductor 197, armature 129, armature 180, armature 174, and through the winding of cut-off relay 171 to battery. Relay 550 energizes before the second finder units relay 220 has had sufficient time to fully operate and accomplishes the following functions: at armature 583 and its resting contact relay 550 disconnects ground from conductor 213 to prevent the next finder units relay, in this case relay 220, from fully operating, and at its working contact completes a locking circuit through the upper winding of relay 550 from grounded armature 5101 and armatures 576 and 580. At armature 584 relay 550 completes a

circuit through the upper winding of start relay 587 in order to maintain this relay in energized position after the marking ground is removed from start conductor 137. At armature 582 relay 550 completes a circuit for energizing finder group line relay 120 as follows: ground by way of armature 582, armature 5108, conductor 219, armature 215, conductor 190, armature 123, and through the winding of finder group line relay 120 to battery. Cut-off relay 171 energizes in series with the common line test relay 550 and at armature 176 maintains its circuit closed independent of armatures 180 and 174, at armature 177 disconnects relay 173 from the upper line conductor, at armature 178 completes a circuit for energizing relay 170 and opens the circuit of line relay 172. Relay 170, upon energizing, at armature 174 opens a point in the original energizing circuit of cut-off relay 171 and at armature 175 disconnects ground from start conductor 137. Line relay 172, upon deenergizing, at armature 179 disconnects direct ground from conductor 156 at its working contact and at its resting contact substitutes the ground through the lower winding of line test relay 550 so as to maintain conductor 156 grounded to busy the line at the called terminal.

Finder group line relay 120, upon energizing over the above traced circuit, at armatures 127 and 128 completes a circuit for energizing line relay 690 in Fig. 6, over the following circuit: from ground through the winding of line relay 690, resting contact and armature 664, conductor 279, armature 216, conductor 199, armature 127, through the talking conductors including the calling subscriber's loop to armature 128, conductor 198, armature 217, conductor 289, armature 662 and resting contact, and through the winding of relay 692 to battery. Line relay 590, upon energizing, at armature 691 completes a circuit for energizing impulse relay 640 as follows: ground by way of armature 691, armature 633, resistance 643, and through the winding of impulse relay 640 to battery. The circuit for energizing slow to release relay 600 may be traced from grounded armature 691 through the normally closed springs controlled by armature 634, and through the winding of relay 600 to battery. Impulse relay 640, upon energizing, at armature 641 shorts armature 633 to maintain the relay energized, and at armature 642 prepares a point in the circuit for maintaining relay 600 in operated position. Relay 600, upon energizing, at armature 601 completes an obvious circuit for energizing slow to release relay 610, at armature 602 connects direct ground to conductor 299, thereby connecting direct ground instead of ground through the lower winding of relay 550 to conductor 156 in order to maintain the calling line busy to other subscribers; and at armature 603 connects ground through the normally closed springs controlled by armature 607 to conductor 219 to maintain the finder group line relay 120 in energized position. Relay 610, upon energizing, at armature 611 grounds conductor 214 to maintain the locking circuit of the operated finder control relay 122 and the locking circuit of the operated finder units relay 210. At armature 612 relay 210 prepares a point in the energizing circuit of the trunk test relay 660, at armature 613 completes an obvious energizing circuit for relay 620 through its lower winding and also completes a circuit by way of armatures 686 and 678 through the upper winding of relay 630 for energizing the latter relay, at armature 614 pre-

pares a point in the energizing circuit of relay 740, and at armature 615 prepares a point in the energizing circuit for the time release relay 604. Relay 620, upon energizing, at armature 621 connects the well known dial tone through the calling subscriber's loop over the following circuit: from dial tone by way of armatures 621, 661, and 681, conductor 706, armatures 792 and 793, conductor 708, resting contact and armature 672, through the tone condenser TC to conductor 693, through the talking condenser, resting contact and armature 664, and thence over the circuit previously traced through the calling substation loop. At armature 622 relay 620 connects a multiple ground to conductor 214 to maintain the finder group control relay and finder units relay in energized position, at armature 623 prepares the circuit for energizing the series relay 650, as well as preparing an impulsing circuit to the counting relays; at armature 624 prepares a point in the locking circuit for busy relay 670, at armature 625 connects ground to conductor 329 to prepare locking circuits for a number of relays, and at armature 627 grounds conductor 747. At armature 626 and its resting contact relay 620 removes one of the ground connections from the common all link busy conductor 629 and at its working contact grounds guard conductor 616 to cause the allotter to preselect another idle link. Relay 630, upon energizing, at armature 631 connects battery through resistance 609 to talking conductor 289 by way of armature 662 in order to improve the impulsing circuit, at armature 632 opens a point in the circuit for energizing the connector group line relays, at armature 633 opens the original energizing circuit of impulsing relay 640, which, however, is held energized through its own armature 641, and at armature 634 completes a new circuit for maintaining relay 600 energized as follows: from ground by way of armature 667, armature 642 and working contact, armature 634 and working contact, and through the winding of relay 600 to battery. At armature 635 relay 630 prepares a further point in the impulsing circuit to the counting relays, at armature 636 prepares a point in its own locking circuit through its lower winding, at armature 637 prepares a point in the operating circuit for the counting relays, at armature 638 prepares a point in the circuit for energizing relay S1, and at armature 639 disconnects the generator start conductor 657.

When the guard conductor 616 is grounded in response to the operation of relay 620 a circuit is completed for energizing, in this case, the second link selecting relay 502 in series with relay 586 as follows; from grounded guard conductor 616, armature 510, through the upper winding of relay 502 and through the winding of relay 586 to battery. At armature 593 relay 586 opens the circuit to the link connecting relay 5100 which thereupon deenergizes after an interval, and at armature 594 completes a circuit from grounded armature 596 for energizing the relay 591. Link selecting relay 502, upon energizing, at armature 513 prepares a circuit for the link connecting relay in the second link similar to link connecting relay 5100, at armature 514 opens a point in the circuit for grounding the guard conductor associated with the third link, at armature 515 prepares a point in the circuit for grounding the guard lead 616' associated with the second link in case the call is not completed, at armature 516 connects guard lead 616' associated with the second link to the upper winding of the third link

selecting relay 503 to prepare for the energization of the latter relay as soon as the guard lead 616' is grounded, at armature 517 completes a locking circuit for itself through the lower winding over the previously traced locking circuit extending from grounded armature 5001 through the winding of relay 585, and at armature 518 opens the locking circuit of the first link selecting relay 501. Link selecting relay 501, upon deenergizing, at armature 508 prepares a point in the circuit for grounding guard conductor 616' in case the call is not completed, and at armature 512 prepares a point in the locking circuit for the sixth link selecting relay 506, and at armature 510 opens the original energizing circuit of relays 502 and 586 which now deenergize. Relay 5100, upon deenergizing, at armatures 5102 and 5106 opens the circuits extending to the finder group control relays, at armature 5101 opens the locking circuits of relays 548 and 550, thereby causing the deenergization of the latter relays, at armature 5108 disconnects ground at armature 582 from the conductor 219 which, however, is grounded at armature 603, and at armature 5112 disconnects one of the multiple grounds from conductor 214.

At armature 584 relay 550, upon deenergizing, opens the circuit through the upper winding of start relay 587 and the latter relay now deenergizes in case no other line in line group 20 is calling. Group test relay 548 at armature 575 opens a further point in the circuit of the finder group control relay 122, at armature 576 again prepares the circuit for relay 549, and at armature 577 again prepares the circuit for operating the group selecting relays. Relay 591, upon energizing over the above traced circuit, operates its vibrating arm 5006 and closes an uninterrupted energizing circuit to relay 590 from grounded armature 596.

In case the second link is busy ground on the guard lead 616' closes a circuit for energizing link selecting relay 503 and relay 586 in series as follows: from grounded link conductor 616', armature 516, through the upper winding of link selecting relay 503, and through the winding of relay 586 to battery. In the same manner as just described for the second link selecting relay 502 the link selecting relays 503, 504, 505 and 506 operate in sequence opening the locking circuit to the preceding link selecting relay and connecting the guard lead of their associated link to the succeeding link selecting relay until an idle link is found or all links become busy.

In case no other call is waiting start relay 587 deenergizes and at armature 596 opens the circuit of relays 591, 590 and 589. Relay 586, upon deenergizing, when an idle link is found, at armature 593 prepares a point in the circuit for energizing the link connecting relay similar to link connecting relay 5100 in the second link. However, should another call be waiting the circuit through the lower winding of relay 587 is still maintained by way of the start conductor similar to start conductor 137 and the grounded resistances such as R2, R3 or R4 and does not, therefore, restore. In this case when relay 586 deenergizes said relay at armature 593 will complete the circuit for energizing the link connecting relay similar to relay 5100, and at armature 594 opens the circuit to relay 591 causing the weighted spring 5006 to vibrate and interrupt the circuit to relay 590. The link connecting relay similar to relay 5100 to the idle link now operates and closes a circuit to relay 549 to cause the opera-

tion of the allotter in the same manner as previously described.

In case the calling line is not found within a predetermined time, the timing arrangement controlled by relays 589, 590 and 591 will be operated to cause the allotter to select another idle link. In this case if the calling line has not been found by the time the weighted spring 5006 ceases its vibrations relay 590 will restore and at armature 5005 open the circuit to relay 589 at its working contact and at its resting contact completes a circuit for energizing link selecting relay 502 and relay 586 in series as follows: from ground by way of armature 596, armature 5005 and resting contact, armature 5002, armature 5000 and working contact, armature 597, armature 509, armature 539, guard lead 616, armature 510, through the upper winding of relay 586 to battery. Relays 586 and 502 operate to cause the allotter to preselect another idle link in the same manner as previously described. The link connecting relay, such as 5100, will deenergize in response to the operation of relay 586 in order to open the circuit extending to the relays in the link and to the relays in the allotter.

In case all of the links become busy ground will therefore be removed from the common all link busy conductor 629 with the result that all link busy relay 588 will deenergize. At armature 599 relay 588 opens a point in the circuit for energizing the link connecting relays, such as 5100, at armature 5000 opens a point in the circuit for grounding the various guard conductors at its working contact and at its resting contact prepares a circuit for operating the all link busy meter relay ALB, and at armature 5001 and working contact opens the locking circuit to the link selecting relays and relay 585, and at its resting contact completes the circuit for energizing relay 591 as follows: from ground by way of armature 5001 and resting contact, armature 5002, and through the winding of relay 591 to battery.

Relay 591, upon energizing, at spring 5006 again completes the circuit for relay 590 and the latter relay at armature 5005 again completes the circuit for relay 589. Relay 589, upon energizing, at armature 5002 opens the circuit to relay 591 and at armature 5003 prepares a circuit for the all link busy meter relay ALB. Relay 591, upon restoring causes its weighted reed spring 5006 to vibrate and intermittently interrupt the circuit of relay 590. Relay 590 does not restore immediately due to its slow releasing action, but as the vibrations of spring 5006 decrease in amplitude the circuit of relay 590 is opened for a sufficient time to permit relay 590 to restore. At armature 5005 relay 590 opens the circuit of relay 589 at its working contact and at its resting contact completes the circuit for operating the all link busy relay ALB as follows: from ground by way of armature 5001 and resting contact, armature 5005 and resting contact, armature 5003, armature 5000 and resting contact, and through the winding of relay ALB to battery. Relay ALB operates over this circuit and operates the meter M to register an all link busy condition. After an interval slow to release relay 589 deenergizes, at armature 5003 opens the circuit through the all link busy relay ALB, and at armature 5002 again completes the circuit for relay 591. Relay 591 again operates and the foregoing cycle of operations of relays 590, 589, and 591 continue until an idle link becomes available.

When a link becomes idle ground is again con-

nected to the common conductor 629 to energize the all link busy relay 588. At armature 5001 and resting contact relay 588 opens the circuit to relays 589, 590, and 591 allowing them to restore in case no call is waiting, and at its working contact completes a circuit for energizing the link selecting relay 501 and relay 586 in series as follows: from ground by way of armature 5001 and working contact, armature 592 through the upper winding of relay 501, and through the winding of relay 586 to battery. At armature 593 relay 586 opens a point in the circuit to link connecting relay such as relay 5100 and at armature 594 completes the circuit for operating relay 591 in case a call is waiting. Relay 501, upon energizing, at armature 511 completes its locking circuit through the winding of relay 585, thereby causing the energization of the latter relay. This circuit may be traced from grounded armature 5001 and working contact, through the winding of relay 585, through armatures 536, 530, 524, 518 and 511, through the lower winding of relay 501 to battery. At armature 507 relay 501 prepares a circuit to the link connecting relay 5100, at armature 509 prepares a point in the circuit for grounding the guard lead 616, and at armature 510 connects guard lead 616 to the second link selecting relay 502. Relay 585 at armature 592 opens a point in the original energizing circuit of relay 501. In case the first link is busy ground will be encountered on the guard lead 616 and the second link selecting relay 502 and relay 586 will operate in series in the manner previously described. At armature 517 relay 502 closes its locking circuit through its lower winding in series with relay 585, at armature 513 prepares the circuit for the link connecting relay in the second link and at armature 516 connects the guard lead 616' of the second link to the upper winding of the third link selecting relay 503. At armature 518 relay 502 opens the locking circuit of relay 501 allowing such relay to deenergize. If the second link is busy ground on the guard lead 616' completes the circuit for energizing the third link selecting relay 503 in a similar manner. Relays 503, 504, 505 and 506 operate in sequence opening the locking circuit to the preceding link selecting relay and connecting the guard leads of their associated links to the upper windings of the succeeding link selecting relays until an idle link is found. When an idle link is found the absence of ground on the guard lead prevents further operation of the link selecting relays and opens the circuit of relay 586 which thereupon deenergizes. Relay 586, upon restoring, at armature 594 opens the circuit to the time control relay 591 and at armature 593 prepares a point in the circuit for the link connecting relay of the preselected idle link.

When the calling subscriber hears the well known dial tone such subscriber will dial the first two digits of the called number in accordance with the called subscriber's line and then the third digit in accordance with the ringing code assigned to the desired subscriber on this line. In response to the operation of the calling device CD at the calling line for the first digit the circuit extending over the heavy talking conductors to relays 690 and 692 is interrupted in accordance with the digit dialed. Whenever the dialling circuit is interrupted line relay 690 deenergizes and at armature 691 opens the circuit of the impulsing relay 640. Impulsing relay 640 therefore follows the impulses and at armature 641 opens a point in its own locking circuit, at armature 642 and working contact opens the circuit of slow to release relay 690 which remains in energized position during the impulsing period due to its slow releasing characteristics and at its resting contact completes a circuit for energizing the series relay 650 as follows: from ground by way of armature 667, armature 642 and resting contact, armature 623, and through the winding of relay 650 to battery. Relay 650 is also a slow to release relay and maintains its armatures attracted throughout the impulsing period. Relay 650, upon energizing, at armature 651 connects battery through resistance 609 in shunt of the battery through the relay 692 to improve the impulsing circuit, at armature 652 completes a circuit for energizing relay 710, at armature 653 completes a locking circuit by way of armature 636 through the lower winding of relay 630 and grounds conductor 697 by way of armature 637 in order to operate the counting relays shown in Fig. 8 and at armature 654 completes a circuit for energizing relay S1 in Fig. 8 as follows: from ground by way of armature 638 and working contact, armature 654 and working contact, armature 671, conductor 705, armature 782, armature 791 and resting contact, conductor 765, and through the winding of relay S1 to battery. The circuit for energizing relay 710 may be traced from grounded armature 667, armature 642 and resting contact, armatures 623, 635 and 652, conductor 733, armature 703 and resting contact, and through the winding of relay 710 to battery. Relay S1 at armature 806 grounds conductor 729 to provide a locking circuit for the impulse counting relays and at armature 805 completes a locking circuit for itself which may be traced from grounded armature 625, conductor 329, armature 793, conductor 761, armature 873, armature 805 and through the winding of relay S1 to battery. Relay S1 at its remaining armatures connects up the connector group control relays CGR, relays 750, 760, and 800 to the impulse counting relays. Relay 710 at armature 711 prepares a circuit for reenergizing impulsing relay 640 when the line relay 690 is again energized, at armature 712 prepares a point in the circuit for testing the busy or idle condition of the called line, and at armature 714 prepares a circuit for energizing relay 700. Relay 700 will not energize at this time because its lower winding is short circuited from grounded conductor 733 by way of armature 703 and resting contact, and by way of armature 714 and working contact, armature 722 and resting contact, to grounded conductor 697.

When line relay 690 reenergizes after the termination of the first impulse a circuit may be traced for reenergizing impulsing relay 640 as follows: from grounded armature 691, conductor 725, armature 711, resting contact and armature 701, conductor 726, and through the winding of impulsing relay 640 to battery. At armature 641 impulsing relay 640 again completes its locking circuit through resistance 643, at armature 642 and resting contact opens the circuit of series relay 650 and also removes ground from conductor 733 and at the working contact of armature 642 again completes the circuit for relay 690 before the latter relay has had time to deenergize. In response to the removal of ground from conductor 733 the short circuit around the lower winding of relay 700 is removed with the result that relay 700 now energizes in series with relay 710 as follows: from ground by way of armature 653, armature 637 and working contact, 75

conductor 697, resting contact and armature 722, armature 714 and working contact, through the lower winding of relay 700 and through the winding of relay 710 to battery. Relay 710 is maintained energized over this circuit. Relay 700, upon energizing, at armature 701 and resting contact opens the previously traced energizing circuit for relay 640 which is now held energized over its own locking circuit, and at its working contact prepares a point in the circuit for again reenergizing the impulsing relay 640 after the next impulse. At armature 703 and resting contact relay 700 opens the original energizing circuit of relay 710 and at its working contact prepares a circuit for energizing relay 720 through the upper winding of relay 700. At armature 704 relay 700 connects grounded conductor 697 to conductor 716 to energize counting relay 870 by way of armature 861.

At armature 871 relay 870 prepares a point in the circuit to the first connector unit relay 310, at armature 872 prepares a point in the circuit to the seventh connector units relay, and also prepares the circuits for the finder group relay 432 and relay 800, at armature 873 temporarily opens the locking circuit of relay S1 which is without effect during the impulsing period, at armature 874 prepares the circuit for energizing counting relay 860, at armature 875 completes a locking circuit for itself, at armature 876 opens a point in the locking circuit of relay 830, at armature 877 completes a circuit for energizing counting relay 880, at armatures 878 and 879 prepares circuits for connecting the code combination conductors C7 and C1 to the lower winding of ringing relay 810. The locking circuit for relay 870 may be traced as follows: from ground at armature 806, conductor 729, armatures 845, 855, 865 and 875 through the winding of relay 870 to battery. Counting relay 880 energizes over the following circuit: from grounded conductor 697, armatures 826 and 836 in multiple, armatures 877, and through the winding of relay 880 to battery. Relay 880, upon energizing, at armature 811 opens the original energizing circuit of relay 870 and at armature 882 completes the locking circuit for itself independent of armature 887.

In response to the second impulse of the series line relay 690 again deenergizes and again opens the circuit of the impulsing relay 640 which likewise deenergizes. At armature 642 and resting contact relay 640 again completes the circuit for the series relay 650 before the latter relay has had time to deenergize, and also grounds conductor 733 for energizing relay 720 in series with relay 700. This circuit may be traced from grounded conductor 733 by way of armature 703 and working contact, through the lower winding of relay 700, and through the upper winding of relay 720 to battery. Relay 700 is maintained energized over this circuit and relay 720, upon energizing, at armature 721 prepares a circuit for reenergizing relay 640 when line relay 690 again energizes and at armature 722 opens the locking circuit of relay 710 which now deenergizes. Relay 710, upon deenergizing, at armatures 713 and 714 completes the locking circuit through the lower winding of relay 720 as follows: from grounded conductor 697 by way of resting contact and armature 714, armature 722 and working contact, armature 713 and through the lower winding of relay 720 to battery.

