Dec. 29, 1925. 1,568,038

S. B. WILLIAMS, JR., ET AL

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 7, 1922 13 Sheets-Sheet 1

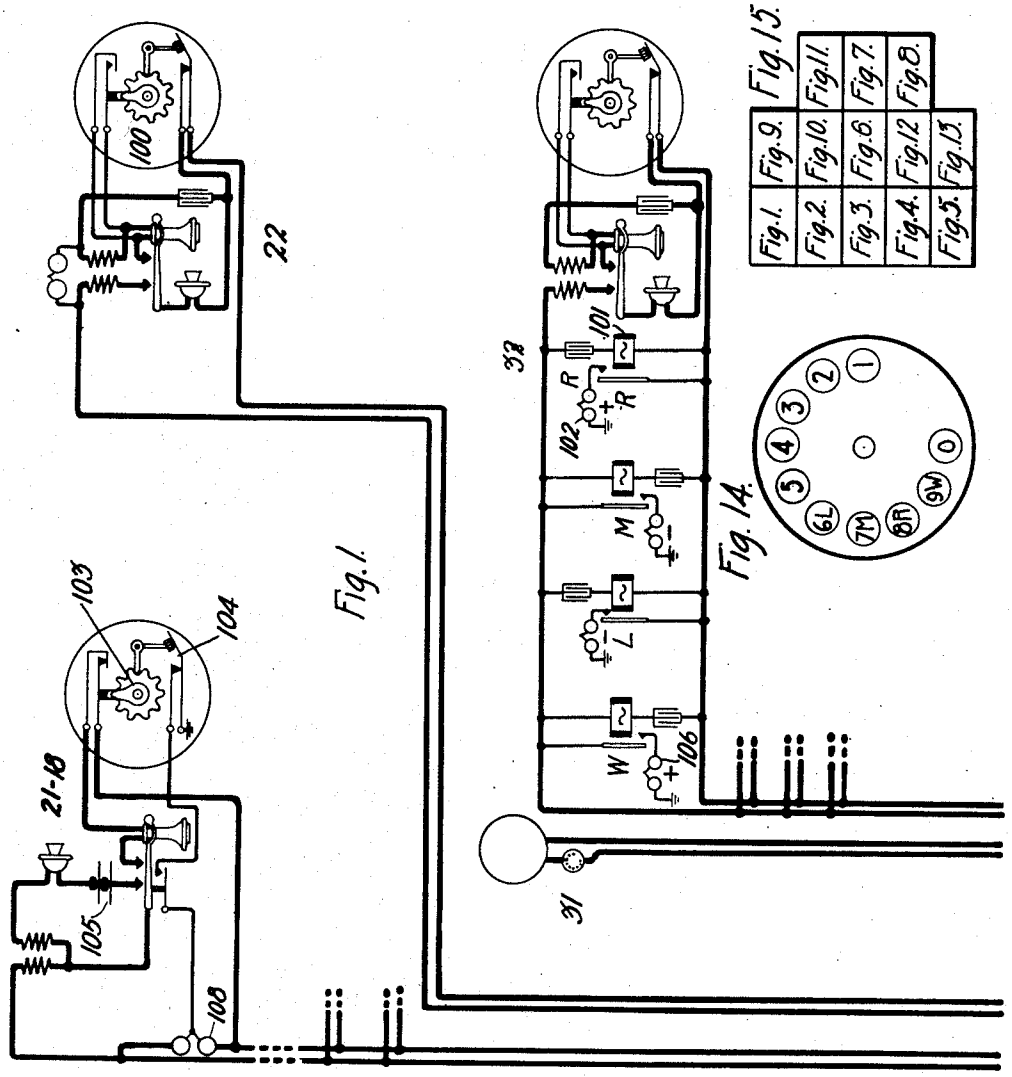

Fig. 1.

Fig. 15.

		Fig. 11.	Fig. 7.	Fig. 8.
	Fig. 9.	Fig. 10.	Fig. 6.	Fig. 12	Fig. 13.
Fig. 1.	Fig. 2.	Fig. 3.	Fig. 4.	Fig. 5.

Fig. 14.

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AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 7, 1922 13 Sheets-Sheet 2

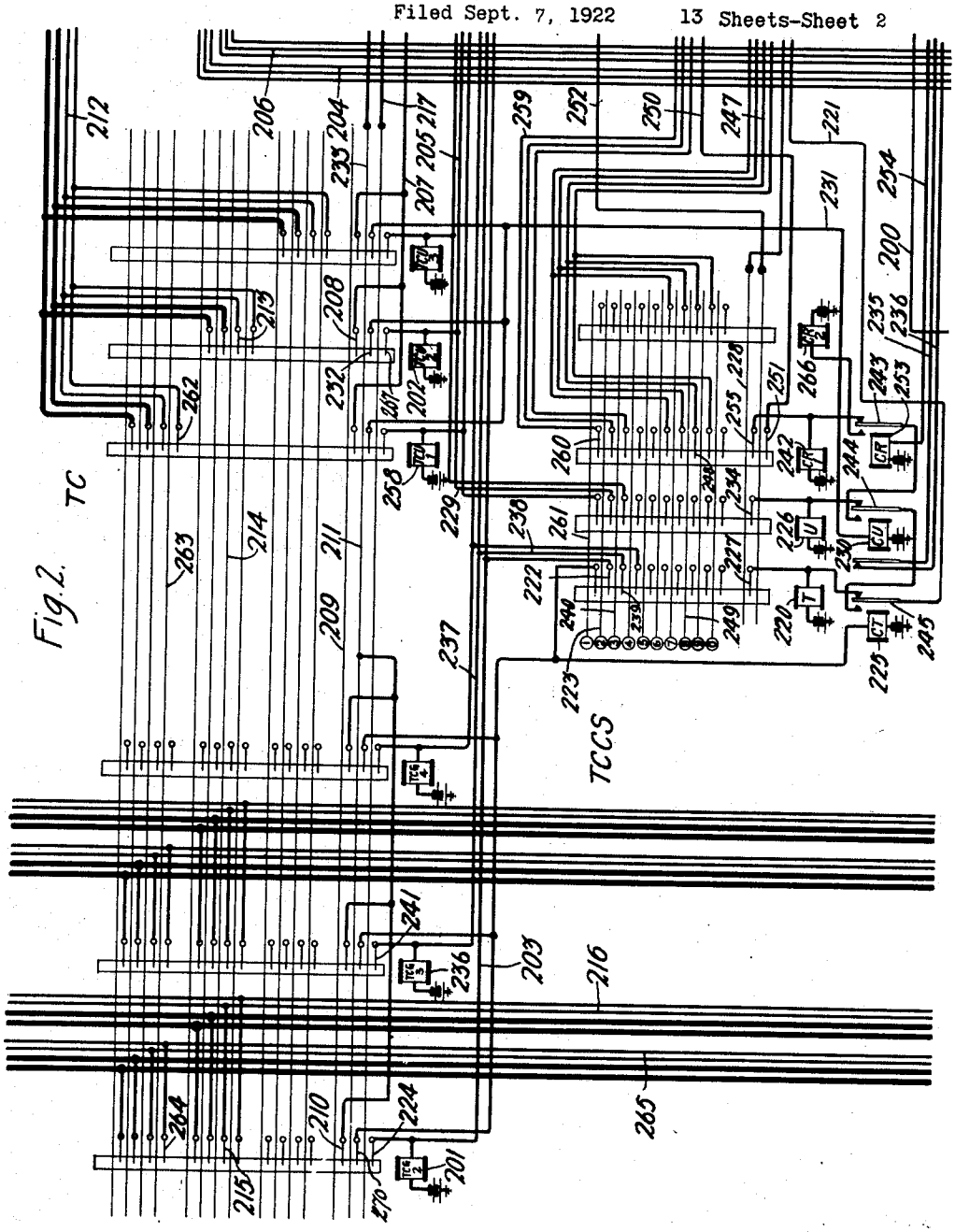

Fig. 2.

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AUTOMATIC TELEPHONE SYSTEM

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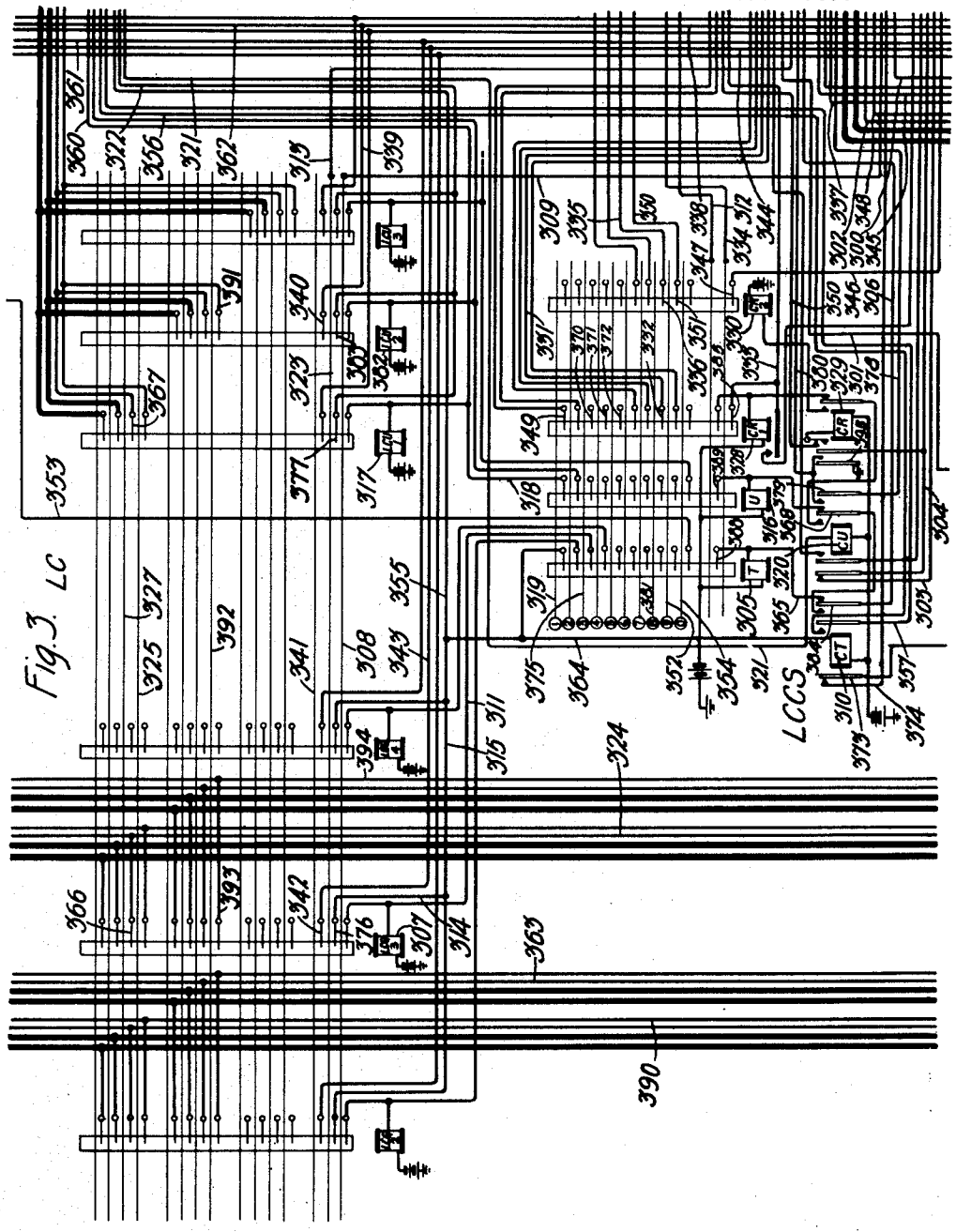

Fig. 3.

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AUTOMATIC TELEPHONE SYSTEM

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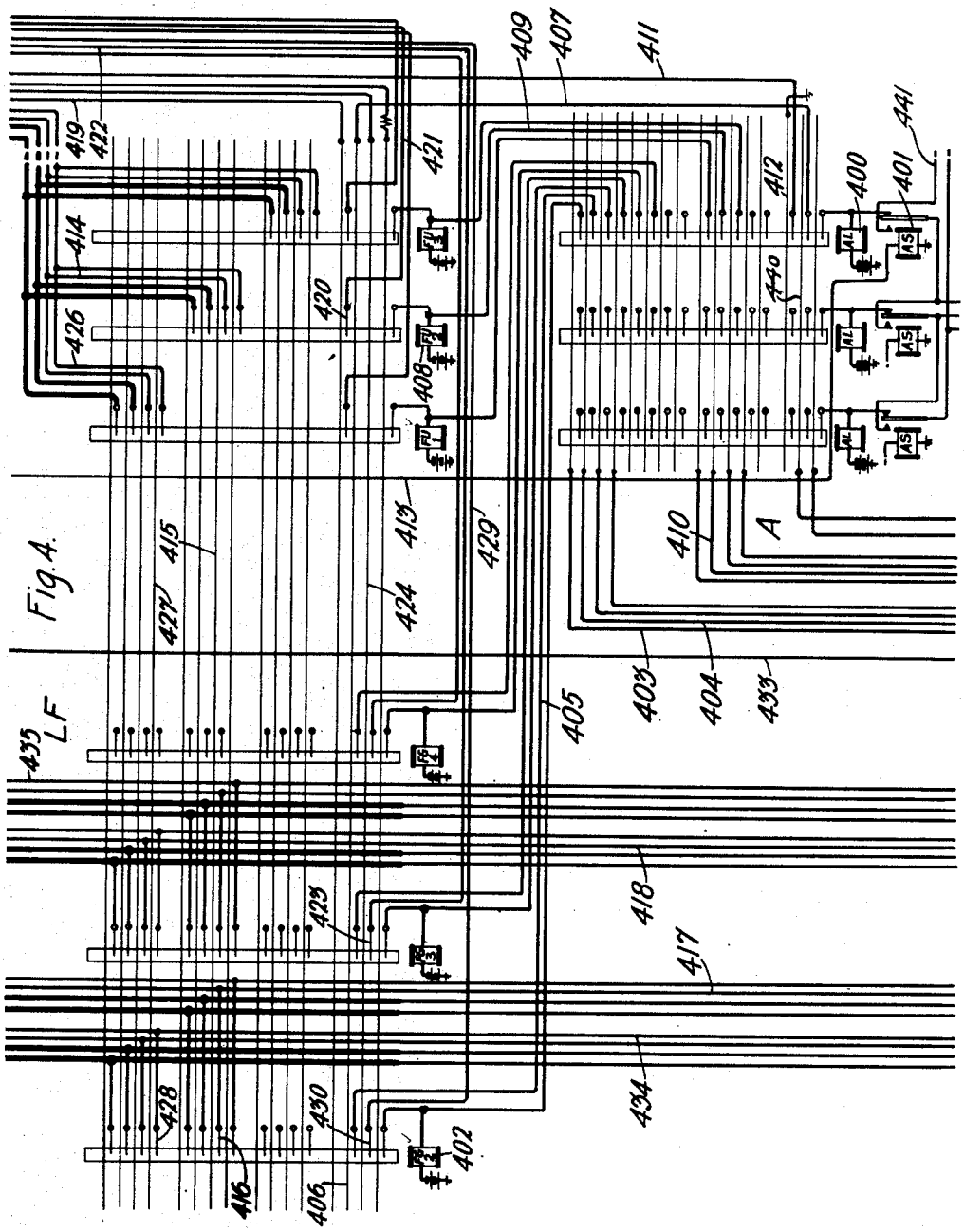

Fig. 4.