At the end of the second impulse line relay 690 again energizes and this time completes a circuit for energizing relay 640 from grounded armature

691 by way of conductor 726, armature 721, working contact and armature 701, conductor 726, and through the winding of relay 640 to battery. At armature 641 relay 640 again completes its own locking circuit and at armature 642 again completes the circuit for slow acting relay 600 and also removes ground from conductor 733. In response to the removal of ground from conductor 733 the circuit through the lower winding of relay 700 is opened and the latter relay thereupon deenergizes. At armature 701 relay 700 opens the last mentioned energizing circuit of relay 640 and prepares a point in the alternate energizing circuit for the same relay, at armature 703 again prepares the circuit for relay 710, and at armature 704 disconnects ground from conductor 716 and connects ground to conductor 709 for energizing counting relay 860 by way of armature 874. Counting relay 860 at armature 861 prepares the circuit extending to the finder group control relay 422, at armature 862 prepares the circuit extending to the finder units relay 380 which, however, is ineffective at this time and is only effective during the dialling of the second digit; at armature 862 prepares the energizing circuit for counting relay 850, at armature 864 completes its own locking circuit, at armature 865 opens the locking circuit of relay 870, and at armatures 866 and 867 prepares circuits for connecting the ringing relay 810 to the combination ring conductors C8 and C2 in case the third digit or the code ring digit is being dialled. The locking circuit for relay 860 extends from grounded conductor 729 by way of armatures 845, 855 and 864. Counting relay 870 deenergizes and at armature 873 again completes the locking circuit for relay S1, and at armature 876 prepares a point in the locking circuit for counting relay 830. At armatures 874 and 877 relay 870 opens the initial energizing circuits of relays 860 and 880, respectively, but said relays do not deenergize at this time because the same are maintained energized over their previously traced locking circuits, and at armature 872 opens the prepared circuit for the connector group control relay 432.

In response to the third impulse relays 690 and 640 deenergize and the latter relay at armature 642 again grounds conductor 733. Since relay 700 is in deenergized position the circuit for energizing relay 710 is completed through the resting contact of armature 703 from grounded conductor 733 and the latter relay upon energizing at armatures 713 and 714 opens the locking circuit of relay 720 whereupon relay 720 now deenergizes. At armature 711 relay 710 again prepares the energizing circuit for impulsing relay 640. At armature 722 relay 720 short circuits the upper winding of relay 700 by way of armature 714 and armature 703.

At the end of the third impulse line relay 690 energizes and at armature 691 completes the circuit for energizing relay 640. At armature 642 relay 640 disconnects ground from conductor 733 in order to remove the previously traced short circuit around the upper winding of relay 700. In the same manner as previously described relay 700 now energizes in series with relay 710 and relay 700 at armature 704 completes the circuit from grounded conductor 697 for energizing counting relay 850 by way of operated armature 863. At armature 851 relay 850 prepares a circuit for operating connector group control relay 432, at armature 852 prepares the circuit for energizing relay 760 or connector units relay 380, at armature 853 prepares the energizing circuit of

counting relay 846, at armature 854 completes its own locking circuit by way of armature 845 and grounded conductor 729, and at armature 855 opens the locking circuit of counting relay 866, which now deenergizes. Relay 866, upon deenergizing, at armature 861 opens the prepared circuit for the connector group control relay 422, at armature 862 opens the initial energizing circuit of relay 850, and at armature 865 prepares a point in the locking circuit for relay 870.

The foregoing cycle of operations of the impulse repeating relays 710, 700 and 720 continues until the end of the impulse series. That is, at the start of each odd impulse relay 710 energizes and relay 720 deenergizes and at the end of each odd impulse relay 700 energizes and grounds conductor 716 to operate the counting relay having its circuit prepared by the last actuated counting relay. At the start of each even impulse relay 720 energizes and causes relay 710 to deenergize and at the end of each even impulse relay 700 deenergizes and grounds conductor 709 to operate the counting relay having its circuit prepared by the last actuated counting relay. The energizing circuit for the impulsing relay 846 is taken through armatures 701, 711 and 721 so that on "light impulses" (weak impulses received over "leaky" lines) the circuit to relay 846 cannot be closed until after relay 710 or 720 operates thus insuring the proper operation of the impulse repeating relays. Impulse counting relays 850, 840 and 830, respectively, operate in response to the third, fourth and fifth impulses of the series. Each counting relay opens the locking circuit of the preceding counting relay, prepares the circuit to the succeeding counting relay. Each counting relay prepares the circuit to its associated connector group control relay in the same manner as described for counting relay 860.

On the sixth impulse counting relay 820 energizes from grounded conductor 709 by way of armature 823, and at armature 825 closes its own locking circuit to grounded conductor 723, at armatures 812 and 822 switches the generator lead 646, at armature 823 transfers the operating circuit for the connector group control and connector units relays, at armature 824 completes a circuit for maintaining relay S1 in operated position from grounded conductor 761, at its inner upper armature opens a point in its original energizing circuit after the relay is locked up by way of armature 825. At armature 826 relay 820 opens the locking circuit of relay 830 since relay 830 is at this time also energized, at armature 827 prepares circuits for connecting the code ringing combination leads C1 to C10, inclusive, to the lower winding of relay 810, and at armature 828 prepares a point in the circuit for connecting relay 810 to the mask conductor M2. Relay 830, upon deenergizing, at armature 831 again prepares the circuit of counting relay 870.

On the seventh impulse of the series relay 870 reenergizes closing its locking circuit at armature 875, opening the locking circuit of relay 830 at armature 876, preparing the circuit of relay 880 at armature 872, and at armature 874 preparing the circuit of relay 860. Counting relay 830 deenergizes and at armature 836 completes the circuit from grounded conductor 697 for reenergizing relay 820 by way of armature 877. Relay 830 operates and closes its locking circuit at armature 882 and at armature 881 opens the initial energizing circuit of relay 870. Succeeding impulses of the series operate relays 850, 850, and 840 in sequence, as previously described. The

following chart shows the relationship between the impulses dialled, the impulse repeating relays, the impulsing counting relays, and the circuits controlled thereby for the different digits.

Impulsing chart

	Imp. rept. rlys. and counting relays energized for each impulse	1st digit prepares ckt. for relays (S1-oper.)	2nd digit prepares ckt. for relays (S2-oper.)	3rd digit selects ring. comb. lead	
1st Imp.	710, 700-880, 870-----	-----	310	C1	
2nd Imp.	720-880, 860-----	422	320	C2	
3rd Imp.	710, 700-880, 850-----	432	330	C3	
4th Imp.	720-880, 840-----	442	340	C4	
5th Imp.	710, 700-880, 830-----	452	350	C5	
6th Imp.	720-830, 820-----	462	360	C6	
7th Imp.	710, 700-820, 880, 870-----	800	370	C7	
8th Imp.	720-820, 880, 860-----	-----	380	C8	
9th Imp.	710, 700-820, 880, 850-----	760	390	C9	
10th Imp.	720-820, 880, 840-----	750	300	C10	

After the last impulse of the series, series relay 650 deenergizes and at armature 652 opens the impulsing circuit to the impulse repeating relays 700, 710 and 720. At armature 653 relay 650 opens the locking circuit through the lower winding of relay 630 and also removes ground from conductor 697 to open the locking circuit of counting relay 880 and the locking circuit for the operated impulse repeating relays. At armature 654 relay 650 opens the initial energizing circuit of relay S1, and at the resting contact of armature 654 completes the circuit for energizing the selected connector group control relay, relay 760, relay 750, or relay 800, depending upon the digit dialled.

If the first digit received is the digit 1 series relay 650 upon restoring at armature 654 opens the circuit of relay S1 and the latter relay upon restoring at armature 806 opens the locking circuit to counting relay 870. At armature 653 relay 650 disconnects ground from conductor 697 to deenergize relay 800. In response to the deenergization of series relay 650 the counting relays 870 and 860 are restored to their normal position without accomplishing any useful function. This circuit arrangement is provided to prevent a preliminary impulse from tying up the equipment.

In case the first digit is the digit 9 series relay 650, upon restoring, at armature 654 closes the circuit for energizing relay 760 as follows: from ground by way of armature 638 and working contact, armature 654 and resting contact, armature 685 and resting contact, armature 677, conductor 735, armature 823 and working contact, armature 652, armature 817, conductor 778, and through the winding of relay 760 to battery. The digit 9 is only dialled when a trunk connection to another exchange is desired and will be described in detail hereinafter.

If the first digit is the digit 0 series relay 650, upon restoring, at armature 654 closes the circuit for energizing relay 750 as follows: from ground at armature 638 over the previously traced circuit to conductor 735, thence by way of armature 823 and working contact, armature 842, armature 815, conductor 777, and through the winding of relay 750 to battery. The digit 0 is only dialled when a trunk connection to a different exchange is desired, and will be described more fully hereinafter.

In case the first digit dialled is 7 series relay 650, upon restoring, at armature 654 closes the circuit for energizing relay 800 as follows: from ground at armature 638, over the previously 75

traced circuit to conductor 735, and thence by way of armature 823 and working contact, armature 872, armature 819, and through the winding of relay 890 to battery. Relay 890 closes the circuit to the connector group relay 432, and prepares to ring the lines in this group or the 30-line group with the second set of ten codes. It will therefore be seen that there may be as many as twenty subscribers on any of the lines in the 30-line group: the digit 3 to be used for calling the first ten subscribers on a line in the 30-line group; while the digit 7 will be used for calling the last ten subscribers on a line in the 30-group. These operations will be described more fully hereinafter.

In case the first digit is 2, 3, 4, 5 or 6, series relay 650, upon restoring, at armature 654 completes the circuit for energizing the connector group control relay in accordance with the digit dialled. In this case assuming that the first digit dialled is the digit 3, then the connector group control relay 432 is energized over the following circuit: from ground by way of armature 638 and thence over the previously traced circuit to conductor 735 and thence by way of armature 823 and resting contact, armature 851, armature 816, conductor 483, through the winding of relay 432 to battery. Connector group control relay 432, upon energizing, at armature 435 completes a locking circuit for itself from grounded conductor 314, which conductor, it will be remembered, was grounded by way of conductor 329 at armature 625 of relay 820. At the upper armatures of relay 432 the test leads are connected to the connector units relays through the windings of all of the cut-off relays in the 30-line group in a manner similar to that illustrated by the connection of conductor 494 through armatures 437 and 479 to the winding of cut-off relay 471 associated with the line 33. At armatures 433 and 434 relay 432 prepares circuits for energizing the connector group line relays 430 and 431, and at armature 436 completes a circuit for energizing relay 790 as follows: from ground by way of armature 426, conductor 487, armature 807, conductor 754, and through the winding of 790 to battery.

At armature 791 relay 780, upon energizing, at armature 791 and resting contact opens the initial energizing circuit of relay S1 and at its working contact prepares the circuit for energizing relay S2. At armature 792 relay 780 disconnects dial tone from the calling subscriber's line, at armature 793 disconnects ground from conductor 761, thereby opening the locking circuit of relay S1, at armature 795 prepares a circuit for selecting an idle trunk, and at armature 794 completes a locking circuit for itself which may be traced as follows: from ground by way of armature 625, armature 658 and resting contact, armature 676, conductor 698, through the normally closed springs controlled by armature 786, armature 794, and through the winding of relay 790 to battery. Relay S1, upon restoring, at armatures 808, 809, and 814 to 818, inclusive, disconnects the connector group control relays from the impulse counting relays, at armature 807 opens the initial energizing circuit of relay 790, at armature 819 opens a point in the circuit for relay 890, and at armature 806 disconnects ground from conductor 729 to open the locking circuit of the impulse counting relays which now restore.

The equipment is now ready to receive the second digit of the called number and in the same

manner as previously described the line relay 690 and the impulse repeating relay 840 follow the second series of impulses. The series relay 650, the impulse repeating relays 700, 710 and 720, and the counting relays operate as previously described, and in accordance with the previously disclosed chart. In this case, however, instead of series relay 650 completing a circuit for energizing relay S1 the circuit for relay S2 is completed as follows: from ground by way of armature 638 and working contact, armature 654 and working contact, armature 671, conductor 705, armature 782, armature 791 and working contact conductor 759, and through the winding of relay S2 to battery. At armature 829 relay S2 completes its own locking circuit which may be traced from grounded conductor 329 by way of armature 781 and conductor 758. At armature 839 relay S2 grounds conductor 729 to prepare the locking circuits for the impulse counting relays. At armature 848 prepares circuits for relay 780 and at the remaining armatures connects the connector units relays CUR to the impulse counting relays. The impulse counting relays operate in the same manner as previously described and prepare the circuits to the connector units relays in accordance with the digit dialled.

After the last impulse of the second series is received series relay 650 deenergizes and closes the circuit for energizing the idle connector units relay, opens the initial energizing circuit of relay S2, and opens the circuit of the impulse repeating relays to allow them to restore. Assuming that the second digit dialled is the digit 3 then when series relay 650 deenergizes said relay at armature 654 completes a circuit for energizing the connector units relay 330 as follows: from ground by way of armature 638 and working contact, armature 654 and resting contact, armature 685 and resting contact, armature 677, conductor 735, armature 823 and resting contact, armature 851, armature 869, conductor 3 in cable 315, and through the winding of relay 330 to battery. At armature 331 finder units relay 330 completes a locking circuit from grounded conductor 329, at armature 333 prepares a circuit for energizing connector group line relay 430, at armature 338 connects the test lead of the called line, in this case line 33, to conductor 399, at armatures 336 and 337 prepares a point in the circuit for connecting the talking conductors of the called line to talking conductors 389 and 379, and at armature 332 completes a circuit for energizing relay 780 by way of conductor 325, armature 348, conductor 776, and through the winding of relay 780 to battery.

At armature 781 relay 780 opens the locking circuit of relay S2, at armature 782 opens a point in the initial energizing circuits of both relays S1 and S2, at armature 783 prepares a point in the circuit for transmitting the ring back tone to the calling subscriber, at armature 784 prepares a point in the test circuit to determine whether the line called is busy or idle, at armature 785 completes a locking circuit for itself from grounded conductor 747 by way of armature 772, and at armature 786 transfers the locking circuit of relay 790 from conductor 698 to conductor 735. At armature 787 relay 780 prepares a point in the pick-up circuit of the ringing machine, at armature 788 prepares a point in the circuit for grounding conductor 729, at armature 789 prepares a circuit for maintaining relay 610 in energized position, and at armature 779 prepares a point in the hold circuit for relay 890.

Relay S2, upon deenergizing, at armature 839 opens the locking circuit of the impulse counting relays, at armature 848 opens the initial energizing circuit of relay 780, and at the remaining armatures disconnects the connector units relays from the impulse counting relay. The impulse counting relays thereupon deenergize and the equipment is ready to receive the third or ringing digit of the called number.

The called subscriber is signalled by means of various combinations of long and short rings. Subscribers 1 to 5 are signalled by a long ring accomplished by ground over the first mask lead M1 followed by a series of short rings accomplished by ground pulses over the combination leads C1 to C5 to operate ringing relay 810. Subscriber 6 is signalled by two long rings accomplished by ground over the first and second mask leads M1 and M2 to operate ringing relay 810 for two long periods. Subscribers 7 to 10 on a line are signalled by a series of short rings accomplished by ground pulses over the combination leads C7 to C10 followed by a long ring accomplished by ground over the second mask lead M2 to operate ringing relay 810. Subscribers 11 to 20, whenever twenty subscribers are on a single line, are signalled by a series of short rings accomplished by ground pulses over the combination leads C1 to C10, inclusive, to operate ringing relay 810. In the particular instance shown the first digit to be dialled in order to signal subscribers 11 to 20, inclusive, is the digit 7 which, due to the operation of the counting relays, causes the energization of relay 800 to open both mask leads M1 and M2 as well as selecting a connector group control relay in a certain line group, in this case the line group 30.

In response to the third digit line relay 690 and impulse repeating relay 640 follow the impulses as previously described. Relay 640 causes the energization of series relay 650 and the impulse repeating relays as previously described. In this case, however, series relay 650 at armature 654 opens the locking circuit of relay 790 instead of closing the circuit for relays S1 or S2. Relay 710, upon energizing at the beginning of the first impulse of the third series, at armature 712 completes a circuit for testing the idle or busy condition of the called line. In case the called line is busy ground will be connected to armature 479 and this ground extending by way of armature 547, conductor 494, armature 338, resting contact and armature 308, conductor 399, normally closed springs controlled by armature 753, conductor 723, armature 673 and resting contact, normally closed springs controlled by armature 683, conductor 719, armature 784, armature 712, armature 702 and resting contact, conductor 727, and through the lower winding of busy relay 610 to battery for energizing the latter relay.

In case the called line is idle relay 700, upon operating at the end of the first impulse, transfers the test lead of the called line from the busy relay 670 to the line test relay 680 at armature 702. In case the called line is idle, line test relay 680 is energized over the following circuit: ground through the upper winding of relay 680, conductor 728, working contact and armature 702, armature 712, and thence over the previously traced circuit to armature 479 and through the resting contact of armature 479 and through the winding of cut-off relay 471 to battery. The line test relay 680 and cut-off relay 471 energize in series over this circuit. Relay 790 restores as soon as its locking circuit is opened by the opera-

tion of series relay 650 and at armature 796 prepares the locking circuit for the impulse counting relays by grounding conductor 729. The impulse counting relays operate in response to the impulses received in the same manner as previously described, to prepare the connection of ring leads to the winding of the ringing relay 810.

Relay 680, upon energizing, at armature 681 opens a point in the dial tone circuit, at armature 682 prepares the circuit for energizing the connector group line relay corresponding to the digit dialled; at armature 683 connects direct ground to the test conductor of the called line instead of ground through the upper winding of line test relay 680, at armature 684 completes a locking circuit through its lower winding by way of armature 668 and grounded conductor 329, at armature 685 prepares a point in the circuit for energizing relay 890 of Fig. 8, at armature 686 opens the circuit extending through the upper winding of relay 630, at armature 687 prepares a point in the circuit for maintaining the slow to release relay 610 energized on reverting calls, and at armature 688 completes a circuit for grounding the generator start conductor 657 for energizing the generator start relay 900 in Fig. 9.

Cut-off relay 471, upon energizing over the previously traced circuit, at armatures 477 and 478 opens the circuit to relays 473 and 472 and at the working contact of armature 478 completes the circuit for energizing relay 470. The connection of direct ground to the test conductor of the called line at armature 683 makes the called line test busy to other subscribers calling the same. At armature 476 cut-off relay 471 connects this direct ground by way of conductor 457 to mark the line busy in the calling terminals of the finder group and units relays. Relay 470, upon operating, at armature 475 prepares a locking circuit for itself.

At the end of the series of impulses series relay 650, upon restoring, at armature 653 opens the locking circuit through the lower winding of relay 630 and also disconnects ground from conductor 697; at armature 652 opens a point in the impulsing circuit to the impulse receiving relay; at armature 651 opens a multiple circuit through resistance 609; and at armature 654 prepares the circuit for energizing relay 890. Relay 630, upon deenergizing, at armature 634 transfers the circuit for relay 600 to the contact 691 of relay 690; at armatures 635 and 637 opens a point in the circuit to the impulse receiving relay to prevent further operation of the impulse counting relays if the circuit to relay 640 is again interrupted, at armature 631 removes the resistance 609 from in multiple with relay 692 to improve transmission; at armature 632 completes a circuit for energizing the connector group line relay associated with the called line, in this case relay 430; at armature 638 prepares a further point in the circuit for energizing relay 890, and at armature 639 connects ground to the generator start lead 657 by way of armatures 745 and 688 for energizing the generator start relay 900 in Fig. 9.

The circuit for energizing the connector group line relay 430 may be traced as follows: from ground by way of armature 632, armature 682, conductor 319, armature 333 of the operated finder units relay 330, conductor 355 through armature 433 of the operated connector group control relay 432 and through the winding of connector group line relay 430 to battery. At armatures 438 and 439 relay 430 connects the talking conductors of the called line to the winding of

relay 740 and relay 774. One side of the called subscriber's line is connected by way of ground at armature 614, conductor 746 through the lower winding of relay 740, resting contact of armature 731, 742, and 752 and said armatures, conductor 774, resting contact and armature 813, conductor 389, armature 337, conductor 495, armature 438, to the upper line conductor of line 33. Battery through the winding of relay 774 is connected to the lower line conductor of the called line by way of resting contact and armature 751, conductor 768, resting contact and armature 812, conductor 379, armature 336, conductor 496, armature 439 and thence to the lower line conductor of line 33.

When generator start relay 900 energizes in response to the deenergization of relay 630 after the last digit has been dialled, relay 900 at armature 976 completes a circuit for energizing relay 890, at armature 977 completes an obvious circuit for energizing slow to operate relay 939, at armature 976' completes a circuit for energizing relay 960, and at armature 978 temporarily grounds the generator alarm lead extending to Fig. 11. The circuit for energizing relay 890 may be traced from ground by way of armature 638 and resting contact, armature 685 and working contact, conductor 736, armature 787, conductor 718, through the left hand winding of relay 890, pick-up conductor PU, armature 976, armature 984, and through the resistance to battery. Relay 890, upon energizing, at armature 892 completes a locking circuit for itself as follows: from ground by way of armature 932, hold conductor H, armature 892, conductor 715, armature 779, conductor 717, and through the right-hand winding of relay 890 to battery. At armature 891 relay 890 completes a circuit for energizing relay 730 from ground by way of armature 936 over the drain conductor D, armature 891, conductor 737, and through the winding of relay 730 to battery. Relay 730 at armature 731 and its working contact connects ground through the resistance 732 to the talking conductor by way of armatures 742, 752 and 813 to discharge the condensers on the line being signalled. The condensers connected to this line conductor are discharged so as to prevent the discharge of such condensers from operating the ring-cut-off relay 740 before the called subscriber answers. At armatures 893 and 894 relay 890 connects the mask leads M1 and M2 to the contacts of the impulse counting relays and to the upper winding of ringing relay 810. At the remaining armatures relay 890 connects the combination ringing conductors C1 to C10, inclusive, to the contacts of the impulse counting relays.