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AUTOMATIC TELEPHONE SYSTEM

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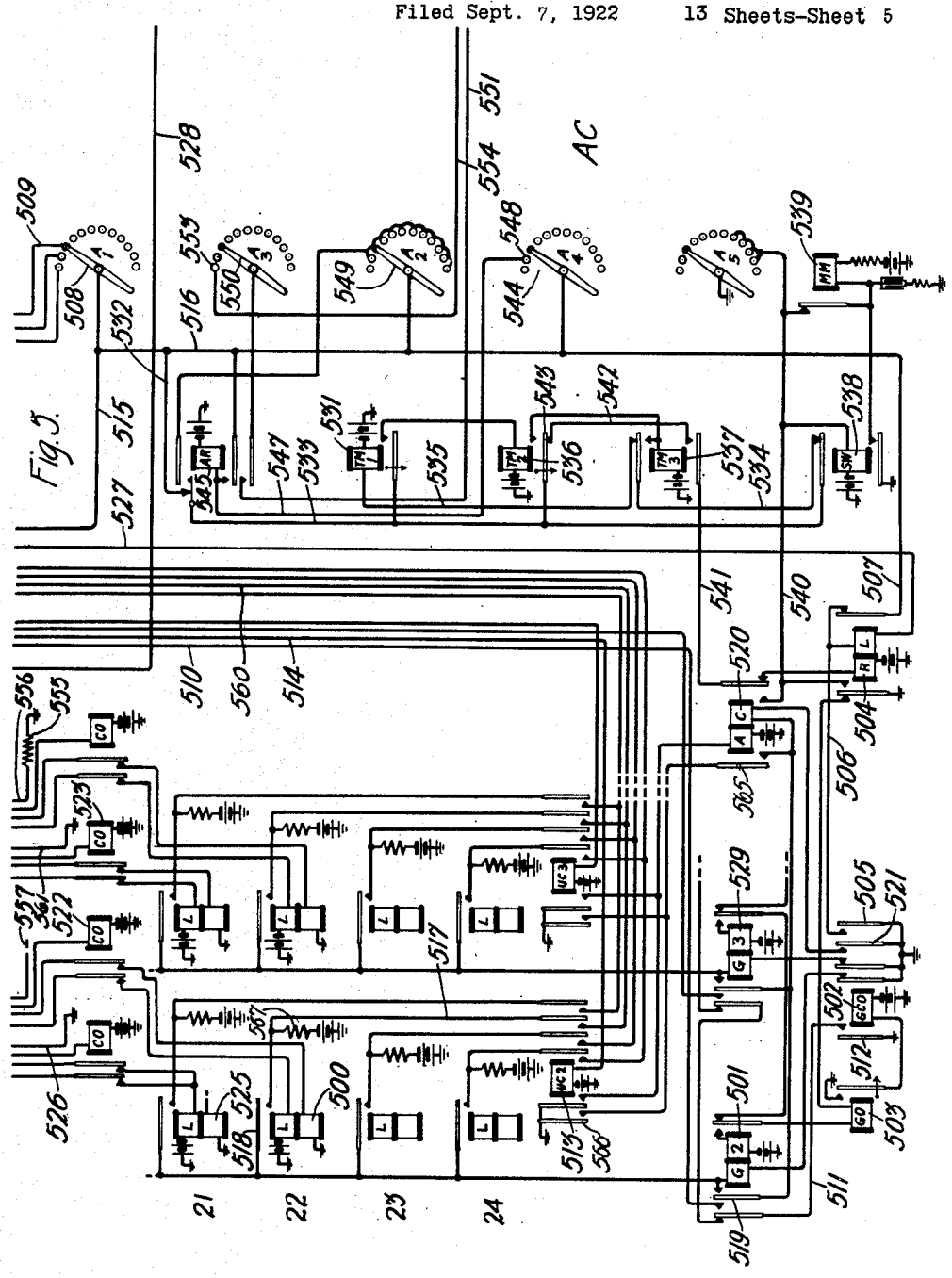

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AUTOMATIC TELEPHONE SYSTEM

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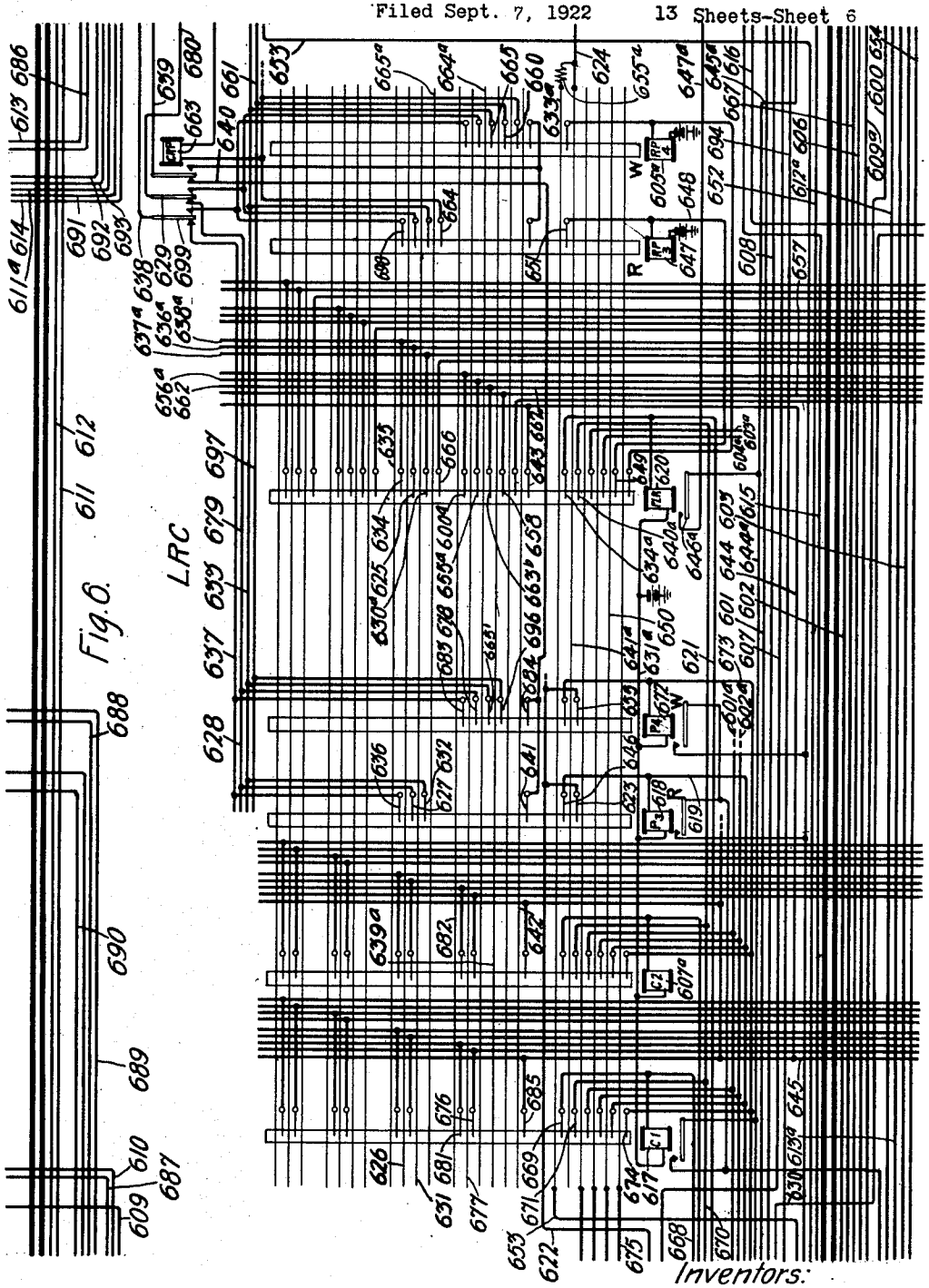

Fig. 6.

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AUTOMATIC TELEPHONE SYSTEM

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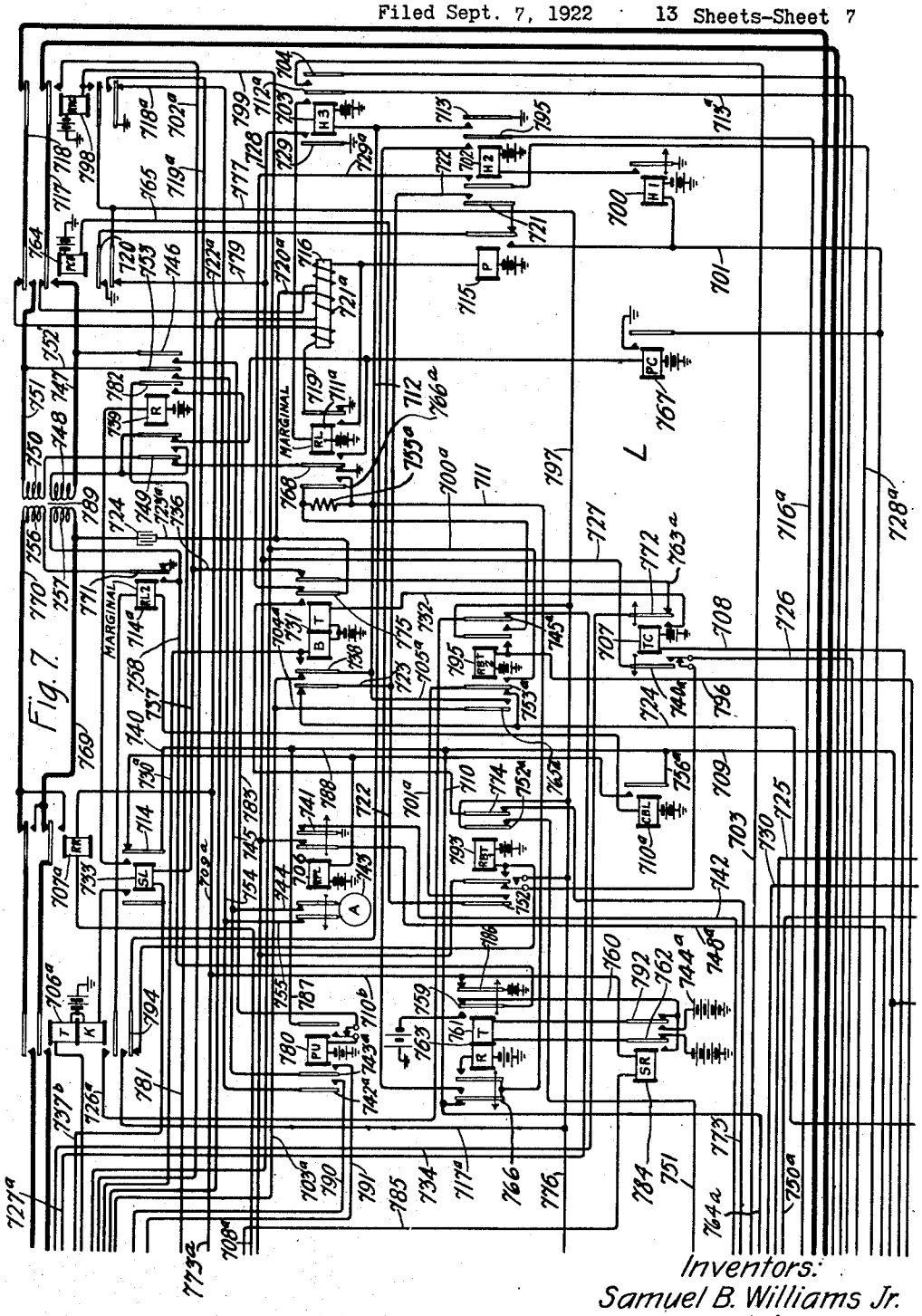

Fig. 7.

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AUTOMATIC TELEPHONE SYSTEM

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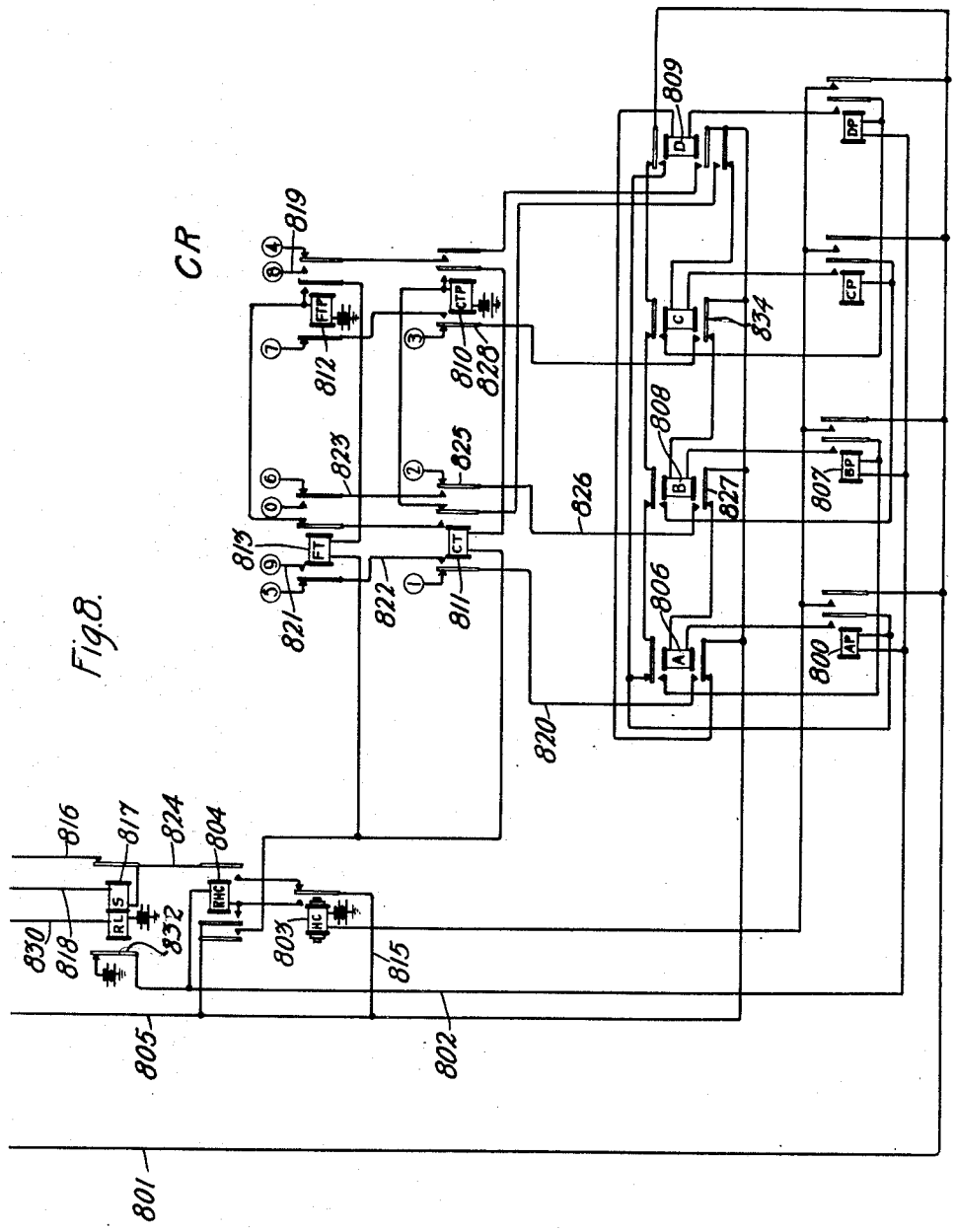