The circuit for energizing relay 960 extends from grounded armature 932, armature 976', armature 980 and resting contact, through the winding of relay 960, and by way of armatures 976 and 984 to the resistance and battery. The connection of ground to the general alarm lead at armature 978 if maintained thereon for a predetermined time causes the alarm equipment to operate and transmit an alarm in case the ringing machine or the code interrupter fails to operate. At armature 977 relay 900 also completes a circuit for energizing relay 940 by way of the resting contact and armature 985. Relay 940 energizes and operates its armature 989 to prepare a circuit for energizing the lower left-hand primary winding of the ringing transformer RT by way of springs 988 and armature 991, and at springs 986 prepares a circuit for short circuiting its own winding. A short interval after the energization of relay 940 relay 939 energizes and

opens the circuit of relay 960 at armature 984 which had previously energized and attracted its armature 981. At armature 983 relay 939 grounds the interrupter start lead for operating the interrupter relays 914 and 915 of the code interrupter and at armature 985 and its working contact completes a short circuit around relay 940 by way of springs 986 and armature 989. Relay 960 deenergizes. In response to the deenergization of relay 960 spring 981 starts to vibrate and prepares an intermittent circuit for slow to release relay 938. When relay 940 is short circuited said relay releases its armature 989 to open the short circuit around its own winding at springs 985, and to open the prepared circuit to the left-hand winding of the ringing transformer at springs 988. Vibrating armature 989 due to the weight on its lower end engages the spring 987 to prepare the circuit through the right hand primary winding of ringing transformer RT. Relay 940 now energizes from grounded armature 977 by way of resistance A and again completes, upon the operation of its vibrating armature 989, the short circuit around its own winding, and at the same time preparing the circuit through the lower left hand winding of the ringing transformer RT. Relay 940 again restores and removes its short circuit while the momentum of the weighted spring again closes the circuit to the right hand winding of the ringing transformer. The foregoing cycle of operations of relay 940 continues until its circuit is opened at armature 977. When relay 939 energized said relay at armature 983 grounded the interrupter start lead thereby completing a circuit for energizing interrupter relay 915, and the latter relay at armature 937 completes an obvious energizing circuit through the lower winding of relay 975. Relay 975, upon energizing, at armature 990 completes a locking circuit through its upper winding from grounded armature 977 and at armatures 991 and 992 completes the circuits to the left-hand and right-hand primary windings of the ringing transformer RT. The magnetic fields of the left-hand and right-hand primary windings of the ringing transformer RT are in opposite directions and when energized alternately by the vibrating armature 989, as previously described, they induce an alternating current in the upper secondary windings of the ringing transformer for ringing purposes. A part of the alternating current generated in the secondary winding of the ringing transformer extends by way of the condenser Y through the winding of alternating current relay 958 to ground. Relay 958 energizes and at armature 979 closes a circuit through the vibrating armature 981 for relay 938. Relay 938 energizes and is maintained energized as long as relay 958 is energized and armature 981 vibrates. Relay 938 at armature 982 removes ground from the alarm lead extending to Fig. 11 to prevent the transmission of an alarm. If for some reason ringing current is not generated then relay 958 does not energize to close the circuit to 938. Relay 938 will therefore not energize and the generator alarm conductor is maintained at ground potential to operate the alarm equipment after a predetermined interval.

When ground is connected to the interrupter start lead at armature 983 interrupter relay 915 alone energizes at this time because interrupter relay 914 is short circuited from the grounded interrupter start lead through the winding of relay 914 and by way of armature 957 back to

the interrupter start lead. Interrupter relay 915, upon energizing, at armature 936 disconnects ground from the winding of relay 730 to cause its deenergization. At armature 937 relay 915 completes the previously traced circuit through the lower winding of relay 975 and at armature 957 removes the short circuit from around relay 914 to permit the latter relay to energize by way of the grounded interrupter start lead. At armature 974 relay 915 completes the circuit for energizing master control relay 912 as follows: from ground at armature 983, armature 974, armature 973 and resting contact, and through the winding of master control relay 912 to battery. At armature 953 relay 912 prepares a circuit for energizing the odd code forming relays and completes a circuit for energizing the first code forming relay 901 as follows: from grounded interrupter start lead, armature 954 and resting contact, armatures 953, 951 and 950, and through the winding of relay 901 to battery. At armature 972 relay 912 prepares a circuit for energizing master control relay 913 in series with relay 912 but relay 913 does not energize at this time because its energizing winding is short circuited from the grounded interrupter start lead by way of resting contact and armature 971, armature 972 and working contact, through the upper winding of relay 913, resting contact and armature 973, and armature 974 to grounded interrupter start lead. Code forming relay 901, upon energizing, operates its upper armatures 9010 to 9016, inclusive, to prepare circuits for grounding the combination ring conductors C1 to C6, inclusive, and C10. At armature 941 relay 901 prepares the energizing circuit of the second code forming relay 902 and at armature 961 completes a locking circuit for itself through the normally closed springs controlled by armature 917 of relay 902 to the grounded start conductor. At armature 916 relay 901 completes a circuit for energizing relay 910 as follows: from grounded interrupter start lead through the normally closed springs controlled by armature 917, armature 916, through the normally closed springs controlled by armature 970, and through the winding of relay 910 and the resistance to battery. At armature 928 relay 901 connects the grounded interrupter start lead to mask conductor M1 for energizing ringing relay 910. This circuit may be traced from the grounded interrupter start lead by way of armature 928, mask lead M1, armature 893, resting contact and armature 828, armature 803, and through the upper winding of relay 810 to battery. Relay 810, upon energizing, at armature 951 opens the initial energizing circuit of code forming relay 901 and at armature 970 completes a locking circuit for itself from grounded interrupter start lead. After an interval interrupter relay 914 energizes and at armature 955 connects ground to the combination ring conductors C1 to C6, inclusive, and C10 by way of the operated armatures of the energized code forming relay. At armature 955 relay 914 completes a short circuit around interrupter relay 915 as follows: from grounded interrupter start lead through the winding of relay 915 by way of armature 956 back to grounded interrupter start lead. After an interval interrupter relay 915 deenergizes, at armature 936 again completes the circuit for energizing relay 730, and at armature 957 completes the previously traced short circuit around interrupter relay 914 to cause its deenergization. At armature 974 relay 915 opens the short cir-

cuit from around the upper winding of master control relay 913 with the result that relay 913 now energizes in series with master control relay 912 as follows: from ground by way of interrupter start lead, resting contact and armature 971, armature 972 and working contact, through the upper winding of relay 913 and through the winding of relay 912 to battery. At armature 954 relay 913 disconnects the grounded interrupter start lead from the odd numbered code forming relays at its resting contact and at its working contact prepares a circuit from the grounded interrupter start lead for energizing the even numbered code forming relays. At armature 973 relay 913 prepares a point in the circuit for later energizing the master control relay 911, at armature 929 connects the mask lead M2 to armature 923, and at armature 930 connects the mask lead M1 to armature 919.

A short interval after interrupter relay 915 deenergizes and short circuits relay 914 at armature 957, interrupter relay 914 deenergizes, and at armature 956 opens the short circuit around relay 915 to permit the latter relay to reenergize from the grounded interrupter start lead. At armature 955 relay 914 disconnects ground from the ringing combination leads. Relay 915 operates from grounded interrupter start lead, and the foregoing cycle of operations of relays 915 and 914 continue until ground is removed from the interrupter start lead at armature 983 by the deenergization of relay 939.

The second time relay 915 is energized, or on the second impulse, the interrupter relay completes a circuit for energizing master control relay 911 as follows: Grounded interrupter start lead, armature 974, armature 973 and working contact, through the lower winding of relay 913 and through the upper winding of relay 911 to battery. Relay 913 is maintained energized over this circuit until interrupter relay 915 deenergizes. Master control relay 911 at armature 952 completes the circuit for energizing the next even numbered code forming relay, in this case relay 902, as follows: from grounded interrupter start lead, armature 954 and working contact, armature 952, armature 941, and through the winding of code forming relay 902 to battery. At armature 971 the master control relay 911 opens the locking circuit of relay 912 and prepares a locking circuit for itself which is completed when relay 912 deenergizes. Master control relay 912 deenergizes and at armature 972 completes a locking circuit from the lower winding of relay 911 to grounded interrupter start lead by way of armature 971. At the end of the impulse period, or at the time when interrupter relay 915 deenergizes, the latter relay at armature 974 opens the circuit through the lower winding of relay 913 to cause the latter relay to deenergize. At armature 954 relay 915 opens the original energizing circuit of code forming relay 902 at its working contact and at its resting contact prepares the circuit for energizing the next odd code forming relay, and at armature 973 prepares the circuit for energizing relay 912.

Code forming relay 902, upon energizing, at its upper armatures prepares circuits for grounding the combination ringing conductors C1 to C6, inclusive, C9 and C10. At armature 942 relay 902 prepares the circuit for the next code forming relay and at armature 962 completes a locking circuit for itself by way of normally closed springs controlled by armature 918 to the grounded interrupter start lead, and at armature 917 75

opens the locking circuit of the first code forming relay 901 which now deenergizes and also connects the grounded interrupter start lead to mask conductor M1, thereby maintaining conductor M1 grounded.

On the next or third impulse the circuit to master control relay 912 is again closed. The master control relay 912, upon energizing, at armature 912 opens the locking circuit of master control relay 911 which now deenergizes, and at armature 953 connects the grounded interrupter start lead to the next odd code forming relay, in this case relay 903. Relay 911, upon deenergizing, at armature 952 opens a point in the original energizing circuit of the even numbered code forming relays and at armature 971 completes the short circuit around the upper winding of relay 913. At the end of the impulse when relay 915 deenergizes the short circuit around the upper winding of relay 913 is removed and relay 913 thereupon energizes in series with relay 912. The foregoing cycle of operations of relays 913, 911 and 912 continues until ground is removed from the interrupter start conductor whereupon the interrupter relays 914 and 915 will restore.

The following chart shows twenty-four periods of operations of the code interrupter relays in which the periods conform to the energized and deenergized conditions of the master interrupter relays 914 and 915. For example, as shown in the chart, the first vertical column indicates the energized condition of the interrupter relays 914 and 915. The second vertical column indicates which of the master control relays are operated. For the first period it will be seen in accordance with the chart that master control relay 912 is energized. The third column indicates which of the code forming relays are operated for the various periods. It will also be seen that code forming relays 901 and 910 are energized for the first and second periods. The last column indicates which of the combination ringing leads are grounded during the different periods. As indicated in the chart during the first period when relay 914 is energized, relays 901, 910 and 912 are also energized and the combination ringing leads M1, C1 to C6, inclusive, and C10 are grounded. During the third period, or the third impulse as previously described, relays 902, 910, 911, and 913 are energized and the ringing leads M1, C1 to C6, inclusive, and C9 and C10 are grounded.

Code interrupter chart (one cycle)

Periods	Interrupter relays 914 and 915	Master control relays oper.	Code forming relays oper.	Ring combination leads grounded
1	Energ.	912	901-910	M1-C1, 2, 3, 4, 5, 6, 0.
2	Deenerg.	912-913	901-910	M1.
3	Energ.	911-913	902-910	M1-C1, 2, 3, 4, 5, 6, 9, 0.
4	Deenerg.	911	902-910	M1.
5	Energ.	912	903-910	M1-C5, 6, 8, 9, 0.
6	Deenerg.	912-913	903-910	M1.
7	Energ.	911-913	904-910	M1-C1, 2, 3, 4, 6, 7, 8, 9, 0.
8	Deenerg.	911	904-910	M2, C2, 3, 4, 5, 7, 8.
9	Energ.	912	905-910	M2.
10	Deenerg.	912-913	905-910	M2-C3, 4, 5, 6, 7, 9, 0
11	Energ.	911-913	906-910	M2.
12	Deenerg.	911	906-910	M2-C4, 5, 8, 9, 0.
13	Energ.	912	907-910	M2.
14	Deenerg.	912-913	907-910	M2-C5, 7, 8, 9.
15	Energ.	911-913	908-910	
16	Deenerg.	911	908-910	
17	Energ.	912	909-910	
18	Deenerg.	912-913	909-910	
19	Energ.	911-913	909	
20	Deenerg.	911	909	
21	Energ.	912	909	
22	Deenerg.	912-913		
23	Energ.	911-913		
24	Deenerg.	911		
1	Energ.	912	901-910	M1-C1, 2, 3, 4, 5, 6, 0.
2	Deenerg.	912-913	901-910	

In the same manner as previously described the code forming relays are successively energized to prepare the circuit for the succeeding code forming relay and to open the locking circuit for the preceding code forming relay to cause the preceding code forming relay to deenergize. Each code forming relay is thus energized and during the time that interrupter relay 914 is energized such code forming relay will ground the combination ringing leads in accordance with its upper armatures and in accordance with the chart. It will be noticed that the first four code forming relays 901 to 904, inclusive, maintain ground on the mask conductor M1 continuously as long as any one of these code forming relays are energized and in the case of code forming relay 904 mask conductor M1 is maintained grounded by relay 904 until master control relay 913 deenergizes. This circuit may be traced from grounded interrupter start lead armature 919 and armature 930 to conductor M1. After relay 913 deenergizes there is a period of time in which neither of the mask conductors M1 or M2 are grounded by the code forming relays.

When the interrupter relays energize for the ninth period thereby causing the energization of master control relay 912 and code forming relay 905 the mask conductor M2 is now grounded as follows: from grounded interrupter start lead, armature 920 to mask conductor M2. In a similar manner mask conductor M2 is maintained grounded continuously by the operation of code forming relays 905, 906, 907 and 908, and master control relay 913. The last circuit for maintaining mask conductor M2 grounded extends from grounded interrupter start lead through armature 923 and armature 929 of relay 913 to conductor M2. From the foregoing it will be seen by referring to the chart, that mask conductor M1 is maintained continuously grounded from the first period through the seventh and that mask conductor M2 is continuously grounded starting with the ninth period through the fifteenth period.

Code forming relay 908 is energized during the fifteenth period and at armature 948 prepares the circuit for relay 909, at armature 968 completes its own locking circuit, at armature 923 maintains ground on the mask lead M2 until relay 913 deenergizes, at armature 931 completes a circuit for energizing relay 959 by way of its lower winding. Relay 959 at armature 980 opens a point in the circuit of relay 960 at its resting contact, and at its working contact completes a locking circuit for itself through its upper winding by way of armature 976 and the holding conductor H which is grounded at armature 932. When the interrupter relays 914 and 915 are energized during the seventeenth period, master control relay 912 is energized to complete the circuit for energizing code forming relay 909 by way of armatures 953 and 948. At armature 950 relay 909 opens a point in the initial energizing circuit of code forming relay 901, at armature 949 prepares a point in the circuit for short circuiting relay 910, at armature 969 completes its own locking circuit, at armature 924 opens the locking circuit of relay 908, at armature 933 opens a point in the circuit for connecting battery to the pick-up lead PU, and at armature 932 removes ground from the hold conductor H for unlocking relay 909 and relay 959.

When the interrupter relays are energized during the nineteenth period master control relays

911 and 913 are energized to complete a circuit for short circuiting relay 910. This circuit may be traced from grounded interrupter start lead by way of armature 954 and working contact, armatures 952 and 949 through the winding of relay 910, armature 970, to interrupter start lead. Relay 910, upon restoring, at armature 951 prepares a point in the circuit for the first code forming relay 901, at armature 970 opens a point in its own locking circuit and prepares a point in its initial energizing circuit, at armature 925 prepares a point in the circuit for short circuiting relay 909, and at armature 934 prepares a point in the circuit for connecting battery to the pick-up lead PU.

When the master control relays 912 and 913 are energized during the twenty-second period relay 909 is short circuited as follows: from grounded interrupter start lead, armature 969 through the winding of relay 909, and by way of armatures 925, 926 and 927 back to interrupter start lead. Relay 909, upon restoring, at armature 950 prepares a point in the circuit for energizing code forming relay 901, at armature 949 opens a point in the circuit to relay 910, at armature 969 opens a point in its own locking circuit, at armature 924 prepares a locking circuit for relay 908, at armature 932 again connects ground to hold conductor H, and at armature 933 prepares a circuit for connecting battery to the pick-up lead which circuit is completed at armature 925 when relay 911 energizes in the twenty-third period.

The connection of battery to pick-up lead PU completes the circuit for energizing relay 960 as follows: from ground by way of armature 932, armature 976, armature 980 and resting contact, relay 960, pick-up conductor PU, armatures 935, 934 and 933, and through the resistance to pick-up battery. The connection of negative battery to pick-up lead PU also completes the circuit for reenergizing relay 890 in case the called subscriber has not answered at this time. The circuit for reenergizing relay 890 may be traced as follows: from ground by way of armature 638 and resting contact, armature 685 and working contact, conductor 736, armature 787, conductor 718, through the left-hand winding of relay 890, to battery on the pick-up conductor PU. As will be seen by referring to the code interrupter chart, none of the code forming relays are energized during the twenty-third and twenty-fourth periods, and in case the called party has not answered the code interrupter starts on its second cycle of operations through its 24 periods.

At the beginning of the code cycle it will be remembered that relay 890 energized to prepare the ringing circuit and to prepare the circuit for operating relay 730. Since the third digit dialled was 3 it will be remembered that relays 710, 700, 880 and 850 are operated to select the ring combination lead C3. (See impulsing chart.) The code ring for the called subscriber #333 is one long ring followed by two short rings. As previously described, since the mask conductor M1 is continuously grounded during the first seven periods of the operation of the interrupter relays, ringing relay 810 is energized for a corresponding period of time to produce a long ring. The circuit for energizing relay 810 extends from the grounded mask conductor M1 through armature 893, resting contact and armature 828, armature 803, and through the upper winding of ringing relay 810 to battery. Ringing lead combination C3 is

grounded during the first, third and seventh periods, at which time a circuit through the lower winding of ringing relay 810 is completed as follows: from the grounded ring combination lead C3, armature 883, armature 857, resting contact and armature 827, and through the lower winding of ringing relay 810 to battery. This latter circuit, however, is ineffective during the first, third and seventh periods because the ringing relay 810 is already energized through its upper winding over the mask lead M1. Relay 810, upon energizing, at armature 811 connects the generator lead 646 to conductor 767 for transmitting a ring back tone to the calling subscriber as follows: from generator lead 646, armature 811, conductor 767, working contact and armature 783, conductor 708, resting contact and armature 872, tone condenser TC, to talking conductor 693 and thence through the talking condenser and over the heavy talking conductor to the calling line. At armature 812 relay 810 connects the ringing current to the called line to signal the called subscriber over the following circuit: generator lead 646, resting contact and armature 821, working contact and armature 812, talking conductor 379, armature 336, conductor 496, armature 439, over the lower talking conductor extending to the called line, and thence through the switchhook springs, ringing condenser, and bells at station 333 to ground. The other subscribers having their ringers connected to this line conductor are also signalled. In case the subscribers on this line should have their ringers bridged across the two line conductors instead of the ringers being grounded the return circuit to the ground in such a case would extend by way of the upper talking conductor, armature 438, conductor 495, armature 337, conductor 389, armature 813 and working contact, and through armature 822 and working contact to ground.

During the eighth period of the operation of the code interrupter ground is disconnected from the mask lead M1 by the deenergization of master control relay 913 previously described. In response to the removal of ground from conductor M1 the circuit through the upper winding of ringing relay 810 is opened with the result that the ringing relay now deenergizes to disconnect ringing current from the called line. Up to this point the operation of the ringing relay 810 has produced one long ring since the conductor M1 has been grounded from the first to the seventh periods, inclusive. As previously described, during the ninth period the mask conductor M2 is grounded but in this case since relay 820 is not energized this mask conductor M2 is not connected to the ringing relay 810. The ringing relay 810 is therefore free to energize whenever the combination ring lead C3 is grounded. By referring to the code interrupter chart it will be seen that in response to the operation of code forming relays 905 and 906 code combination ring conductor C3 is grounded during the ninth and eleventh periods of operation of the code interrupter relays. Ringing relay 810 therefore energizes during the ninth period and again energizes during the eleventh period to transmit ringing current to the called line to produce two short rings. Since the combination ring conductor C3 is not again grounded during the remaining periods of the code interrupter, ringing relay 810 is not again energized. From the foregoing it will be seen that in one complete cycle of operation of the code interrupter, ringing relay 810 has been operated during periods 1 to 7, inclusive, dur-

ing the ninth period and during the eleventh period to transmit the ringing code to the called subscriber or the ringing code comprising one long ring and two short rings. The following is the code ringing chart showing the ringing code for subscribers 1 to 20, inclusive, for the digits 1 to 0, inclusive.

Code ringing chart

Code ring digits	Ringing code for subscribers 1 to 10	Ringing code for subscribers 11 to 20 (when 1st digit is 7)
1	1-long-----	2 short-1 short.
2	1-long-1 short-----	2 short-2 short.
3	1-long-2 short-----	2 short-3 short.
4	1-long-3 short-----	2 short-4 short.
5	1-long-4 short-----	3 short-4 short.
6	1-long-1 long-----	4 short-1 short.
7	1 short-1 long-----	3 short-1 short.
8	2 short-1 long-----	3 short-2 short.
9	3 short-1 long-----	3 short-3 short.
0	4 short-1 long-----	4 short-2 short.

The first five subscribers on a line have their ringers connected to the same talking conductor, while the remaining five subscribers have their ringers connected to the other talking conductor in case the ringers are grounded. Assuming that subscriber 336 instead of 333 has been called, two long rings are transmitted by ringing relay 810. In this case the third digit dialled would be the digit 6 and therefore, referring to the impulsing chart, it will be seen that relays 720, 830 and 820 are energized to select the ring combination lead C6. As previously described, mask conductor M1 is grounded during the periods 1 to 7, inclusive, and since the impulsing relays 830 and 820 are energized, relay 810 is energized during this period of time as follows: grounded mask conductor M1, armature 893, resting contact and armature 804, armature 837, working contact and armature 827, and through the lower winding of relay 810 to battery. Ringing relay 810 is deenergized in during the eighth period in response to the deenergization of relay 913 and since mark conductor M2 is grounded during the periods 9 to 15, inclusive, ringing relay 810 is energized over the following circuit: from grounded mask conductor M2, armature 894, working contact and armature 823, armature 803, and through the upper winding of ringing relay 810 to battery. Ringing relay 810 connects generator to the called line in the same manner as previously described to transmit two long rings to signal subscriber 336.

Subscribers 337, 338, 339 and 330 are signalled by a combination of short rings followed by one long ring. Assuming now that subscriber 337 is being called, and in response to the dialling of the digit 7 relays 710, 700, 820, 880, and 870 are energized to select ringing combination lead C7. In this case during the time mask lead M1 is grounded no circuit is completed for ringing relay 810 because counting relay 820 is energized and counting relay 830 deenergized. The grounding of mask conductor M1 is therefore ineffective to operate ringing relay 810. By referring to the code interrupter chart it will be seen that ringing combination lead C7 is grounded by the operation of code forming relay 904 during the seventh period. A circuit may now be traced for energizing ringing relay 810 as follows: from grounded conductor C7, armature 886, armature 877, working contact and armature 827, and through the lower winding of ringing relay 810 to battery. Ringing relay 810 is operated over the above traced circuit to produce a short ring on the

called line. Since relay 820 is energized at this time the grounding of mask conductor M2 during groups nine to fifteen, inclusive, causes the continuous energization of ringing relay 810 during these periods to transmit a long ring to the called line. Subscriber 337 is therefore signalled by one short and one long ring. In the same manner as just described the remaining subscribers on this line may be signalled in accordance with the third digit dialled. By referring to the impulsing chart it can be seen which of the impulse repeating and counting relays are energized for any digit in order to select a particular ringing combination lead. Then by referring to the code interrupter chart it will be seen when the two mask conductors M1 and M2 and the code ring combination leads C1 to C10, inclusive, are grounded for the different groups, the code ringing chart shows the different ringing codes for the different subscribers.

Assuming now that line 33 has twenty subscribers thereon, and that subscriber 736 is desired, the calling subscriber will dial the digits 7, 3 and 6. As previously described, in response to dialling the first digit, the digit 7, relay 800 is energized and locked in energized position. Relay 800 also completes the circuit for energizing connector group relay 432 in the same manner as previously described. At armatures 803 and 804 relay 800 opens the circuits to the mask conductors M1 and M2 so that the grounding of the mask conductors M1 and M2 is ineffective for energizing the ringing relay 810. Ringing relay 810 is thereafter only energized over its lower winding in accordance with the number of times ground is connected to the combination ringing leads C1 to C10, inclusive. In the particular case assumed, that is, in calling subscriber 736, relays 720, 830 and 820 are energized to select ring combination lead C6. By referring to the code interrupter chart it will be seen that ring combination lead C6 is grounded during the first, third, fifth, seventh, and eleventh periods. Each time combination lead C6 is grounded a circuit may be traced for energizing ringing relay 810 as follows: ground from lead C6, armature 895, working contact and armature 804, armature 837, working contact and armature 827, and through the lower winding of ringing relay 810 to battery. Ringing relay 810 energizes in response to each of these impulses to transmit the code of four short rings followed by one short ring.

Assuming that subscriber 733 had been dialled, then counting relay 850 selects the combination ringing lead C3 and each time combination lead C3 is grounded a circuit may be traced by way of armature 883, armature 857, resting contact of armature 827, and through the lower winding of relay 810 to battery. In case subscriber 730 is signalled, then counting relays 820 and 840 are energized to select lead C10. Each time lead C10 is grounded by the operation of the code interrupter, a circuit may be traced for energizing ringing relay 810 as follows: from grounded conductor C10, armature 897, armature 846, working contact and armature 827, and through the lower winding of ringing relay 810 to battery. The ringing relay 810 operates each time the selected ring lead is grounded to transmit a series of short rings followed by a series of short rings, to signal subscribers 11 to 20 on this line.

When the called party hears his code signal and answers either between code pulses or code cycles, a circuit is completed through the subscriber's loop for energizing ring cut-off relay 740 as fol-

lows: from ground by way of armature 614, conductor 746, through the lower winding of relay 740, resting contact and armature 731, resting contacts and armatures 742 and 752, conductor 774, resting contact and armature 813, conductor 389, armature 337, conductor 495, armature 430, over the line conductors and through the substation loop comprising the receiver, transmitter, and calling device at the substation, back over the line conductor, armature 439, conductor 496, armature 336, conductor 379, armature 812 and resting contact, conductor 760, armature 751 and resting contact, and through the impedance 774 to battery. Relay 740, upon energizing, at armature 744 completes its locking circuit through its upper and lower windings in series to grounded armature 614 by way of conductor 746, at armature 742 connects the winding of relay 770 to talking conductor 774 extending to the called line and at armatures 741, 742 and 743 completes the talking circuit between the calling and called subscribers' lines, and at armature 745 removes ground from the generator start lead 657 to deenergize relay 900 and stop the ringing machine shown in Fig. 9. Relay 770 energizes over the called line loop as follows: from ground through the winding of relay 770, working contact and armature 742, resting contact and armature 752, talking conductor 772, resting contact and armature 813, conductor 389, and thence over the previously traced circuit including the operated armatures of the connector units relay 336 and the connector groups relay 430, through the called subscriber's line loop back to talking conductor 379, through armature 812 and resting contact, conductor 760, armature 751, through the winding of the impedance 772 to battery. At armature 771 relay 770 prepares a point in the automatic trunk hunting circuit to be explained more fully hereinafter, at armature 772 opens the locking circuit of relay 760, and at armature 773 disconnects the lower winding of relay 604 from the time pulse lead 655 to prevent the automatic disconnection of this switch. Relay 760 upon restoring, at armature 781 prepares a locking circuit to relay S2, at armature 782 prepares a point in the initial energizing circuit of relay S1, at armature 783 opens a point in the ring back tone circuit, at armature 784 opens a point in the initial line testing circuit, at armature 785 opens a point in its own locking circuit, and at armature 786 prepares a point in the locking circuit for relay 750, at armature 787 opens a part of the circuit through the left-hand winding of relay 890, at armature 788 opens the locking circuit for the impulse counting relays to allow the same to restore, at armature 789 opens a point in the holding circuit of relay 610, and at armature 779 opens the holding circuit of relay 890 to allow the latter relay to deenergize. The counting relays restore to their normal position or the position shown in the drawing, and relay 890, upon deenergizing, disconnects the code interrupter from the link circuit.

Talking battery to the calling party is completed through the windings of relay 690 and 692 over the heavy talking conductors extending to the calling line, and talking battery to the called party is furnished through the windings of relays 770 and 774 over the previously traced circuit including the heavy talking conductors extending to the called line. The talking circuit between the two subscribers includes talking conductors 693 and 695 and the two talking condensers. The

calling subscriber is now directly connected to the calling subscriber and may converse as desired.

After the conversation and in response to the called party replacing his receiver the circuit to relays 770 and 774 is opened to cause the deenergization of relay 770. Relay 770 at armature 773 connects the lower winding of time release relay 604 to the time pulse lead 655 to insure the release of this equipment if the calling subscriber fails to disconnect. When the calling subscriber replaces his receiver the circuit to relays 690 and 692 is opened to deenergize line relay 690. Relay 690, upon restoring, at armature 691 opens the circuit of relay 640 and likewise opens the circuit to slow to release relay 600. Relay 640, upon deenergizing, at armature 642 completes the circuit for energizing series relay 650 which operates at this time without any useful function. After an interval relay 600 deenergizes and at armature 601 opens the circuit to slow to release relay 610, at armature 602 removes ground from the test lead 290 extending to the calling line to allow the cut-off relay 171 to restore and free the calling line, and at armature 603 opens the circuit to the operated finder group line relay 120 to allow it to restore to normal.

Cut-off relay 171 deenergizes, at armatures 178 and working contact opens the circuit to relay 170, and at its resting contact connects ground to relay 172 to prepare for its energization on succeeding calls. At armature 177 cut-off relay 171 connects the impedance 173 to the subscriber's line, and at armature 176 disconnects its own winding from the test conductor in the finder relay groups.

Relay 610, upon restoring, at armature 611 opens one of the multiple grounds to the locking circuits of the finder group control relay 122 and finder units relay 210, at armature 612 opens a point in the circuit to the trunk test relay 660, at armature 613 opens the circuit through the lower winding of relay 620, at armature 614 opens the locking circuit through the lower winding of relay 740, and at armature 615 opens a point in the circuit extending through the lower winding of time release relay 604. Relay 740 deenergizes when its circuit is opened at armature 615, and at armature 745 prepares a point in the circuit for starting the ringing machine, and at armatures 741, 742 and 743 opens the talking circuit. Relay 620, upon deenergizing, at armature 622 opens the locking circuit of finder group control relay 122 and finder unit relay 210, thus allowing these relays to restore, at armature 623 opens a point in the circuit through series relay 650, at armature 624 opens a point in the locking circuit of busy relay 670 in case the latter relay is locked in energized position, at armature 625 opens the locking circuit to relay 680, trunk test relay 660 in case it is locked in energized position, trunk relays 750 and 760 in case they are locked in energized position, relay 890 in case it is locked in energized position, and also opens the locking circuits of finder unit relay 330 and connector group control relay 432, thus allowing these relays to restore and free the called line. At armature 626 relay 620 removes ground from the guard lead 616 to make this equipment available for other calls and at the resting contact of armature 626 connects ground to the common all link busy conductor 629 for maintaining the all link busy relay 503 in energized position, and at armature 627 disconnects ground from conductor 747. Relay 680, upon deenergizing, at armature 682 opens the circuit to the finder group line relay 430, and at armature 75

663 disconnects ground which made the called line busy. In response to the operations just described all of the relays are returned to their normal positions and the link circuit is now available for use in other calls.

Having explained the operations which take place when an idle line is called, a description will now be given of the operations which take place when the called line is busy. It will be remembered that during the receipt of the impulses of the third digit impulse repeating relay 710 energizes and at armature 712 completes the circuit for energizing busy relay 670 from the ground encountered on the test lead of the busy called line by way of the circuit previously traced through the right-hand winding of busy relay 670. Relay 670, upon energizing, at armature 671 opens a point in the circuit for relays S1 and S2, and at armature 672 connects the busy tone to the calling subscriber over the following circuit: from busy tone lead 689, working contact and armature 672, tone condenser TC to conductor 693, through the talking condenser, and thence over the heavy talking conductors through the calling subscriber's loop. At armature 673 relay 670 prepares a circuit for momentarily grounding the test lead of the called line during the release operation of the link, at armature 674 opens a point in the trunk test circuit, and at armature 675 completes a locking circuit for itself as follows: from ground by way of armature 667, armature 624, armature 675, and through the upper winding of busy relay 670 to battery. At armature 676 relay 670 removes ground from conductor 689, at armature 678 opens the circuit extending through the upper winding of relay 630, at armature 679 prepares a point in the circuit through the lower winding of line test relay 680, and at armature 688 prepares a circuit for reenergizing relay 610.

At the end of the third digit series relay 650 deenergizes in the same manner as previously described, and at armature 653 opens the locking circuit of relay 630. At armature 633 relay 630 closes the initial energizing circuit for relay 640, at armature 634 transfers the circuit for relay 600 to armature 691, at armature 637 prepares a point in the circuit used in making reverting calls, and at armature 639 prepares a point in the circuit for grounding the generator start lead.

When the calling subscriber hears the well-known busy tone, such subscriber will replace his receiver and in so doing opens the circuit of relay 690 whereupon relay 690 deenergizes. The deenergization of relay 690 opens the circuit of relays 600 and 640 at armature 691. Relay 640, upon restoring, at armature 642 completes a circuit for energizing the series relay 650, the operation of which at this time is without effect. Relay 600, upon restoring, at armature 603 opens the circuit to the finder group line relay 120, thus allowing it to deenergize and disconnect the calling line from the link circuit, at armature 602 removes ground from the test lead of the calling line to free the calling line and to allow the line cut-off relay 171 to likewise deenergize. At armature 601 relay 600 opens the circuit of relay 610 which deenergizes after an interval. At armature 611 relay 610 opens one of the multiple ground connections to the locking circuit of the finder group control relay 122 and the finder unit relay 210, at armature 613 opens the circuit through the lower winding of relay 620, and at armature 615 opens the circuit through the lower

winding of time release relay 604. Relay 620, upon restoring, at armature 621 opens a point in the dial tone circuit, at armature 622 opens the locking circuit of the operated finder control relay 122 and finder unit relay 210 to cause the same to deenergize, at armature 623 opens the circuit to series relay 650, at armature 624 opens the locking circuit of busy relay 670, at armature 625 removes ground from conductor 329 to deenergize the relays locked thereto as previously described, at armature 626 removes ground from the guard lead 616 to free the link circuit, and at the resting contact of armature 626 grounds the all link busy conductor 629 to maintain the all link busy relay 588 in energized position. At armature 627 relay 620 opens the locking circuit of relay 780. Relay 780 deenergizes and at armature 788 opens the locking circuit to the operated impulse counting relays allowing them to restore in the same manner as previously described. Busy relay 670, upon deenergizing, opens the busy tone circuit at armature 672, and at armature 673 removes ground from the test lead of the called line. The connector group control relay 432 and the connector units relay 330 deenergize when ground is removed from conductor 329 by the release of relay 620. All of the relays are now returned to their normal position and may be used in subsequent calls.

A description will now be given of the operations which will take place when a subscriber calls another subscriber on his own line. Assuming that the calling subscriber 216 desires to make a reverting call and call another subscriber on his own line, for example, subscriber 217, the calling subscriber 216 will seize an idle link circuit and operate the same in accordance with the digits 2, 1, and 7 in the same manner as previously described. At the start of the third digit since the called line is on the same line as the calling line the called line will therefore test busy and the busy relay 670 will energize in the same manner as previously described. When the calling subscriber hears the well known busy tone such subscriber will replace his receiver, thereby opening the circuits of relays 690 and 692. Relay 690, upon restoring, at armature 691 opens the circuit to relay 640 and to relay 600 as previously described. Relay 640, upon deenergizing, at armature 642 energizes series relay 650, at armature 654 connects ground to the test lead of the calling line to maintain the calling line cut-off relay 171 in energized position as follows: ground by way of armature 653, armature 637 and resting contact, working contact and armature 673, conductor 723, through the normally closed springs controlled by armature 753, conductor 399, armature 313 of the operated connector units relay 60310, conductor 497, armature of the operated connector group control relay 422, to conductor 156 included in three-conductor cable 159, armature 179 and resting contact, and through the winding of cut-off relay 171 to battery. Slow to release relay 600, upon deenergizing when its circuit is opened at armature 691, at armature 601 opens the circuit to relay 610, at armature 603 opens the circuit to the finder group line relay 120, and at armature 602 and its working contact removes ground from the winding of cut-off relay 171, but cut-off relay 171 does not deenergize at this time because such relay is maintained in energized position from ground by way of armature 653 over the circuit extend-

ing through the operated connector relay as previously described. At the resting contact of armature 602 relay 600 completes a circuit for energizing line test relay 680 as follows: from ground at armature 653 over the circuit previously traced to conductor 156, and thence by way of armature 179 and resting contact, armature 176, armature 129, conductor 197, armature 218, conductor 299, armature 602 and resting contact, armatures 669 and 679, and through the lower winding of test relay 680 to battery. From the foregoing it will be seen that since the called line is the same as the calling line in making a reverting call the ground circuit applied by the series relay 650 to be called line is extended through the connector and finder relay contacts back to the line test relay 680 in order to energize the latter relay. Relay 680, upon energizing, at armature 684 completes its locking circuit and extends a multiple ground to cut-off relay 171 as follows: from ground by way of armature 625, armature 668 and resting contact, armature 684, armature 679, armature 669, resting contact and armature 602, conductor 299 and thence through the armatures of the operated finder unit and finder group relays to armature 176 and the winding of relay 171. At armature 687 relay 680 completes a circuit for energizing relay 610 as follows: from ground by way of the normally closed contacts controlled by armature 607, armatures 658 and 687, conductor 739, armature 789, conductor 738, and through the winding of relay 610 to battery. At armature 682 relay 680 completes a circuit from grounded armature 632 by way of conductor 319 and the operated connector unit relay 310, and the operated connector group control relay 422, through the winding of connector group line relay 420 to battery, for energizing the latter relay, and at armature 685 completes a circuit for energizing relay 890 as previously described. At armature 688 relay 680 completes the circuit for grounding the generator start lead 657 to energize relay 900 and start the ringing machine in Fig. 9.

The ringing machine and code interrupter in Fig. 9 operates in the same manner as previously described in response to the operation of relay 900 when the generator start lead 657 is grounded in response to the operation of relay 680. When battery is connected to pick-up lead PU at armature 976 by the operation of relay 900 in case the ringing machine is not in use, or when the pick-up lead PU is connected to battery by way of armatures 933, 934 and 935, by the operation of relay 911, near the end of a code cycle, the circuit of relay 890 is completed through its left-hand winding from ground at armature 638 by way of armatures 685 and 787 and conductor 718. Relay 890 energizes and closes its previously traced locking circuit at armature 892 from the grounded hold conductor H through its right-hand winding and connects the combination ringing leads C1 to C10, inclusive, and the mask leads M1 and M2 to the impulse counting relays. Ground impulses transmitted over the ringing combination leads and the mask leads by the code interrupter operate the ringing relay 810 in accordance with the operated impulse counting relays to transmit current in the same manner as previously described. In reverting calls the ringing current is transmitted from the generator lead 646 by way of either armature 821 or 822, dependent upon the code signalling digit dialled, and

thence by way of armatures 812 and 813, conductors 379 and 389, through the operated armatures of the operated connector unit relay 310, in this case armatures 316 and 317, conductors 499 and 398, through the armatures of the operated connector group line relay 420, to conductors 157 and 158 included in the three-conductor cable 159, and from thence over the line conductors of the calling and called line through the ringers to ground.

In case the subscriber making the reverting call has his ringers connected to the same line conductor as the called subscriber, then the calling subscriber will hear the code signal. However, should the ringers of the called subscriber be connected to the other conductor, then the calling subscriber will not hear the code signal and must wait a sufficient length of time to allow one or more complete signals to be transmitted before removing his receiver. When this call is answered by any subscriber on the line, ring cut-off relay 740 energizes and the equipment operates in a manner similar to that previously described. Relay 740, upon energizing, at armature 744 completes a locking circuit through both its windings in series to ground at armature 614, at armature 745 opens the circuit to relay 900 in the ringing machine, and at armature 742 completes the circuit for energizing relay 770. Relay 770 energizes over the subscriber's line loop in series with relay 774, and at armature 772 opens the locking circuit 780, and at armature 773 opens the circuit through the lower winding of relay 604. Relay 780, upon restoring, at armature 788 opens the locking circuit to the impulse counting relays, at armature 787 opens a point in the original energizing circuit of relay 890, at armature 779 opens the locking circuit of relay 890 to allow this relay to restore, and at armature 789 opens the circuit to relay 610.