Fig. 8.

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S. B. WILLIAMS, JR., ET AL.

AUTOMATIC TELEPHONE SYSTEM

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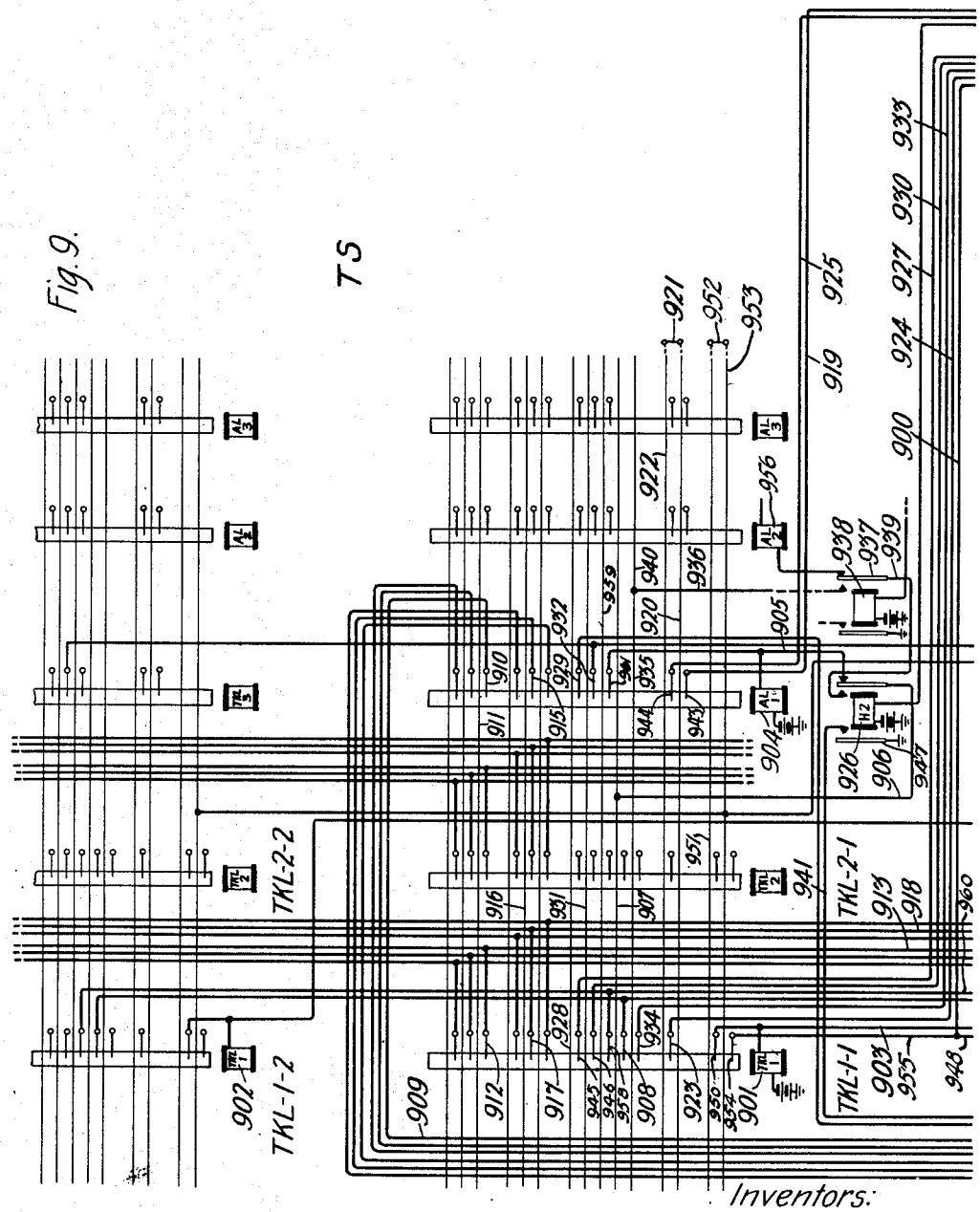
Fig. 9.