Relay 610 deenergizes after an interval, and at armature 611 opens one of the multiple grounds to the finder group control relay 122 and the finder unit relay 210. At armature 613 relay 610 opens the circuit of relay 620, at armature 614 opens the locking circuit of the ring cut-off relay 740 to allow it to restore, and at armature 615 opens another point in the circuit extending to the lower winding of time release relay 604. Relay 620, upon restoring, at armature 622 opens the locking circuit to the finder group control relay 122 and the finder unit relay 210, at armature 625 opens the locking circuit of relay 680 and opens the locking circuit of the connector group control relay 422 and the connector unit relay 310. At armature 623 relay 620 opens the circuit to series relay 650, at armature 626 removes ground from the guard lead 616 to make this equipment available for use on another call, at its resting contact grounds the common conductor 629 to maintain the all link busy relay 588 in energized position, and at armature 624 opens the locking circuit of relay 670. Ring cut-off relay 740 deenergizes and opens the loop circuit to the called line. The finder group control relay 122 and the finder unit relay 210 deenergize and disconnect the test lead of the calling line from the incoming side of this equipment. Relay 680 deenergizes and at armature 682 opens the circuit of the connector group line relay 420. Series relay 650, upon restoring, at armature 653 removes ground from the test lead of the subscriber's line, thereby opening the circuit of the cut-off relay 171. The connector group control relay 422 and the connector unit relay 310 re-

store and disconnect the test conductor of the calling line from the outgoing side of this equipment. Relay 670, upon deenergizing, at armature 672 opens a point in the busy tone circuit.

5 The cut-off relay 171 associated with the calling line now restores and opens the circuit to relay 170 and at armatures 177 and 178 closes a circuit for energizing relays 172 and 173 over the subscriber's loop. Relay 172, upon energizing, at
10 armature 181 closes the locking circuit of relay 170 before it fully deenergizes and at armature 179 grounds the test lead 156 to make this line busy to other calls. All of the relays in this link circuit are now restored and the link may be used
15 on other calls. Talking battery to the calling and called subscriber is furnished through the windings of relays 172 and 173.

When both subscribers on line 21 replace their receivers the circuit to the relays 172 and 173
20 is opened and relay 172, upon deenergizing, at armature 181 opens the locking circuit of relay 170, at armature 179 and its working contact removes ground from the test lead to free this line, and at its resting contact connects the cut-off
25 relay 171 to test lead 156 to permit this line to be called. Relay 170 deenergizes after an interval and at armature 175 prepares a point in the start circuit for operating the relay allotter to connect an idle link to this line when calling.

30 The local subscribers have access to two groups of switch-through trunks. The first group of trunks are in the 30-line group in the place of the last three lines in that group, while the second group of trunks are in the 20-line group in
35 the place of the last three lines in that group. In order for a local subscriber to seize an idle trunk in the first group such subscriber will dial the digit 9, or in case a trunk in the second group is desired the subscriber will dial the digit 0.

40 When a calling subscriber initiates a call the preselected idle link is connected to the calling line and in response to the subscriber thereon dialling the digit 0 the impulse repeating relay 720 and the impulse counting relays 820, 880 and
45 840 are operated at the end of the impulsing period in the same manner as previously described. When series relay 650 deenergizes after the last impulse of this series a circuit is completed for energizing relay 750 as follows: from
50 ground by way of armature 638 and working contact, armature 654 and resting contact, armatures 685 and 677, conductor 735, armature 823 and working contact, armature 842, armature
55 815, conductor 777, and through the winding of relay 750 to battery. Relay 750, upon energizing, at armatures 751 and 752 disconnects relays 774 and 770 and switches the talking conductors straight through. At armature 753 relay 750
60 transfers the test conductor of the called trunk from the line test relay 680 and connects it in place thereof to the trunk test relay 660, and at armature 754 closes the circuit for energizing the connector group control relay 422 as follows:
65 ground at armature 627, conductor 747, armature 763 and resting contact, armature 754, conductor 798, armature 818, conductor 482, and through the winding of relay 422 to battery. At armature 755 relay 750 completes its own locking circuit to grounded conductor 329, and at
70 armature 756 prepares a point in the circuit for operating the trunk hunting connector unit relays.

Relay 422, upon energizing, at armatures 423 and 424 prepare circuits for the connector group
75 line relays 420 and 421. at armature 425 com-

pletes its own locking circuit over grounded conductor 314, at its upper armatures connects the test leads of all the trunk lines and subscribers' lines in the 20-group to the contacts of the connector unit relay, and at armature 426 completes
5 a circuit for energizing relay 790. This circuit may be traced from grounded armature 426, conductor 487, armature 807, conductor 734, and through the winding of relay 790 to battery. At
10 armature 794 relay 790 completes its locking circuit to grounded conductor 698 by way of the normally closed springs controlled by armature 786, at armature 793 opens the locking circuit of relay S1 which thereupon deenergizing, and
15 at armature 795 completes the trunk hunting circuit for energizing the first trunk hunting connector unit relay 380. Relay S1, upon deenergizing disconnects the connector group relays and opens the locking circuit of the impulse
20 counting relays. Trunk hunting relay 380 energizes over the following circuit: from ground by way of armature 625, armature 668 and resting contact, resting contact and armature 676, conductor 698, armature 756, armature 795, conductor 324, resting contacts and armatures 384, 394,
25 304, and through the winding of relay 380 to battery. At armature 381 relay 380 completes its own locking circuit before operating any of the other armatures. At armature 383 relay 380 prepares a point in the circuit for energizing connector group line relay 421, at armature 382 prepares
30 a point in the circuit for relay 780, which, however, is ineffective during the trunk hunting operation. The locking circuit for relay 380 may be traced as follows: grounded conductor 329, by
35 way of armature 305 and 395 and their resting contacts, armature 381, through the winding of relay 380 to battery. At armature 384 relay 380 opens a point in its original energizing circuit after its locking circuit is closed at armature 381,
40 and at its working contact prepares a circuit for energizing slow to operate relay 390. As will be noted, the three trunk hunting connector unit relays 380, 390, and 300 are slow to operate, and therefore do not operate immediately when their
45 energizing circuits are completed. At armature 388 relay 380 connects the test conductor of the first trunk to conductor 399 by way of armature 308 and resting contact. The operation at this point depends upon whether the test conductor
50 of the engaged trunk line is grounded or not. In case the trunk line is busy, then ground on the test conductor of the called trunk will short circuit the upper winding of the trunk rest relay 660 thereby preventing its operation. In case
55 the trunk had been idle then the operation of the armature 388 by relay 380 would connect battery through the winding of the cut-off relay associated with this trunk to the upper winding of trunk test relay 660 to cause the operation
60 of said relay. In order to fully explain the operation it will be assumed that this first trunk is busy and therefore the trunk test relay is prevented from operating due to the short circuit through its upper winding. After a short interval trunk hunting connector unit relay 390 energizing from grounded conductor 324 by way of
65 armature 384 and at armature 391 completes its locking circuit by way of armature 305 and grounded conductor 329 before operating any of the other armatures. At armature 393 relay 390 prepares a point in the circuit for energizing connector group relay 421, at armature 395 opens
70 the locking circuit of relay 380, at armature 394 opens a point in the original energizing circuit 75

of relay 380, and at its working contact prepares the circuit for relay 300. At armature 390 relay 390 connects the test lead of the second trunk to the upper winding of trunk test relay 660. In case the second trunk is likewise busy then ground on the test lead will prevent the operation of trunk test relay 660 in the same manner as previously described. In case the trunk line is idle then battery through the line cut-off relay associated with this trunk line would cause the energization of trunk test relay 660. Assuming that this trunk is busy, then relay 300 will energize after the first trunk hunting connector unit relay 320 deenergizes to complete the energizing circuit for relay 300 extending from grounded conductor 324 by way of armature 384 and resting contact, armature 394 and working contact. Relay 300 energizes after an interval to first operate its locking armature 301 to lock itself to grounded conductor 329, and at armature 305 opens the locking circuit of relay 390. At armature 303 relay 300 prepares a circuit for relay 421, at armature 304 and resting contact opens a point in the original energizing circuit of relay 320, at armature 304 and working contact prepares the circuit for busy relay 670, and at armature 303 connects the test lead of the third or last trunk in this group to the winding of trunk test relay 660. After an interval 300 deenergizes, and at armature 394 completes the circuit for energizing the busy relay 670 only in case the last trunk in the group is busy. This circuit may be traced from grounded armature 625, through armature 668 and resting contact controlled by trunk test relay 660, armature 676, conductor 690, armature 756, armature 795, conductor 324, armature 384 and resting contact, armature 394 and resting contact, armature 304 and working contact, conductor 309, and through the upper winding of busy relay 670 to battery. Busy relay 670, upon energizing, at armature 672 transmits the busy tone over the previously traced circuit through the subscriber's calling loop.

When an idle trunk is found trunk test relay 660 energizes from battery through the winding of cut-off relay associated with the idle trunk to stop further operations of the trunk hunting relays by disconnecting ground from conductors 690 and 324 at armature 660 before the succeeding trunk hunting relay has had time to fully operate and close its locking circuit. Assuming now that the first idle trunk was the last trunk in the group, then when relay 300 energizes, said relay at armature 303 completes the circuit for energizing trunk test relay 660 in series with the cut-off relay 101 as follows: from ground through the upper winding of trunk test relay 660, armature 612, armature 674, conductor 724, armature 753 and working contact, conductor 399, armature 308, conductor 491, armature 410, conductor 166 included in the three-conductor cable 169, armature 109 and resting contact, and through the winding of cut-off relay 101 to battery. Relay 660, upon energizing, at armature 661 opens a point in the circuit for transmitting dial tone to the calling line, at armatures 662 and 664 disconnects relays 692 and 690 from the calling line and transfers the calling line to conductors 694 and 696, at armature 663 completes a circuit for energizing connector group relay 421, and at armature 665 temporarily connects direct ground to the test lead of the called line. At armature 666 relay 660 completes a circuit through the upper winding of relay 620 for

maintaining relay 620 in operated position, at armature 667 opens a point in the impulsing circuit and the circuit to relay 550, at armature 668 completes a locking circuit through its lower winding from grounded armature 625 and at its resting contact opens a point in the original energizing circuit of the trunk hunting connector unit relays, and at armature 669 connects a multiple ground to maintain the finder group line relay 120 in energized position. Relay 790 deenergizes when its locking circuit is opened at armature 668 by the operation of relay 660. Line relay 690, upon deenergizing when its circuit is opened at armature 664, at armature 691 opens the circuit of relay 640 which deenergizes. At armature 642 relay 640 opens the circuit of relay 600. Cut off relay 101, upon energizing in series with the trunk test relay 660, at armature 106 connects conductor 166 to conductor 146, at armature 107 opens the circuit of relay 103, and at armature 108 opens the circuit to relay 102 and completes the circuit for relay 100. Relay 100 energizes and at armature 105 prepares a point in its own locking circuit.

Connector group line relay 421, upon energizing, at armatures 411 and 412 closes the calling subscriber's loop in series with relays 1002 and 1007 in the trunk circuit in Fig. 10. Relays 1022 and 1007 energize in series over the following circuit: from ground through the winding of relay 1007, resting contact and armature 1010, lower right-hand winding of repeating coil RC, conductor 148, conductor 167 included in cable 169, armature 411, conductor 492, armature 307, conductor 369, armature 813 and resting contact, conductor 774, armature 752 and working contact, conductor 696, working contact and armature 666, conductor 279, armature 216, conductor 199, armature 127, through the calling subscriber's loop and armature 128, thence by way of conductor 198, armature 217, conductor 289, armature 662 and working contact, conductor 694, working contact and armature 751, conductor 768, resting contact and armature 813, conductor 279, armature 308, conductor 493, armature 412, conductor 138, in cable 169, conductor 147, upper right-hand winding of repeating coil RC, armature 1015 and resting contact, and through the winding of relay 1002 to battery. Relay 1002 at armature 1017 connects ring back tone by way of conductor 640 and armature 1020, 1024 and 1027 to conductor 147 and thence over the heavy talking conductors as previously traced to the calling subscriber. Relay 1007, upon energizing, at armature 1034 connects both windings of relay 1003 in series to the left-hand winding of repeating coil RC, and at armature 1033 completes a circuit for energizing slow to release relay 1009 as follows: ground by way of armature 1032, armature 1033, normally closed springs controlled by armature 1037 and through the winding of relay 1009 to battery. At armature 1039 relay 1009 connects ground at the normally closed springs controlled by armature 1053 through the upper winding of relay 1012 to conductor 146 to busy the trunk and hold relay 620 in energized position. At armature 1040 relay 1009 connects ground to the generator start lead 657 by way of armature 1044 to energize relay 900 to start the ringing machine shown in Fig. 9. At armature 1043 relay 1009 opens the circuit of relay 1003 and connects the generator lead 640 to the left-hand winding of repeating coil RC by way of conductor 1057.

armature 1115, and conductor 1056. At armature 1042 relay 1009 starts the spring 1041 vibrating to prepare a circuit for relay 1008. The circuit for energizing relay 1012 extends by way of ground through the normally closed springs controlled by armature 1053, through the upper winding of relay 1012, armature 1039, conductor 146, armature 106, where the circuit divides, one branch going to battery through the winding of cut-off relay 100 to maintain this relay in energized position, and the other branch extending by way of resting contact of armature 109, conductor 166, armature 410, conductor 491, armature 308, conductor 399, armature 753, conductor 724, armature 674, armature 666, and through the upper winding of relay 620 to battery for maintaining this relay in energized position.

Relay 600 deenergizes an interval after its circuit is opened at armature 667 by the operation of trunk test relay 660, and at armature 601 opens the circuit of slow-to-release relay 610. At armature 602 relay 600 disconnects one of the multiple grounds from the test conductor of the calling line, which line, however, is maintained at busy potential from ground through the winding of relay 1012 as previously traced over armature 665 and thence by way of the test conductor 299 to the winding of cut-off relay 171 and conductor 156. At armature 603 relay 600 disconnects one of the multiple grounds from the finder group line relay 120 which relay is not maintained energized from grounded armature 659. Relay 610 deenergizes after an interval and at armature 611 disconnects one of the multiple grounds from conductor 214, at armature 612 opens the circuit extending to the upper winding of relay 660, at armature 613 opens the circuit extending through the lower winding of relay 620, and also opens the circuit extending through the upper winding of relay 630. Relay 630 deenergizes in response to this operation, but relay 620 is maintained in energized position through its upper winding, as previously described. At armature 614 relay 610 opens a point in the circuit to relay 740 and at armature 615 opens a point in the circuit through the lower winding of time release relay 604.

Referring now to the trunk circuit shown in Fig. 10 and at a time when vibrating spring 1041 practically stops its vibrations, relay 1008 energizes. At armature 1037 relay 1008 completes a locking circuit for itself from grounded armature 1032 and also opens the circuit to relay 1009. At armature 1038 relay 1008 connects time release relay 1013 to the time pulse conductor 655, and at armatures 1035 and 1036 shunts armatures 1039 and 1040. After an interval relay 1009 deenergizes and at armature 1043 disconnects generator from the trunk and connects the trunk to relay 1003.

In the trunk circuit at the distant exchange the high resistance relay 1063 is normally energized over the following circuit: from ground through the winding of relay 1063, resting contact and armature 1075, normally closed springs controlled by armature 1078, through the left-hand windings of repeating coil RC1 in parallel, over conductors 1054 and 1055 in parallel, through the left-hand windings of repeating coil RC, conductor 1056, armature 1115, conductor 1057, armature 1043 and resting contact, through the normally closed springs controlled by armature 1034, and through the upper winding of relay 1003 to

battery. Due to the high resistance of relay 1063 relay 1063 alone is energized over this circuit and at armature 1071 completes the circuit for energizing relay 1062. When relay 1009 operates and connects generator to the trunk alternating current relay 1064 energizes. Relay 1063 deenergizes to open the circuit to slow-to-release relay 1062. The generator circuit for energizing relay 1064 extends from the generator conductor 646 by way of working contact and armature 1043, conductor 1057, armature 1115, conductor 1056, to the left-hand windings of repeating coil RC, and thence by way of conductors 1054 and 1055 through the left-hand windings of repeating coil RC1, through the normally closed springs controlled by armature 1078, armature 1075 and resting contact, through the condenser and winding of relay 1064 to ground. At armature 1073 relay 1064 maintains slow-to-release relay 1062 operated and at armature 1072 completes the circuit for lighting the signal lamp L to inform the operator of the call.

When the operator observes the illumination of lamp L she will insert the plug or her cord circuit into the jack J in order to answer the call. Springs 1079 complete a circuit for operating relay 1065 in response to the insertion of the plug into the jack J, and said relay at armature 1074 opens a point in the circuit for relay 1061, at armature 1075 opens the circuits of both relays 1063 and 1064 to permit relay 1064 to deenergize, and at the working contact of armature 1075 prepares the circuit for supervisory relay 1066. Relay 1066 is a marginal relay and will not energize in series with the high resistance lower winding of relay 1003. Relay 1064, upon deenergizing, at armature 1072 opens the circuit to lamp L and at armature 1073 opens the circuit to relay 1062. Slow-to-release relay 1062 deenergizes after an interval and at armature 1070 prepares a point in the circuit to slow-to-operate relay 1061.

When relay 1009 deenergizes generator is disconnected from the trunk and relay 1003 connected in place thereof. Relay 1003 energizes over the following circuit: from ground through the winding of marginal relay 1066, working contact of armature 1075, to the normally closed springs controlled by armature 1078, through the left hand windings of repeating coils RC1 and RC, to conductor 1056, armature 1115, conductor 1057, armature 1043, working contact and armature 1034, and through the lower and upper windings of relay 1003 in series to battery.

At armature 1018 relay 1003 completes the circuit for energizing relay 1004, and at armature 1019 prepares a circuit for bridging the lower winding of relay 1001 across the right hand windings of repeating coil RC. At armature 1020 relay 1004 disconnects the ring back tone, at armature 1021 prepares a point in the circuit for relay 1001, at armature 1022 prepares a point in the circuit for relay 1005, and at armature 1023 completes the circuit for energizing relay 1011 by way of normally closed springs controlled by armature 1045. At armature 1047 relay 1011 opens a point in the circuit for relay 1005, at armature 1050 prepares a point in the circuit for transmitting a pay-station tone to the operator, and starts spring 1048 vibrating to prepare an energizing circuit for slow-to-operate relay 1010 at armature 1049.

In case the calling line is a pay-station line a pay-station tone is connected to the test lead of the calling line in the well-known manner, 75

and this tone is transmitted to conductor 146 over the previously traced circuits and thence by way of armature 1035 and the upper winding of relay 1012 to ground at the normally closed springs controlled by armature 1053. The tone transmitted through the upper winding of relay 1012 induces a similar current in the lower winding which is transmitted through the condenser C and armature 1050 through the talking conductors of the trunk line, and thence to the operator in the well known manner. When the operator hears this tone she is informed that the calling subscriber is a pay-station subscriber. When vibrating spring 1043 has practically ceased to vibrate, slow to operate relay 1010 is operated by way of armature 1049. At armature 1045 relay 1010 completes its own locking circuit from grounded armature 1023 and also opens the circuit of relay 1011. At armature 1044 relay 1010 disconnects ground from generator start lead 657 to stop the ringing machine and at its working contact closes a multiple locking circuit for relay 1008, and at armature 1046 opens a point in the circuit through the lower winding of relay 1013. Relay 1011, upon restoring, at armature 1049 opens the initial energizing circuit of relay 1010, at armature 1050 opens the circuit through the lower winding of relay 1012 to cut off the pay-station tone, and at armature 1047 prepares a locking circuit for relay 1005.

The operator may verify the presence or absence of pay-station tone by disconnecting temporarily. When the operator removes her plug relay 1065 restores and closes the circuit to relay 1003 at armature 1075. Relay 1003 in the trunk line TR deenergizes on account of the high resistance of relay 1003. Relay 1003 at armature 1019 completes the circuit for energizing relay 1005 by way of armature 1022. At armature 1024 relay 1005 opens the ring-back tone circuit, at armature 1026 short circuits the lower winding of relay 1001, and at armature 1025 closes its own locking circuit as follows: from ground by way of armature 1025, armature 1020, armature 1014 and resting contact, armatures 1051 and 1047, and through the winding of relay 1005 to battery. Relay 1004 deenergizes shortly after its circuit is opened at armature 1019 and at armature 1022 opens the original energizing circuit of relay 1005. At armature 1023 relay 1004 opens the locking circuit of relay 1010 to permit the latter relay to deenergize. Relay 1010, upon deenergizing, at armature 1044 opens one of the multiple locking circuits to relay 1003 and grounds generator start conductor 657 for restarting the ringing machine. At armature 1045 relay 1010 prepares a point in the circuit to relay 1011 and at armature 1046 prepares a point in the circuit through the lower winding of time release relay 1013.

When the operator again answers by inserting her plug into the jack J relay 1065 is again energized to connect relay 1065 to relay 1003. Relay 1003 at armature 1019 closes a circuit for reenergizing relay 1004. At armature 1023 relay 1004 completes the circuit for energizing relay 1011. Relay 1011, upon energizing, at armature 1050 connects the lower winding of relay 1012 across the trunk line in order to retransmit the pay-station tone, and at armature 1047 opens the locking circuit of relay 1065 to deenergize the latter relay. In the same manner as previously described vibrating spring 1043 closes an

intermittent circuit to relay 1010 to cause its operation after a predetermined time.

Relay 1010 operates when the vibrating spring 1043 has practically ceased to vibrate and at armature 1045 closes its own locking circuit as well as opening the circuit to relay 1011. At armature 1044 relay 1010 removes ground from the generator start lead to stop the ringing machine, and at armature 1046 disconnects the lower winding of relay 1013 from the time pulse lead 655. Relay 1011 deenergizes and at armature 1050 disconnects the pay-station tone from the trunk line. The operator will complete the desired connection in the well known manner. Talking battery for the calling subscriber is supplied through the windings of relay 1002 and 1007 and the calling subscriber may converse over the heavy talking conductors through the repeating coils to the called subscriber in the well known manner.

When the calling subscriber replaces his receiver the circuit through relays 1002 and 1007 is opened and the relays deenergize. At armature 1033 relay 1007 opens the locking circuit of relay 1008, and at armature 1034 disconnects the lower high resistance winding of relay 1003 from the trunk to cause the marginal relay 1066 in the trunk circuit TC to operate. Relay 1006 is a marginal relay and will operate only in series with the upper winding of relay 1003. At armature 1076 relay 1066 opens the loop circuit bridged across the tip and ring conductors of the cord circuit in order to give supervision to the operator. This loop circuit includes armature 1076 and retard coil 1032, and the tip and ring springs of the jack J. When the operator removes the plug from the jack J springs 1079 are opened to open the circuit to relay 1065 which thereupon deenergizes. At armature 1075 relay 1065 opens the circuit to relay 1066 and at armature 1075 and its resting contact connects the high resistance relay 1063 to the trunk. Relay 1003 deenergizes in series with high resistance relay 1063 and at armature 1019 opens the circuit of relay 1004. Relay 1004, upon deenergizing, at armature 1023 opens the circuit to relay 1010 to cause its deenergization. Relay 1010 at armature 1044 opens the circuit of relay 1003 to cause its deenergization. At armature 1035 relay 1003 removes ground extending through the upper winding of relay 1012 from the test lead 146 to make this equipment test idle and to allow the preceding equipment to release and restore to normal for use in other calls. Relay 1012 deenergizes without effect at this time, and relay 1063, upon energizing, over the trunk circuit at armature 1071 completes the circuit for energizing relay 1062. The trunk line TR and trunk circuit TC shown in Fig. 10 are now restored to normal position and may be used on subsequent calls.

When ground is disconnected from conductor 146 by the deenergization of relay 1003 cut-off relays 101 and 171 deenergize and release relay 620 in Fig. 6 are likewise deenergized. Relay 620 at armature 626 removes ground from the guard lead 316 to free this equipment, at armature 625 opens the locking circuits of relays 660 and 750 and the operated group control and connector unit relays 422 and 300 to permit their deenergization, at armature 622 opens the locking circuit of the operated finder group control and unit relays 122 and 210 to permit their deenergization. Relay 660, upon deenergizing, at armature 663 opens the circuit of connector group line relay 75

421 to permit its deenergization; and at armature 659 opens the circuit of the finder group line relay 120 to permit its deenergization. The remaining operated relays in the link deenergize to restore the link circuit to normal position in the same manner as previously described.

Incoming trunk calls are completed by the toll operator plugging in on the desired trunk and dialling the number of the desired subscriber. It will now be assumed that in response to a call in the distant exchange local subscriber 336 is desired in a trunk connection. The operator at the distant exchange will plug one of her cord circuits into an idle trunk jack extending to the desired local exchange. When the cord circuit is plugged into the jack of the selected trunk, assuming that the trunk shown in Fig. 10 is the trunk selected, springs 1079 complete a circuit for energizing relay 1065. At armature 1074 relay 1065 opens a point in the circuit for energizing alarm relay 1061, at armature 1075 disconnects the high resistance winding of relay 1063 from the trunk and connects relay 1066 in place thereof. Relay 1063 deenergizes and opens the circuit of relay 1062 which also deenergizes and at armature 1070 prepares a circuit for the alarm relay 1061. When relay 1066 is substituted in the trunk circuit extending to the local exchange in place of relay 1063 relay 1003 in the trunk line TR energizes over the following circuit: from ground through the winding of marginal relay 1066, working contact and armature 1075, normally closed springs controlled by armature 1078, through the left hand windings of repeating coil RC in parallel, over conductors 1054 and 1055 in parallel, through the left-hand winding of repeating coil RC in parallel, conductor 1056, armature 1116, conductor 1057, armature 1043 and resting contact, normally closed springs controlled by armature 1034 and through the upper winding of relay 1003 to battery. At armature 1018 relay 1003 completes the circuit for energizing relay 1004 and at armature 1019 prepares a point in the circuit for bridging the lower winding of relay 1001 across the right hand windings of repeating coil RC and conductors 147 and 148. At armature 1020 relay 1004 opens a point in the ring back circuit, at armature 1021 completes a circuit for energizing relay 1001, at armature 1022 prepares a circuit for relay 1005, and at armature 1023 completes the circuit for energizing relay 1011. Relay 1001 energizes over the following circuit: From ground by way of armature 1036 and resting contact, armature 1021, normally closed springs controlled by armature 1029, and through the upper winding of relay 1001 to battery. At armature 1014 relay 1001 prepares a circuit for energizing relay 1006, at armature 1015 opens a point in the circuit to relay 1007, and at armatures 1015 and 1016 and their working contacts connects the lower winding of relay 1001 in bridge of the right-hand winding of the repeating coil RC and conductors 147 and 148. The circuit for energizing relay 1011 may be traced from grounded armature 1023 through the normally closed springs controlled by armature 1045, and through the winding of relay 1011 to battery. At armature 1047 relay 1011 opens a point in the circuit for relay 1005, at armature 1050 connects the lower winding of relay 1012 and condenser C in bridge of trunk conductors 147 and 148, and at armature 1049 starts the spring 1048 vibrating to prepare a circuit for relay 1010. When vibrating spring 1048 practically ceases to vibrate relay 1010 ener-

gizes, and at armature 1046 opens a point in the circuit to relay 1013. Relay 1011 deenergizes and at armature 1049 opens a point in the original energizing circuit of relay 1010.

When the lower winding of relay 1001 is bridged across the trunk conductors 147 and 148 a circuit may then be traced for energizing relays 102, 103 and 1001 in series as follows: from ground through the resting contact of armature 108, through the winding of line relay 102, conductor 148, through the lower right-hand winding of repeating coil RC, armature 1016 and working contact, armature 1019, through the lower winding of relay 1001, working contact and armature 1015, through the upper right-hand winding of repeating coil RC to conductor 147, armature 107 and through the winding of relay 103 to battery.

Relay 102, upon energizing, at armature 109 connects ground to test conductor 166 to make this trunk line busy, at armature 138 connects battery through the winding of cut-off relay 101 by way of armature 104 to armature 110 to mark the trunk line as calling, and at armature 137 connects ground to start conductor 137 by way of armature 105 for energizing the start relay 587 in the relay allotter in Fig. 5. The operation from this point on is similar to that previously described in connection with a subscriber initiating a call and will therefore be described briefly. In response to the operation of start relay 587 in the relay allotter the group selecting relays therein operate in the same manner as previously described to operate the finder group control relay 122 in the preselected idle link, after which the finder units relays in Fig. 2 are operated to find the calling trunk marked by battery potential on its test conductor through the winding of its associated cut-off relay 102. Since the calling trunk is the last line in the 20-line group, then when finder units relay 200 energizes line test relay 550 in the relay allotter is energized over the following circuit: from ground through the lower winding of relay 550, armature 5109, cut-through conductor 619, to conductor 299, armature 208, conductor 191, armature 110, armature 104, and through the winding of cut-off relay 101 to battery. At armature 582 relay 550 grounds conductor 219 to energize the finder group line relay 121 as follows: from ground by way of armature 582, armature 5108, conductor 219, armature 205, conductor 189, armature 124, and through the winding of finder group line relay to battery. At armatures 111 and 112 relay 121 connects the trunk line conductors 147 and 148 to the link to energize relays 690 and 692 as follows: from ground through the winding of relay 690, armature 664, conductor 279, armature 206, conductor 193, armature 112, conductor 148, lower right-hand winding of repeating coil RC, armature 1016 and working contact, armature 1019, lower winding of relay 1001, working contact and armature 1015, upper right-hand winding of repeating coil RC, conductor 147, armature 111, conductor 192, armature 207, conductor 289, armature 662, and through the winding of relay 692 to battery. At armature 126 relay 121 prepares a circuit for energizing trunk relay 750. Line relay 690, upon energizing over the above traced circuit, at armature 691 operates relay 640 and 600 as previously described. In response to the operation of relay 600 relays 610, 620 and 630 operate as previously described and relay 620 connects dial tone to the calling loop in the trunk line. Dial tone is transmitted through the re-

peating coils RC and RC' to the calling operator in the well known manner.

The calling operator will now dial the digits of the desired line and in response to the operation of the calling device CD preparatory to sending the first digit, the shunt springs of the calling device CD close a circuit for energizing relay 1067. At armature 1077 relay 1067 closes a shunt around armature 1076 and at armature 1078 disconnects marginal relay 1066 from the trunk line and connects direct ground through the impulse springs in place thereof. When the calling device is released the impulse springs open the circuit to relay 1003 a number of times corresponding to the digit dialled. Relay 1003 deenergizes each time the impulse springs remove ground from the trunk and said relay at armature 1016 opens a circuit to slow-to-release relay 1004 which is maintained energized during the impulsing period due to its slow releasing characteristics. At armature 1018 and its resting contact relay 1003 completes a circuit by way of armature 1022 for energizing slow-to-release relay 1005, and at armature 1019 opens the impulse repeating circuit to line relay 690 in the link circuit. Relay 1005 at armature 1026 short circuits the lower winding of relay 1001 to improve the repeating circuit, and at armature 1025 completes the circuit for energizing relay 1006. The circuit for energizing relay 1006 may be traced from ground by way of armature 1025, armature 1028, armature 1014 and working contact, and through the winding of relay 1006 to battery. Armature 1031 of relay 1006 energizes before other armatures and completes its locking circuit by way of armature 1021 and armature 1036. At armature 1028 relay 1006 opens its original energizing circuit after its locking circuit is closed, and at armature 1029 transfers the circuit to the upper winding of relay 1001 from ground at armature 1036 to ground at armature 1025. At armature 1030 relay 1006 connects a multiple ground to the test lead 146 in order to hold the equipment busy and in operated position after the called party answers.

The opening and closing of the impulse repeating circuit at armature 1019 causes the line relay 690 in the link circuit to operate in accordance therewith. Line relay 690 follows the impulses repeated thereto to cause the operation of the link relays and impulse counting relays as previously described to operate the connector group control relay 432, since in this case the digit 3 is the first digit dialled. Shortly after the last impulse of the first series slow to release relay 1005 deenergizes and at armature 1026 removes the short circuit from around the lower winding of relay 1001. At armature 1025 relay 1005 opens the circuit through the upper winding of relay 1001, but the latter relay, however, is maintained energized over its lower winding in series with relays 690 and 692. In the trunk circuit TC at the distant exchange the shunt springs of the calling device open when the calling device reaches its normal position to cause the deenergization of relay 1067. At armature 1078 relay 1067 substitutes ground through the winding of marginal relay 1066 for the ground through the impulse springs of the calling device. Relay 1066 is marginal and is only energized in series with the upper winding of relay 1003, while relay 1003 is maintained energized from ground either through the impulse springs of the calling device or from the ground through the winding of relay 1000. In response to the transmission of the succeeding

digits of the called number, relays 1067 and 1003 again operate; relay 1003 repeating impulses to relay 690 at armature 1019 and at armature 1018 operating the relay 1005 as before. In the same manner as previously described line relay 690 operates in response to the received impulses to cause the operation of the connector units relay 330 on the second digit, and on the third digit selects the ringing code of the called line. The called line is tested in the same manner as previously described and connects ring back tone to the trunk line conductors 147 and 148 from whence the ring back tone is repeated through the repeating coils RC and RC' to the calling operator.

When the called party answers relay 770 energizes over the called loop, as previously described, in series with relay 774. At armature 771 relay 770 completes the circuit for energizing relay 750 as follows: from ground by way of armature 126 of the operated finder group line relay, in Fig. 1, conductor 187, armature 204, conductor 224, armature 771, and through the winding of relay 750 to battery. At armature 755 relay 750 completes its own locking circuit to grounded conductor 329 and at armature 751 and 752 disconnects relays 770 and 774 from the called line. At armature 753 transfers the test lead of the called line from direct ground at armature 683 to ground through the upper winding of relay 660. Relay 660 now energizes over the following circuit: from ground through the upper winding of relay 660, armature 612, armature 674, conductor 724, armature 753 and working contact, conductor 399, armature 308 and resting contact, armature 338, conductor 494, armature 437, armature 479 and resting contact, and through the winding of cut-off relay 471 to battery. This ground also marks the called line as busy to other subscribers having access thereto. At armature 668 relay 660 completes a locking circuit through its lower winding from grounded armature 625, and at the resting contact of armature 668 opens the locking circuit of relay 680 which thereupon deenergizes. At armature 658 relay 660 closes a multiple circuit for maintaining finder group line relay 121 in operated position, at armature 663 closes a multiple circuit for maintaining connector group line relay 430 in operated position, at armature 669 opens a point in the circuit through the lower winding of relay 680, at armature 667 opens a part of the impulsing circuit to the impulse counting relays, and at armatures 665 and 666 closes a circuit to the upperwinding of relay 620 from ground applied to the test lead 146 of the trunk line extending by way of conductor 299. The upper winding of relay 660 is short circuited from ground on conductor 299 by way of armature 612 and armature 665. Direct ground extending from the test lead 146 of the trunk line by way of conductor 299, armature 665, and armature 674 to the test lead of the called line maintains the called line busy. At armatures 662 and 664 relay 660 transfers the talking conductors extending from the trunk line from the windings of relay 690 and 692, and connects these talking conductors directly to the called line by way of the operated armatures 751 and 752. Relay 680 deenergizes when its locking circuit is opened at armature 660 by relay 660, and at armature 682 removes one of the multiple grounds from the connector group line relay. Relay 690, upon deenergizing, at armature 681 opens the circuit of relay 640 and the circuit of relay 600. Relay 640 deenergizes without effect 75

at this time. Relay 600, upon deenergizing, at armature 601 opens the circuit of relay 610 and at armature 603 opens one of the multiple grounds extending to the finder group relay 121. Relay 5 610, upon deenergizing, at armature 611 opens one of the multiple grounds extending to the locking circuit of the finder group control relay 122 and the finder unit relay 200, at armature 612 removes the short circuit from around the upper winding of relay 660, at armature 615 opens a point in the circuit to the lower winding of time release relay 604, at armature 614 opens the locking circuit to relay 740 to permit its deenergization and at armature 613 opens the circuit 10 extending through the lower winding of relay 620. Relay 620 does not deenergize at this time because ground extending over the test lead of the trunk line is connected by way of armatures 665 and 666 through the upper winding of relay 20 620 to battery.

When relay 660 operates and disconnects relays 690 and 692 from trunk conductors 147 and 148 relay 1001 in the trunk line TR deenergizes. At armatures 1015 and 1016 relay 1001 connects 25 relays 1002 and 1007 across the trunk conductors 147 and 148 and connects the condenser C1 between the right-hand windings of the repeating coil RC. Relays 1002 and 1007 are energized in series through the called subscriber's loop as follows: from ground through the winding of relay 30 1007, resting contact and armature 1016, lower right-hand winding of repeating coil RC, conductor 148, armature 112, conductor 193, armature 206, conductor 279, armature 664, conductor 35 696, working contact and armature 752, conductor 774, resting contact and armature 813, conductor 389, armature 337, conductor 495, armature 438, through the loop at the called subscriber back to armature 439, conductor 496, armature 336, conductor 379, armature 812 and 40 resting contact, conductor 768, armature 751 and working contact, conductor 694, working contact and armature 662, conductor 289, armature 207, conductor 192, armature 111, conductor 147, upper right-hand winding of repeating coil RC, armature 1015 and resting contact, and through 45 the winding of relay 1002 to battery. The operation of relay 1002 at this time is without effect, and relay 1007, upon energizing, at armature 1034 includes the lower high resistance winding in series with the upper winding of relay 1003 in order to deenergize the marginal relay 1066 at the distant exchange. Relay 1066 is marginal and will not remain energized in series with the 50 lower winding of relay 1003. At armature 1076 relay 1066 closes a bridge including the impedance 1082 across the tip and ring conductors of the operator's cord circuit in order to give the operator answering supervision in the well known manner. Talking battery to the called subscriber is furnished through the windings of relays 60 1002 and 1007 over the heavy talking conductors previously traced.

After conversation and in response to the 65 called subscriber replacing his receiver relays 1002 and 1007 deenergize. At armature 1034 relay 1007 disconnects lower winding of relay 1003 and connects up only the upper low resistance winding of relay 1003 to cause the energization of relay 1066 in the trunk circuit TC at the distant exchange. At armature 1076 relay 1066 70 opens the bridge including the retard coil 1082 from across the tip and ring conductor of the operator's cord circuit in order to give the operator at the distant exchange disconnect supervision.

The operator now withdraws the plug of the cord circuit from the jack J thereby opening the circuit of relay 1065. At armature 1075 relay 1065 opens the circuit of relay 1066 which thereupon deenergizes, and at the resting contact of armature 1075 again completes the circuit for high resistance relay 1063. At armature 1071 relay 1063 completes the circuit for energizing relay 1062, and the latter relay at armature 1070 opens a point in the circuit to relay 1061. 5 10

Relay 1003 in the trunk line TR deenergizes when connected in series with the high resistance relay 1063 and at armature 1018 opens the circuit of relay 1004. Relays 1001 and 1005 temporarily operate without effect at this time and relay 1004, 15 upon deenergizing, at armature 1021 opens the locking circuit of relay 1006, which thereupon deenergizes and at armature 1023 opens the circuit to relay 1010 which likewise deenergizes. Relay 1006, upon deenergizing, at armature 1030 disconnects ground from test conductor 146 to restore the cut-off relay 101, cut-off relay 471, and relay 20 620 in the link circuit. Cut-off relay 371 deenergizes in the same manner as previously described to cause relay 470 to release and restore the line 25 circuit to its normal position. Cut-off relay 101 likewise deenergizes to cause the release of relay 100 to restore the trunk line circuit to its normal position. Relay 620 deenergizes when ground is removed from conductor 299 by the deenergization 30 of relay 1006 disconnecting ground from conductor 146, and at armature 622 disconnects ground from conductor 214 to open the locking circuit of finder group control relay 122 and the finder unit relay 200. At armature 625 relay 620 disconnects 35 ground from conductor 329 to open the locking circuits of relays 660 and 750, connector group control relay 432, and the connector unit relay 330. At armature 626 relay 620 removes ground from guard lead 616 to free this link and make it 40 available for other calls, and at the resting contact of armature 626 grounds the all link busy conductor 629. Finder group control relay 122 deenergizes to disconnect the test conductor of the incoming end of the trunk line from the link 45 circuit at armature 110 and at armature 124 opens the circuit to the finder group line relay 121. Finder unit relay 200 and connector unit relay 330 deenergizes when ground is removed from their locking circuits. Connector group 50 control relay 432, upon deenergizing, disconnects the test lead of the called line from the link circuit at armature 437 and at armature 433 opens the circuit to the connector group line relay 430. In the link circuit relay 750 deenergizes when its 55 locking circuit is opened in response to the disconnection of ground from conductor 329. Trunk test relay 660 also deenergizes and at armature 663 opens a further point in the circuit to the connector group line relay 430 and at armature 659 60 opens a further point in the circuit to finder group line relay 121. All of the relays in the link circuit and the relays in the trunk are now at normal position and may be used on other calls. 65

In case the called line was busy when called, then the busy relay 670 instead of line test relay 680 is energized as previously described to connect the busy tone to the calling line conductors, in this case conductors 147 and 148, and is transmitted over the heavy talking conductors and through the repeating coils of the trunk circuit to the operator. When the operator hears the busy tone the operator will remove the plug from the jack to cause the deenergization of relay 1065. 70 75

The deenergization of relay 1065 includes the high resistance winding of relay 1063 in series with relay 1003 in the trunk line TR to cause relay 1003 to deenergize. In this case relay 1003, upon deenergizing, at armature 1019 opens the loop circuit extending to the link and at armature 1018 opens the circuit of relay 1004. Relay 1004, upon deenergizing, at armature 1021 opens the circuit of relay 1006 to cause its deenergization. Relay 1006, upon deenergizing, causes the release of the link in the same manner as previously described, and in addition the deenergization of relay 620 at armature 624 opens the locking circuit through the upper winding of relay 670 to cause its deenergization.