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AUTOMATIC TELEPHONE SYSTEM

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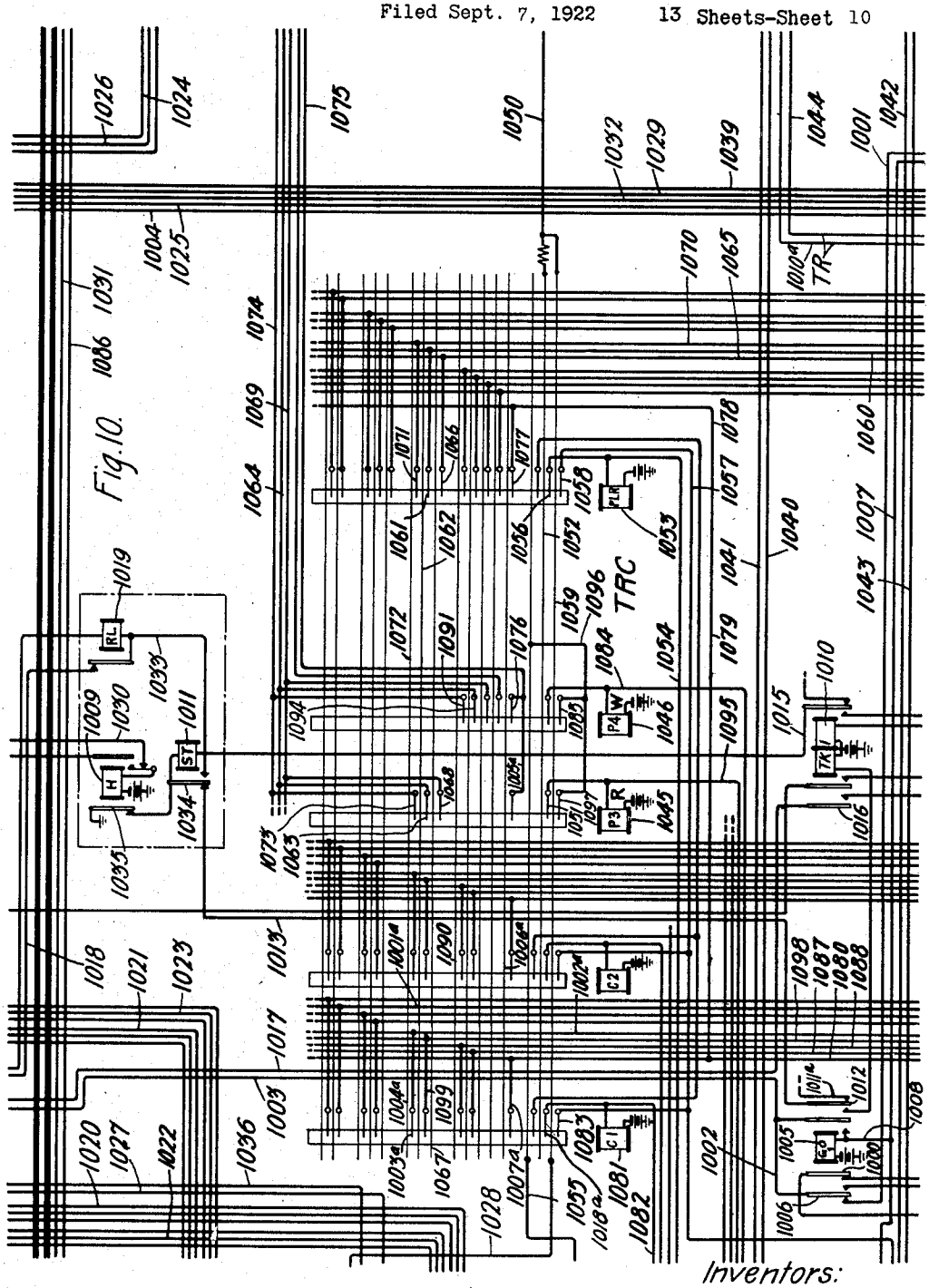

Fig. 10.

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AUTOMATIC TELEPHONE SYSTEM

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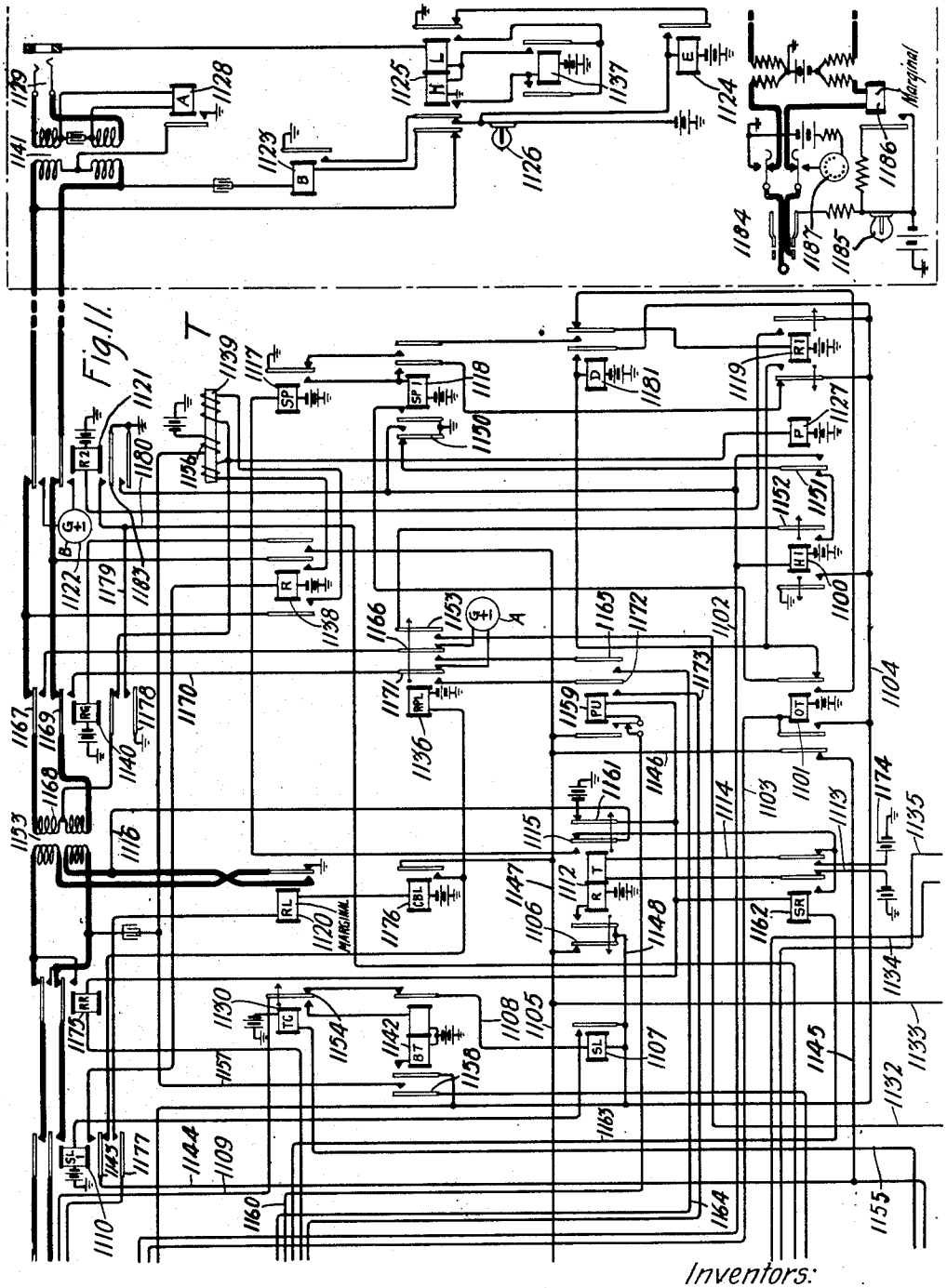

Fig. 11.

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AUTOMATIC TELEPHONE SYSTEM

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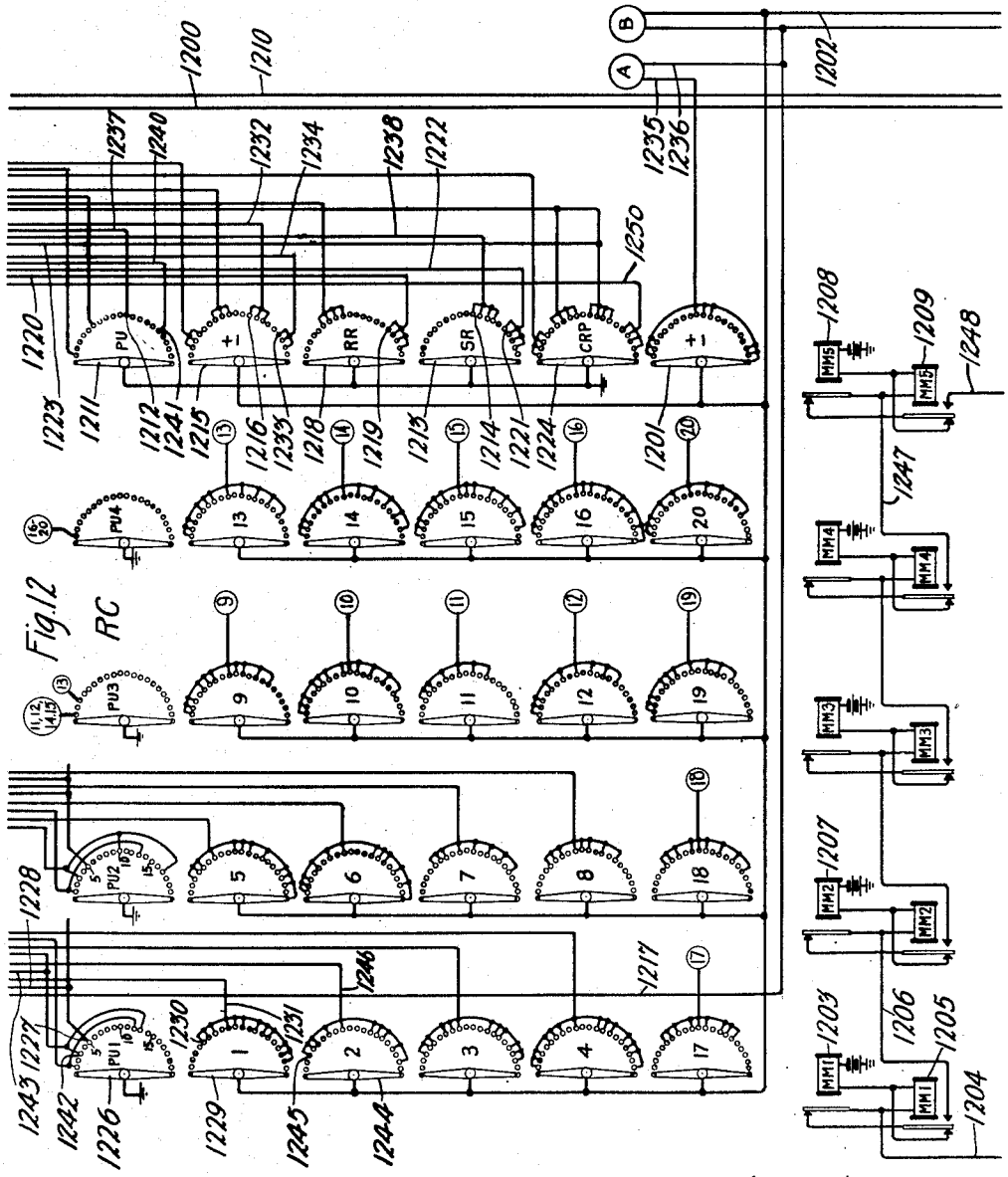

Fig. 12

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AUTOMATIC TELEPHONE SYSTEM

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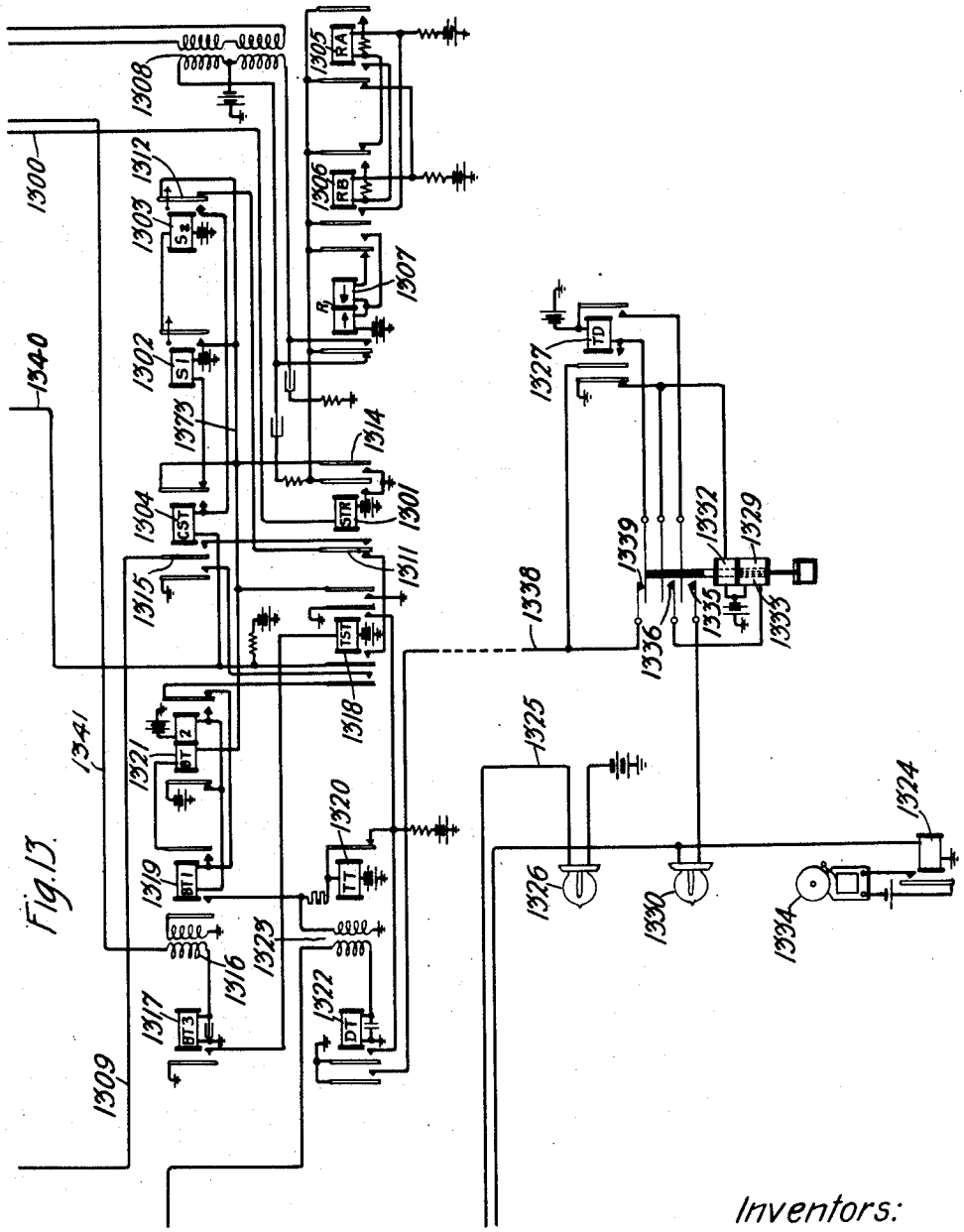

Fig. 13.

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Patented Dec. 29, 1925. 1,568,038

UNITED STATES PATENT OFFICE.

SAMUEL B. WILLIAMS, JR., OF BROOKLYN, NEW YORK, AND EARL S. GIBSON, OF RIDGEWOOD, NEW JERSEY, ASSIGNORS TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

AUTOMATIC TELEPHONE SYSTEM.

Application filed September 7, 1922. Serial No. 586,623.

To all whom it may concern:

Be it known that we, SAMUEL B. WILLIAMS, Jr., and EARL S. GIBSON, citizens of the United States of America, residing at Brooklyn, in the county of Kings and State of New York, and Ridgewood, in the county of Bergen and State of New Jersey, respectively, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to automatic telephone exchanges and more particularly to what are known as community automatic exchanges; that is, systems for small towns and villages wherein various types of subscribers' lines such as rural lines and party lines as well as individual lines terminate in the same exchange, the rural lines being local battery lines and the party and individual lines being common battery lines.

The object of the invention is to provide a system of this character which will be efficient in operation and cheap to manufacture.