When trouble occurs at the local exchange the distant operator is signalled over a particular one of the trunks and is informed when she answers of the nature of the trouble by a series of tones. There are three causes of trouble, any one of which may cause the seizure of this particular trunk if idle to signal the distant operator. The first of these troubles may be the failure of the ringing machine to generate ringing current or the code interrupter may fail to function properly; second, the battery charging equipment may fail; and third, the fuse associated with a link, a trunk, or an alarm sender may blow.

As previously described in case the ringing machine fails to generate ringing current relay 958 fails to operate and therefore the circuit to relay 938 is not completed. Relay 938 in such instances maintains ground on generator alarm lead 1198 at armature 982. Also in case the code interrupter fails to operate properly either by failure to disconnect ground from the hold connector H to deenergize relay 959, or by the failure to connect battery to the pick-up conductor PU to cause the intermittent operation of relay 960, relay 938 deenergizes to ground generator alarm lead 1198. Whenever the generator alarm lead 1198 is grounded a circuit is completed for energizing relay 1103 as follows: ground at armature 982, armature 978, generator alarm lead 1198 extending to Fig. 11, armature 1177, armature 1126 and resting contact, through the winding of relay 1103 to battery. Relay 1103 starts its spring 1114 vibrating to prepare a circuit for energizing relay 1102 which relay is slow to operate and will not operate until springs 1114 practically cease to vibrate. The momentary grounding of generator ground lead 1198 during the normal operation of the ringing machine and code interrupter is not of sufficient duration to cause relay 1103 to be held energized long enough to cause the energization of relay 1102.

In case the battery charging equipment (not shown) should fail to function properly then the charge alarm lead 1197 is grounded to cause the energization of relay 1103 over the following circuit: from grounded charge alarm lead 1197, armature 1181, armature 1129 and resting contact, and through the winding of relay 1103 to battery.

In case a fuse associated with the alarm sender AS should blow, then battery is connected over the fuse lead through the lower winding of fuse alarm relay 1159 to ground to cause its energization. In case a fuse associated with any one of the trunk lines except the alarm trunk line should blow, then battery through the upper winding of relay 1013 is connected by way of conductor 1059 through the upper winding of relay 1159 to ground. Both relays 1013 and 1159 operate over this circuit. Relay 1013 at armature 1052 con-

nects ground from armature 1036 to the trunk test lead 166 to busy the trunk. In case the fuse associated with the alarm trunk line should blow then battery is disconnected from relay 1003 by the blowing of the fuse with the result that relay 1063 in the trunk circuit TC at the distant exchange deenergizes. The deenergization of relay 1063 causes relay 1062 to deenergize and operate and complete the circuit for alarm relay 1061. Relay 1061 energizes and at armature 1068 completes a locking circuit for itself from ground at key K. At armature 1069 relay 1061 completes the circuit for operating the alarm bell B. When the operator answers, the trunk line is dead and she will receive no tones whatever, indicating to her that the fuse on this particular trunk has blown.

In case a fuse associated with any link should blow, for example, the fuse shown in Fig. 6, then battery is connected through the upper winding 20 of relay 604 and over conductor 1059, through the upper winding of relay 1159 to ground to cause relays 604 and 1159 to energize. At armature 605 relay 604 grounds the guard lead 616 to make the link busy and to prevent seizure of this link and at armature 606 disconnects ground from the all link busy conductor 629. At armature 607 relay 604 connects the grounded time cut-off conductor 649 to conductor 219 in place of ground at the normally closed springs controlled by armature 607 in order to maintain the finder group line relay energized, and at armature 608 disconnects the time pulse conductor 655 from the lower winding of relay 604 and connects ground at armature 608 in place thereof to the lower winding of relay 604.

Whenever fuse alarm relay 1159 is energized said relay at armature 1190 operates the fuse alarm lamp and at armature 1189 closes the circuit for energizing relay 1103 over the following circuit: ground by way of armature 1189, armature 1185, armature 1130 and resting contact, and through the winding of relay 1103 to battery.

When the trunk line assigned for trouble signalling is in use as previously described it will be remembered that test lead 166 is grounded through the trunk line relays TLR of Fig. 1 to prevent the operation of a trouble alarm from interfering with the conversation on the trunk line. Ground on conductor 166 completes a circuit for energizing relay 1101 by way of armature 1116. At armature 1111 relay 1101 maintains the normally energized relay 1104 in operated position irrespective of the operated condition of relay 1102. Since relay 1104 is maintained by relay 1101 as long as the trunk line is busy the trunk line is not seized by the alarm sender until such trunk line becomes idle.

As previously described relay 1103 energizes in response to the different trouble signals and prepares the circuit for energizing relay 1102. When spring 1114 practically ceases to vibrate relay 1102 energizes and opens the circuit of relay 1104 in case relay 1101 is not energized. At armature 1116 relay 1104 disconnects relay 1101 and connects ground to conductor 166 to busy the trunk line against outgoing calls by energizing cut-off relay 101 in the usual manner. At armature 1115 relay 1104 disconnects conductor 1056 from conductor 1057 thereby opening the trunk to cause the deenergization of relay 1053 at the distant exchange. At armature 1117 relay 1104 completes the circuit for energizing relay 1105. Relay 1105, upon energizing, at armature 1118 grounds the generator start lead 657 to start the ringing ma-

chine and at armature 1121 completes the circuit for energizing relay 1107 by way of armature 1125. At armature 1119 relay 1105 starts the spring 1120 vibrating to prepare a circuit for the slow-to-operate relay 1106. Relay 1107 operates its weighted armature 1126.

When the trunk line is opened at armature 1115 relay 1063 deenergizes and at armature 1071 opens the circuit to relay 1062. Relay 1062 deenergizes and at armature 1070 completes a circuit from grounded armature 1074 for operating the alarm relay 1061. At armature 1068 relay 1061 locks to the alarm release key K, and at armature 1069 operates the alarm bell B to signal the operator.

When the vibrating spring 1120 has practically ceased to vibrate relay 1106 operates and at armature 1122 connects the trunk leads 1056 and 1057 to cause the reenergization of relay 1063 at the distant exchange. At armature 1124 relay 1106 grounds conductor 148 and at armature 1123 connects battery through the winding of relay 1109 to conductor 147 to prepare the energizing circuit for relay 1109. At armature 1125 relay 1106 connects the resistance ZA in series with relay 1107 and also completes a short circuit for relay 1107 extending from battery at armature 1126 through the armature 1125. Due to this short circuit relay 1107 deenergizes and at armature 1126 opens its short circuit. Relay 1107 is now energized from ground at 1121 through the resistance ZA and, upon operating, again short circuits itself at armature 1126. This cycle of operations is repeated continuously during which the vibrating spring 1126 produces periodic variations in the charge of the condenser YA as the short circuit of relay 1107 is opened and closed. In this manner a special alarm tone is generated for transmission over the trunk line.

When the operator answers relay 1065 is energized from jack springs 1079 to open the original energizing circuit of relay 1061 at armature 1074, and at armature 1075 substitutes the winding of relay 1066 for relay 1063. When relay 1066 is included in the trunk connection relay 1003 energizes over the previously traced circuit. At armature 1018 relay 1003 completes the circuit for energizing relay 1004. At armature 1023 relay 1004 completes the circuit for energizing relay 1011 through the normally closed springs controlled at armature 1045, and at armature 1021 completes the circuit from ground at armature 1036, through the normally closed springs controlled by armature 1029 through the upper winding of relay 1001 for energizing the latter relay. Relay 1011 energizes as before and at the vibrating spring 1048 prepares the circuit for energizing relay 1010. Relay 1001, upon energizing, at armatures 1015 and 1016 connects the lower winding of relay 1001 in bridge of the right-hand windings of the repeating coil RC and the conductors 147 and 148 to complete the circuit for energizing relay 1109. The circuit for energizing relay 1109 extends from grounded armature 1124, conductor 147, lower right-hand winding of repeating coil RC, armature 1016 and working contact, armature 1019, lower winding of relay 1001, working contact and armature 1015, upper right-hand winding of repeating coil RC, conductor 147, armature 1123, and through the winding of relay 1109 to battery. At armature 1131 relay 1109 connects dial tone to conductor 147 over the following circuit: from dial tone conductor 648, resting contact and armature 1176, condenser YB, resting contact and armature 1166, armature 1131, armature 1123, conductor

147, and from thence to the repeating coil RC over the previously traced circuit back to ground at armature 1124. Dial tone is induced into the left-hand winding of repeating coil RC and is transmitted over the trunk conductors 1054 and 1055 to the operator in the well known manner. At armature 1134 relay 1109 connects a multiple ground to relay 1103 so that relay 1103 will remain operated until the cycle of tone signals is completed. At armature 1132 relay 1109 completes the circuit for energizing relay 1108. Relay 1108, upon energizing, at armature 1127 completes the circuit for energizing relay 1151 by way of armatures 1173 and 1164, at armatures 1128, 1129 and 1130 opens the initial energizing circuit of relay 1103 and at the working contacts of these armatures completes a locking circuit for one of the following relays 1156, 1157 or 1158 dependent upon the particular trouble condition which exists. In case the trouble was a generator alarm then relay 1156 is energized over the grounded generator alarm conductor 1198, armature 1177, armature 1128 and working contact, and through the winding of relay 1156 to battery. At armature 1178 relay 1156 completes the locking circuit to grounded alarm conductor 1198 and at armature 1179 connects up the generated alarm tone. In case the trouble is the failure of the charging machine then charge alarm relay 1157 is energized from ground on conductor 30 1197 by way of armature 1181 and armature 1129 and its working contact, and through relay 1157 to battery. At armature 1182 and relay 1157 completes its locking circuit to grounded charge conductor 1197 and at armature 1183 prepares the circuit for connecting up the alarm tone. In case some fuse has blown then relay 1158 energizes from ground at armature 1189 by way of armature 1185 and armature 1130 and its working contact. At armature 1186 relay 1158 completes its own locking circuit and at armature 1187 connects up the alarm tone. At armatures 1180, 1184, and 1188 relays 1156, 1157, and 1158, respectively complete the circuits for illuminating the generator alarm, charge alarm, and fuse alarm lamps.

Relay 1151, upon energizing, operates its spring 1163 which vibrates and when this spring practically ceases to vibrate the circuit for energizing slow-to-operate relay 1152 is completed by way of armature 1162 and ground at armature 1127. At armature 1184 relay 1152 opens the circuit of relay 1151, at armature 1165 closes the circuit through the upper winding of relay 1153, and at armature 1166 removes dial tone from conductor 1199. At the working contact of armature 1166 relay 1152 connects the alarm tone to conductor 1199 in case the fuse alarm relay 1158 is operated. This circuit would extend by way of tone condenser YA, armature 1187, resting contact and armature 1169, working contact and armature 1166, conductor 1199, armature 1131, armature 1123, conductor 147, and thence over the trunk circuit and to the operator in the well known manner.

Relays 1153, 1154 and 1155 are two-step relays and operate only their armatures 1168, 1171 and 1164 on their first step when such relays are energized through their upper windings. Relay 1153 energizes in its first step over the following circuit: from ground at armature 1127, armature 1165, armature 1167 and resting contact, and through the upper winding of relay 1153 to battery. At armature 1168 relay 1153 in its first step closes a short circuit around its lower wind-

ing. Relay 1151 deenergizes after an interval and at armature 1162 opens the circuit of relay 1152. Relay 1152, upon deenergizing, at armature 1166 disconnects the alarm tone in case the fuse alarm 5 relay 1153 is energized, at armature 1164 again completes the circuit for energizing relay 1151 and at armature 1165 removes the short circuit from around the lower winding of relay 1153. At the resting contact of armature 1166 relay 10 1152 again connects dial tone to the trunk line. Relay 1153 now energizes in its second step from ground by way of armature 1127, armature 1168 through the lower and upper windings in series to battery. At armature 1167, relay 1153, in op- 15 erating in its second step, opens a point in its original energizing circuit and prepares a circuit for two step relay 1154. At armature 1169 relay 1153 opens a point in the fuse alarm tone circuit and at its working contact prepares a point in the charge alarm tone circuit. Relays 1151 and 20 1152 operate in the same manner as previously described, and relay 1152 at armature 1164 opens the circuit of relay 1151 and at armature 1165 completes the circuit for energizing relay 1154 in 25 its first step as follows: ground by way of armature 1127, armature 1165, armature 1167 and working contact, armature 1170 and resting contact, and through the upper winding of relay 1154 to battery. Relay 1152 at armature 1166 dis- 30 connects dial tone at its resting contact and at its working contact completes the circuit for giving an alarm tone in case the charge alarm relay 1157 is operated. This alarm circuit would extend through the tone condenser YA, armature 35 1163, resting contact and armature 1172, working contact and armature 1166, and thence over the previously traced circuit to the trunk line and operator. Relay 1154 operates only its armature 40 1171 on its first step and completes a short circuit through its lower winding through armatures 1170, 1167 and 1165. Relay 1151 again de- energizes and at armature 1162 again opens the circuit of relay 1152. Relay 1152, upon deener- 45 gizing, at armature 1166 disconnects the alarm tone if connected and at its resting contact again connects dial tone to the trunk line. At arma- 50 ture 1164 relay 1152 again completes the circuit for energizing relay 1151 and at armature 1165 removes the short circuit from around the lower winding of two-step relay 1154 to permit the latter relay to energize through its second step. The relay 1154 energizes through its second step 55 from ground at armature 1127, armature 117, through the lower and upper windings of relay 1154 to battery. At armature 1170 relay 1154 opens a point in its original energizing circuit and at its working contact prepares the circuit for two-step relay 1155. At armature 1172 relay 1154 disconnects the alarm tone in case the 60 charge alarm relay is operated, and at its work- ing contact prepares a circuit for connecting the alarm tone in case the generator alarm relay 1156 is operated. Relays 1151 and 1152 again operate as previously described, relay 1152 opening the 65 circuit of relay 1151, and at armature 1165 completing the circuit for operating two-step relay 1155 in its first step, and at armature 1166 dis- connects dial tone and connects the alarm tone 70 to the trunk line in case generator alarm relay 1156 is operated. Relay 1155 operates in its first step over the following circuit: from ground at armature 1127, armature 1165, armatures 1167 and 1170 and their working contacts, armature 1174, through the upper winding of relay 1155 75 to battery. Relay 1155 operates only its armature

1175 in its first step thereby completing a short circuit through its lower winding by way of armatures 1174, 1170, 1167 and 1165. Relay 1151 again deenergizes and at armature 1162 again 5 opens the circuit of relay 1152. Relay 1152, upon deenergizing, at armature 1164 closes the circuit of relay 1151, at armature 1165 opens the short circuit from around the lower winding of relay 1155, at armature 1166 removes the 10 alarm tone and connects the dial tone to the trunk line in place thereof. Two-step relay 1155 energizes through its second step from ground- ed armature 1127 by way of armature 1175 and through the lower and upper windings of relay 1155 to battery. At armature 1173 relay 15 1155 opens the circuit of relay 115, at armature 1174 opens a point in its original energizing circuit, at armature 1175 disconnects dial tone and connects the busy tone to the trunk line, in place thereof. From the foregoing it will be seen that 20 when the operator answers the alarm signal the operator hears first the dial tone. The dial tone is then followed either by the alarm tone, to indicate an operated alarm fuse, or by a silent period, to indicate that no alarm fuse has op- 25 erated. After the alarm or silent period the dial tone indicates the end of the alarm fuse test. The dial tone is again followed either by the alarm tone to indicate that the charging equip- 30 ment has failed or by a silent period to indicate that the charging equipment is functioning properly. After this alarm tone or silent period the dial tone indicates the end of the charging equip- 35 ment test. Once more the dial tone is followed either by the alarm tone to indicate this time that the ringing equipment has failed or by a silent period to indicate that the ringing equipment is functioning properly. After the last alarm tone or silent period the busy tone indicates the end 40 of the alarm equipment test and that this equipment has completed all of its tests.

When the operator disconnects by removing her plug relay 1065 deenergizes, thereby disconnecting relay 1066 and connecting high resistance relay 1063 to the trunk by way of armature 45 1075. Due to the high resistance of relay 1063 relay 1003 in the trunk line TR deenergizes. At armature 1019 relay 1003 opens the bridge main- taining relay 1109 energized and at armature 1010 opens the circuit of relay 1004. Relay 1004, 50 upon deenergizing, at armature 1021 opens the circuit of relay 1001 and at armature 1023 opens the circuit of relay 1010 which deenergizes. At armatures 1015 and 1016 relay 1001, upon de- energizing, reconnects relays 1002 and 1007 to 55 the conductors of the trunk line thereby restoring the trunk line TR to normal condition. Relay 1109 deenergizes when its circuit is opened by relay 1003, and at armature 1132 opens the circuit of relay 1108. At armature 1131 relay 60 1109 opens a point in the tone circuit and at armature 1134 opens the circuit of relay 1103. Relay 1108, upon deenergizing, at armature 1127 opens the locking circuits of two-step relays 1153, 1154 and 1155 to cause their deenergization, and 65 at armatures 1128, 1129 and 1130 prepares a point in the circuit for energizing relay 1103. Relay 1103, upon deenergizing at armature 1113 opens the circuit of relay 1102 which thereupon deenergizes. At armature 1112 relay 1102 com- 70 pletes the circuit for energizing relay 1104. At armature 1116 relay 1104 prepares a point in the circuit for relay 1101 at its working contact, and at its resting contact disconnects ground from test conductor 166 to deenergize the cut-off re- 75

lay 101 in the trunk line circuit and to make the alarm trunk free for calls to and from the operator. At armature 1115 relay 1104 connects the conductor 1056 to conductor 1057 and at armature 1117 opens the circuit of relay 1105. Relay 1105, upon deenergizing, at armature 1118 disconnects ground from generator start lead 657 to stop the ringing machine, at armature 1121 opens the circuit of relay 1107 and at armature 1119 opens the circuit to relay 1106. Relay 1107 deenergizes and restores its vibrating armature 1126 to normal position. Relay 1106, upon deenergizing, at armature 1122 opens a point in the dialling conductors 1056 and 1057 now closed at armature 1115, at armature 1123 opens a point in the circuit for relay 1109, at armature 1124 disconnects ground from conductor 149, and at armature 1125 prepares a point for energizing relay 1107. All the relays shown in the alarm senders are now restored to their normal conditions except the particular alarm relay which operated in response to the trouble and this relay remains locked energized over its locking circuit until the trouble is cleared.

Provisions have been made so that the operator may call a special verification number in order to receive the alarm tone series to determine whether the trouble has been cleared or not. This test number will correspond to the number of the line set aside for this purpose, and the operator in order to make a verification test will call this verification line in the same manner as calling a local subscriber. The operator therefore plugs into an idle trunk and causes the connection of an idle link to the trunk in the same manner as previously described. After connection of the link to the trunk line the operator dials the test number to cause the link to connect with this number. The link circuit then connects ground to the test lead of this test number to cause the energization of relay 1110 in Fig. 11. At armature 1135 relay 1110 completes a locking circuit for itself through its lower winding from grounded armature 1133, and at armature 1136 completes the circuit for operating relay 1103. The operator now disconnects from the trunk line in the same manner as previously described. The operation of relay 1103 causes the series of tones to be transmitted over the alarm trunk in the same manner as previously described. In this case, however, when relay 1109 energizes said relay at armature 1133 opens the locking circuit of relay 1110 to cause the deenergization of this relay. At armature 1136 relay 1110 opens the circuit of relay 1103. If the trouble conditions still exist one of the alarm relays 1156, 1157 or 1158 is operated, and the operator hears the alarm tone at the appropriate time during the series of tones. If the trouble condition has been cleared the alarm relays 1156, 1157, 1158 and 1159 are all at normal and the operator therefore does not hear the alarm tone indicating to her that the trouble is clear. When the operator disconnects the equipment returns to its normal condition, as previously described.

Time disconnect has been provided for freeing the link circuits and trunk circuits when the same are held by a permanent line. The link circuit is considered to be held by a permanent line under the following conditions. (1) When the calling subscriber fails to complete a connection to the called line; (2) when the calling subscriber fails to hang up after a completed call; and (3) when the calling subscriber fails to hang up after receiving the busy tone. A timing de-

vice is provided in Fig. 11 for grounding the time pulse lead 655 and the time cut-off lead 649 at predetermined intervals. Leads 649 and 655 are grounded at predetermined time intervals as follows: the clock springs 1194 are periodically closed to complete a circuit for energizing relay 1160. Relay 1160, upon energizing, at armature 1191 and resting contact disconnects ground from the time cut-off lead 649 and at its working contact completes the circuit for energizing relay 1161. Slow to release relay 116, upon energizing, at armature 1193 prepares a point in the circuit for connecting ground to the time pulse lead 655. Clock springs 1194 open after a predetermined time to cause the deenergization of relay 1160. At armature 1191 relay 1160 opens the circuit of slow to release relay 1161 at its working contact, and at its resting contact connects ground to time cut-off lead 649. At armature 1192 relay 1160 connects ground to time pulse lead 655 by way of armature 1193 on the slow acting relay 116. Due to its slow releasing characteristics relay 1161 is maintained energized for an interval after relay 1160 deenergizes and during this interval connects ground to the time pulse lead 655 at armature 1193. When relay 1161 deenergizes ground is removed from the time pulse lead 655 at armature 1193. At the next period of operation, clock springs 1194 again completes the circuit of relay 1160 and the relays operate in the same manner as previously described.

Whenever a link circuit is seized the lower winding of the time release relay, such as relay 604, is connected to the time pulse lead 655. In case the link circuit is not in talking position, that is, in case relay 770 has not operated to open the circuit to relay 604 at armature 773, ground on time pulse conductor 655 completes the circuit for energizing relay 604 as follows: from ground by way of armature 1192, armature 1193, conductor 655, through the normally closed springs controlled by armature 608, conductor 749, armature 773, conductor 748, armature 615, and through the lower winding of relay 604 to battery. At armature 608 relay 604 locks itself in energized position independent of ground on the time pulse lead 655. At armature 607 relay 604 transfers the circuit of the finder group line relay, such as relay 120, from direct ground at the normally closed springs controlled by this armature to ground on the time cut-off lead 649. The finder group line relay 120 is now, therefore, maintained energized from ground over the time cut-off lead 649. At armature 606 relay 604 disconnects one of the multiple ground connections from all link busy conductor 629 and at armature 605 maintains ground on the guard lead 616 to busy this link circuit. If the link reaches talking position before ground is removed from the time cut-off lead 649 relay 770 will energize over the called loop and at armature 773 will open the circuit of relay 604 thereby causing it to deenergize. At armature 607 relay 604 connects direct ground at the normally closed springs controlled by armature 607 to the finder group line relay 120 to hold such relay in energized position. However, if relay 770 does not energize before ground is removed from time cut-off conductor 649 then the disconnection of ground from the time cut-off lead 649 by the operation of relay 1160 causes the deenergization of finder group line relay 120. The deenergization of finder group line relay 120 opens the circuit to relays 690 and 692 of the link thereby causing their deenergization. The deenergization of these latter relays causes the re-

lays in the link to restore to their normal positions in the same manner as previously described. In this case relay 610 at armature 615 opens the locking circuit of relay 604 to cause the latter relay to deenergize. At armature 605 relay 604 disconnects ground from the guard lead 616 to free the link.

When a subscriber fails to hang up his receiver or in the case of a leak across the line great enough to operate line relays, such as line relay 172, such line is considered to be a permanent line. When the link circuit is released and the circuit to the cut-off relay, such as relay 171, is opened either upon the completion of an incoming call or after the line has been automatically disconnected from the link. Cut-off relay 171, upon restoring, at armature 173 opens the circuit to relay 173 and at armatures 177 and 178 connects relays 173 and 172 to the permanent line. Relay 172, upon energizing, at armature 179 grounds the test lead to make the line busy to incoming calls, and at armature 181 closes the locking circuit to relay 170. Relay 179 is maintained operated over its armature 175 and also prevents the grounding of the start conductor 137 extending to the relay allotter. At armature 174 relay 179 prevents connection of battery through the cut-off relay 171 from falsely marking the line as calling in the finder relay group. When permanent condition of the line is removed relay 172 deenergizes and at armature 181 opens the locking circuit to relay 170. At armature 179 relay 172 removes ground from the test lead 180 to free the line. Relay 173, upon deenergizing, at armature 175 prepares the circuit for grounding the start lead 137, and at armature 174 prepares the circuit for marking the line as calling in the finder relay group.

The time release relays in the trunk lines, such as relay 1013 in trunk line TR Fig. 10, prevents the trunk lines from being indefinitely held up in case the operator fails to answer or in case the calling subscriber fails to hang up after conversation after the operator has disconnected. After conversation the operator disconnects, causing the deenergization of relays 1002, 1004 and 1010, as previously described. At this time only relays 1003, 1007, 1002, 1012, and possibly 1005 are in operated positions in case the subscriber fails to hang up. When relay 1013 deenergizes in response to the disconnection of the operator said relay at armature 1046 connects the time pulse lead 555 to the lower winding of time release relay 1013. When time pulse conductor 555 is grounded relay 1013 is energized over the following circuit: from ground at armatures 1192 and 1193, time pulse conductor 555, normally closed springs controlled by armature 1054, armatures 1046 and 1038, and through the lower winding of relay 1013 to battery. At armature 1054 relay 1013 connects direct ground in place of ground on the time pulse conductor 555 for maintaining the relay 1013 in operated position independent of the time pulse conductor 555. At armature 1053 relay 1013 transfers the upper winding of relay 1012 from direct ground at the normally closed springs controlled by this armature to ground on the time cut-off conductor 649. If the trouble condition continues ground is disconnected from the time cut-off conductor 649 after an interval, and this disconnection of ground opens the circuit of relay 1012 and the circuit of trunk line cut-off relay 101. The disconnection of this ground also disconnects the busying ground and also opens the circuit of relay 620 in the link circuit. When

relay 620 deenergizes the link circuit is restored to its normal condition as previous described. The deenergization of the cut-off relay 101 restores the trunk line circuit to its normal position. When relay 1012 deenergizes said relay at armature 1051 opens the circuit of relay 1005 if such relay is operated. When the link circuit releases the relays therein open the circuit extending to relays 1002 and 1007 which now deenergize. At armature 1033 relay 1007 opens the circuit to relay 1003. At armature 1033 relay 1003 opens the circuit to relay 1013 which now deenergizes to place the trunk line TR in normal condition.

Each link circuit is fused separately and battery is fed to all the relays and connections in the link through the windings I, II, and III of relay CB in multiple. If the current drain for one of the links exceeds a predetermined value, say for example, the link circuit in Fig. 6, then relay CB in Fig. 6 operates. At armature 645 relay CB opens the circuit from battery through its No. I winding, at armature 644 opens the circuit for feeding battery through its No. II winding, and at armature 646 closes the circuit for energizing time release relay 604 in series with the fuse alarm relay 1159, in Fig. 11, by way of conductor 1059. The operation of the fuse alarm relay in Fig. 11 causes the trouble alarm signals to be transmitted over the alarm trunk as previously described. The operation of relay 604 at armature 605 grounds the guard lead 616 to busy this link circuit, and at armature 606 removes one of the multiple grounds from all link busy conductor 629. The high resistance of the No. III winding of relay CB protects the link from excessive current drain and may cause all or some of the operated relays in the link to deenergize.

Having described the invention what is considered to be new and is desired to be protected by Letters Patent will be set forth in the following claims.

What is claimed is:

1. In a telephone system, groups of lines, a plurality of links for interconnecting said lines, a first and a second relay group in each of said links, means common to said links responsive to a line in one of said groups initiating a call for marking such group as calling and for seizing an idle one of said links, means in said common means responsive thereto for operating only the relay corresponding to the calling group in the first relay link group of said seized link, means operated by said relay for marking the calling line in the second relay link group, and means for sequentially operating the relays in the second link group to find the marked calling line.

2. In a telephone system, groups of lines, a plurality of links for interconnecting said lines, a first and a second group of relays in each of said links, a relay allotter common to said links having a group of relays for preselecting an idle one of said links, means responsive to a line in one of said groups initiating a call for marking such group as calling in the allotter, a second group of relays in said allotter sequentially operated in response to the initiation of a call to find the calling group, means responsive thereto for operating a relay in the first group in the preselected idle link to mark the calling line in the second relay link group, and means for sequentially operating the relays in said second link group to find the marked calling line.

3. In a telephone system, groups of lines, finder links for extending connections between said lines,

an allotter common to said links and said lines, means responsive to a calling line in one of said groups initiating a call for marking such group as calling in the common allotter, means in said common allotter operated in response to the initiation of a call for finding the marked calling group, and means in an idle one of said links operated in response to the allotter finding the marked calling group for connecting all the lines of said calling group to such idle link for testing purposes.

4. In a telephone system, groups of lines, finder links for extending connections between said lines, an allotter common to said links and said lines, means responsive to a calling line in one of said groups initiating a call for marking such group as calling in the common allotter, means in said common allotter operated in response to the initiation of a call for finding the marked calling group, means in an idle one of said links operated in response to the allotter finding the marked calling group for connecting all the lines of said calling group to such idle link for testing purposes, and means in said connected link operated by said allotter in response to said allotter finding the marked calling group to hunt for the calling line in the calling group.

5. In a selecting system, a plurality of links, a group of selecting relays comprising a relay for each link, means for energizing the first of said relays, means responsive to the operation of said first relay for selecting the first link for use if idle and for operating the second relay in case the first link is busy, means responsive to the operation of said second relay for deenergizing said first relay, for selecting the second link for use if idle and for operating the third relay in case the second link is busy, and means for successively operating said relays as set forth until an idle link is found.

6. In a selecting system, a plurality of links for use in completing connections, a chain of selecting relays comprising a relay for each link, energizing circuits and locking circuits for said relays, one of said relays being normally energized over its locking circuit in case one or more links are idle, each said relay when energizing opening the locking circuit of the preceding relay, preselecting the corresponding link for use, and preparing the energizing circuit for the next succeeding relay in the chain, and means for operating said next succeeding relay over the prepared energizing circuit when said preselected link is made busy to preselect the next succeeding link and in case this link is busy for causing the sequential operation of said relays until an idle link is preselected.

7. In a telephone system, groups of lines, a plurality of links for interconnecting said lines, a group of finder relays, a group of finder unit relays, a group of connector relays, and a group of connector unit relays in each link, means responsive to a line initiating a call for marking the calling group, a group of relays common to said links operated sequentially to find the calling group, means operative when the group is found for operating a finder relay corresponding to the group calling in an idle one of said links, means responsive to the operation of the finder relay for marking the calling line in the finder unit relay group, means operated responsive to the calling group being found for operating said finder unit relays sequentially until the marked calling line is found, and means responsive to impulses transmitted over the calling line for op-

erating a particular one of said connector group relays in the link in accordance with the group number of the called line and for operating a particular one of said connector unit relays in the link in accordance with the unit number of the called line to extend the connection over the link to the called line.

8. In a telephone system, a group of lines comprising both subscribers' lines and trunk lines, a link for interconnecting said lines, a group of relays in said link, each of said relays corresponding to a line in said group, testing means in said link, and means responsive to a calling subscriber dialling only a single digit thereby designating a trunk call in this group of lines for sequentially operating the relays corresponding to the trunk lines in this group of lines to successively connect said trunk lines to said testing means until an idle trunk line in the group is found.

9. In a telephone system, a group of lines comprising both subscribers' lines and trunk lines, a link for interconnecting said lines, a group of relays in said link, each of said relays corresponding to a line in said group, testing means in said link, a circuit controlled by each of said relays when operated for connecting the line corresponding to such operated relay to said testing means, means for operating said relays to connect the subscribers' lines in said group over said circuits to said testing means in response to a calling subscriber dialling the group and units digits designating calls to subscribers' lines in said group, and means for sequentially operating the relays corresponding to said trunk lines to successively connect the trunk lines of said group to said testing means until an idle trunk line is found in case the calling subscriber dials only a single group digit designating a trunk call in this group.

10. In a telephone system, groups of lines, one of said groups comprising both subscribers' lines and trunk lines and some of said groups comprising only subscribers' lines, a link for interconnecting said lines, a group of relays in said link, each said relay corresponding to a line in each of said groups of lines, testing means in said link, means responsive to a calling subscriber dialling the group digit of a called subscriber's number for connecting the group of lines corresponding to such digit to said relay group, means responsive to the calling subscriber dialling the units digit for operating the relay in said group corresponding to the called line in this group, circuits completed by the operation of each relay of said group for connecting only the line of the connected group corresponding to such operated relay to said testing means, and means responsive to a calling subscriber dialling only a single group digit designating a trunk call in said one group of lines for connecting such group of lines to said relay group and for sequentially operating the relays in said group corresponding to successive trunk lines in this group to successively connect such trunk lines to said testing means until an idle one of said trunk lines in the group is found.

11. In a selecting system, a group of selecting relays for making a selection, a conductor, a circuit for energizing the first of said relays including said conductor and the back contacts on all of said relays in series, a circuit for energizing the second of said relays including said conductor and a front contact on said first relay, a circuit for energizing the third of said relays in-

cluding said conductor, the said back contact on said first relay and a front contact on said second relay, circuits for energizing the succeeding relays each including said conductor, the said back contacts of the second preceding relay and of the relays operated previous thereto, and front contacts of the first preceding relay, and means responsive to connecting a source of current to said conductor for sequentially operating said relays over said circuits to make a selection.

12. In an impulse repeating arrangement, a line relay and a line over which it is energized, a pulse relay, an impulse repeating relay and a pair of auxiliary relays controlled by said pulse relay, a circuit for said pulse relay alternately controlled by said pair of auxiliary relays jointly with said line relay and said impulse repeating relay, and means controlled by said impulse repeating relay for repeating impulses.

13. In a telephone system, a ringing relay for transmitting ringing current to a called line, a plurality of code ringing conductors, means for selecting a particular one of said conductors or for selecting a combination of said conductors, means operated in case only one of said code ringing conductors is selected for operating said relay a plurality of times to produce two series of short rings, and means operated in case a combination of said code ringing conductors is selected for operating said relay a plurality of times to produce a code ring comprising a long ring and a series of short rings.

14. In a telephone system, lines, a plurality of links for interconnecting said lines, a set of counting relays and a ringing relay in each link, a plurality of code conductors common to said links, means for controlling the counting relays in any one of said links to establish a connection to one of said lines and for selecting a particular code conductor, means for connecting said code conductors to said link counting relays, an all relay code interrupter common to said links connected to said code conductors, a source of current and means for operating the relays in said interrupter to connect said source to said code conductors in predetermined code combinations to operate said ringing relay over said selected code conductor in accordance with the number of times said source is connected to said selected code conductor.

15. In a telephone system, a ringing relay for transmitting ringing current when energized, a plurality of code ring conductors, a first and a second mask ring conductor, a code interrupter, means in said code interrupter for connecting said source to said code ring conductors in code combinations, means in said code interrupter for connecting said source to the first mask ring conductor for the first half of each code combination, means in said code interrupter for connecting said source to the second mask ring conductor for the second half of each code combination, and means for selectively connecting said code ring conductors and said mask ring conductors to said ringing relay to energize the same in accordance with the connections of said source to said selected conductors.

16. In a telephone system, a ringing relay for transmitting ringing current to a called line, a plurality of code ringing conductors, a plurality of mask ring conductors, means for selectively connecting one or more of said conductors to said relay, means operated in case only one of said code ringing conductors is selected for operating said relay thereover to produce two series of short

rings, and means operated in case one of said code ringing conductors and one of said mask ringing conductors are selected for operating said relay over the selected code ringing conductor to produce a series of short rings and for operating said relay over the selected mask conductor to mask one of said series of short rings thereby producing a long ring in accordance with the mask ringing conductor selected.

17. In a telephone system, a ringing relay for transmitting ringing current, a plurality of code ring conductors, means for selecting a particular one of said code ringing conductors and for connecting the same to said relay, a code interrupter comprising code forming relays, and interrupter relays, a source of current, means for alternately operating said interrupter relays, means controlled by said interrupter relays for sequentially operating said code forming relays, and contacts on said code forming relays for connecting said source to each code ring conductor a predetermined number of times during said sequential operation to energize said ringing relay over the selected code ring conductor in accordance with the number of times said source is connected to said selected conductor.

18. In a divided or bridged code ringing telephone system, a called line having a positive and a negative line conductor, means for extending a connection to said line, ringing means for transmitting a plurality of different ringing codes, a set of counting relays, means responsive to the receipt of a code ring digit for operating said counting relays to select a particular ringing code in accordance therewith, a circuit for transmitting the selected ringing code over the negative line conductor of said called line in case said code ring digit is of a predetermined value or less, and a second circuit controlled by one of said counting relays for transmitting the selected ringing code over the positive line conductor of the called line in case the code ring digit is greater than said predetermined value.

19. In a telephone system, a called line, a plurality of ringing condensers on said line, a ring cut-off relay, a circuit for said relay, a ringing conductor, a code ringing arrangement including means for transmitting codes of ringing current comprising ringing periods separated by silent periods over said conductor to said called line, means for temporarily grounding the ring conductor after each ringing period during a portion of each silent period to discharge the ringing condensers on the called line and for preparing said circuit to energize the ring cut-off relay during the remainder of each silent period, and means responsive to a party on said line answering for completing said circuit to energize said relay on the first silent period after the party answers.

20. In a telephone system, a local exchange, a main exchange, a trunk line interconnecting said exchanges, means in said local exchange operated in case of fault for seizing said trunk line if idle and for signalling the operator at the main exchange, means in said local exchange operated in response to the operator answering for transmitting a series of tones over said trunk line, and means for connecting an alarm tone to said trunk line between certain ones of said tones in accordance with said fault to identify the fault.

21. In a telephone system, a local exchange, a main exchange, a trunk line interconnecting said exchanges, means in said local exchange operated in case of fault for seizing said trunk line if idle

and for signalling the operator at the main exchange, means in said local exchange operated in response to the operator answering for transmitting a series of tones over said trunk line in accordance with said fault to identify the fault, means for freeing said trunk line upon disconnection of the operator therefrom, and verification means controlled by the operator for reoperating said tone transmitting means.

22. In a selecting system, a group of selecting relays for making a selection, a conductor, a circuit for energizing the first of said relays including said conductor and the back contacts on all of said relays in series, a circuit for energizing the second of said relays including said conductor and a front contact on said first relay, a circuit for energizing the third of said relays including said conductor, the said back contact on said first relay and a front contact on said second relay, circuits for energizing the succeeding relays each including said conductor, the said back contacts of the second preceding relay and of the relays operated previous thereto, and front contacts of the first preceding relay, means responsive to connecting a source of current to said conductor for sequentially operating said relays over said circuits to make a selection, and a locking circuit for each of said relays controlled by a succeeding relay.

23. In an impulse repeating arrangement, a line relay and a line over which it is energized, a pulse relay, an impulse repeating relay controlled by said pulse relay, a pair of auxiliary relays alternately controlled by said impulse repeating

relay and said pulse relay, a circuit for said pulse relay controlled by said line relay, said impulse repeating relay and alternately by said auxiliary relays, and means controlled by said impulse repeating relay for repeating impulses.

24. In a telephone system, two different code ringing conductors, means for selecting either one or both ringing conductors, means operated in case the first ringing conductor is selected for producing a series of short rings, for producing a long ring in case the second ringing conductor is selected, and for producing a combination of both a long ring and a series of short rings in case both said ringing conductors are selected.

25. In a telephone system, a local exchange, a main exchange, a trunk line interconnecting said exchanges, a source of dial tone and a source of alarm tone in said local exchange, means in said local exchange operated in case of fault for seizing said trunk line and for signalling the operator at the main exchange, and means in said local exchange operated in response to the operator answering for connecting dial tone followed by a connection of said alarm tone and two further connections of dial tone to said trunk line in case of a first fault, for connecting dial tone twice followed by a connection of said alarm tone and a single further connection of dial tone to said trunk line in case of a second fault, and for connecting dial tone thrice followed by a connection of said alarm tone to said trunk line in case of a third fault.

JOHN E. OSTLINE.