In the circuit arrangement of this invention multi-contact relays instead of step-by-step switches are used to establish the connections. These multi-contact relays consist of a number of bare wires running horizontally with which other bare wires are adapted to engage. A feature of this invention is the provision of a circuit arrangement for preventing sparking at the points where the bare wires engage when the contact between these wires is broken upon the disestablishment of the connections, these wires not being provided with platinum contacts. In accordance with this feature of the invention, the circuits for maintaining the multi-contact relays energized to hold these bare wires in contact is not broken until after the circuits which lead through these bare wires have been opened. More specifically, the circuit is so arranged that upon the breaking down of the connection a relay is released which removes current from what may be termed for convenience the circuit relays. These relays in releasing remove current from the circuits including the bare wires referred to. After this current is removed the circuit of the relay which has been maintaining the multi-contact relays energized is opened and these relays released, but inasmuch as no current is flowing at this time through the points where these bare wires engage, no sparking results. It will be readily apparent that this is a desirable if not a necessary feature where ordinary bare wire with no platinum contacts is used, for otherwise the wire would be burned and rendered useless in a very short time.

Another feature of the invention is the provision of a circuit arrangement for preventing the calling subscriber from dialing more digits than required to build up the particular connection involved.

A further feature is the provision of a circuit arrangement wherein in the case of a revertive party line call the calling party dials the directory number of the desired station and then dials the letter suffix of his own station and then replaces his receiver, whereupon his bell and the called station bell will ring alternately until the called party answers, when the ringing will cease which is the signal for the calling party to remove his receiver and carry on the conversation.

Another feature is the provision of means for preventing two or more lines calling simultaneously from getting the same link circuit.

Another feature is the provision, in a community exchange of the all-relay type, of a circuit arrangement whereby the calling party, in addition to being able to build up local calls automatically, can select one of a number of trunk groups, whereupon an idle trunk in the selected group is connected to his line over which the call is extended to a desired main office.

Another feature is the provision of a circuit arrangement wherein on a revertive call the connector relays are released and the finder relays are held set, thus effecting a saving in current. This is a very desirable feature in systems supplied with current from a small storage battery.

A still further feature is the provision of a circuit arrangement whereby upon the selection of a trunk to one of the central offices, alternating current is momentarily applied thereto to operate a signal at the said office as a calling signal, and upon the

replacement of the receiver by the calling party said current is again applied to operate a disconnect signal at said office.

A further feature is the provision, in a system of the type referred to, of a circuit arrangement, for operating a signal at the central office if all the links are busy or defective.

Another feature is the provision, in a system of the type referred to, of a circuit arrangement for automatically selecting another link if the one selected does not function and extend the calling line within a certain interval.

A further feature is the provision, in a system of the type referred to, and wherein a line finder starting circuit is closed upon the removal of the receiver by the calling party, said circuit being then removed from his control and released when the line is extended by the finder, of means for restoring the start circuit to normal in case the calling party abandons the call before the finder has time to connect with the calling line.

A further feature is the provision of an improved means for generating the required ringing current by means of relays, and a code switch for applying this current to the rural lines, the code switch magnets being operated in sequence and not in unison so as to permit of a relatively small battery being used.

Another feature is the provision of an all-relay generator and a switching arrangement for selectively operating party line bells branched off the line to ground and operated by plus and minus current.

Other features will appear in the following detailed description.

Referring to the drawings:

Fig. 1 shows the various types of subscriber circuits; Fig. 2 shows a trunk connector; Fig. 3 shows a local connector; Fig. 4 shows a line finder; Fig. 5 shows marker and allotter circuits; Figs. 6 and 7 show a link circuit; Fig. 8 shows a counting relay circuit; Fig. 9 shows a trunk selector; Figs. 10 and 11 show a trunk circuit and Fig. 10 also shows a trunk ringing control circuit; Fig. 12 shows a ringing circuit; Fig. 13 shows the tone and alarm circuits; Fig. 14 shows the substation dial, and Fig. 15 is a view showing the manner in which the drawings should be arranged to trace the operation of the circuits.

The system shown in the drawings is particularly adapted to give full automatic service to small towns and the equipment shown provides for eighty subscribers' lines and ten groups of trunks by means of which connections may be extended to other offices. These eighty lines are individual lines, party lines and rural lines. The individual lines are operated on a common battery basis. The subscribers' sets of these lines equipped with the usual bridged arrangement of ringer and condenser for signaling. The party lines are also operated on a common battery basis and are equipped with the standard Bell party line ringing equipment; that is to say an alternating current relay is bridged across the line at each station and when operated connects the associated biased ringer in a ground branch from one side of the line. One call number is assigned to each party line and a letter suffix is used to indicate the station on the line. The directory number for a station on a party line is therefore the line number followed by a letter such as 32—R. The rural lines are operated on a local battery basis. The automatic equipment at the central office is controlled over a so-called simplex circuit from the subscriber's dial, a ground connection being provided at the dial. One call number is assigned to each rural line and the station is indicated by a two digit suffix. The directory number for a station on a rural line is the line number followed by a two digit suffix, such as 21—18.

When the receiver is removed from the hook a distinctive dial tone will be heard as soon as the automatic equipment is ready to receive impulses. The time between the removal of the receiver until the tone is heard is very short.

Calls for stations not on the same party or rural line will be made by dialing the directory number. If the wanted line is busy a distinctive busy tone will be heard when the dialing operation is completed, and the receiver should then be replaced, which releases the automatic equipment. If the station is idle, ringing tone will be heard and will continue until the call is answered. If the call is for a station on the same line, whether party or rural, it is known as a reverting call. If a party line subscriber desires to make a reverting call he dials the listed number and the letter suffix of his own number and then replaces his receiver. The bell of his own as well as that of the called station will ring alternately until the called party answers when the ringing ceases which is the signal for the calling party to again remove his receiver and conversation may proceed. If the calling party is on a rural line and desires to make a revertive call he will only have to dial the listed number and then replace his receiver. All the bells on the line will then ring the code of the called station and will stop ringing when the called party answers, which is the signal for the calling party to remove his receiver and conversation may proceed. The calling party can readily identify a reverting call since the first two digits are the same, the suffix only being different.

In making a trunk call the subscriber will

dial the code for the particular trunk. In the present embodiment of the invention the first digit is zero followed by the number of the particular trunk group. This results in the selection of a trunk and the operation of a signal at the central office to which the trunk extends, whereupon the operator will plug in and ascertain the number desired and then extend the connection. If all the trunks in the desired group are busy the calling party will get a distinctive tone, whereupon he should replace his receiver to restore the automatic equipment.

On incoming trunk calls to the community exchange the operator at the distant main office sets the automatic equipment at the said exchange to connect with the desired line.

The ringing current on an incoming trunk call is automatically applied at the branch exchange. Due to the isolated location of the branch exchange a single low frequency ringing system made up of relays is used. Provision is made for a maximum of twenty stations on a rural line and a code switch for twenty different ringing codes is provided.

A detailed description will now be given of the operations involved in building up the various kinds of connections. In tracing these circuits it should be borne in mind that the hundreds or thousands and hundreds digit of the reference character will indicate the sheet whereon such character will be found.

Individual line to individual line.

The removal of the receiver by the subscriber at substation 22 closes the circuit of line relay 500, which relay in attracting its armature 518 operates group relay 501 over a circuit including a normal contact of relay 502. Group relay 501 at its right armature closes a locking circuit for itself including group relay 503 and a normal contact of relay 504. To provide against two or more group relays 501, 529, etc., operating simultaneously and thus seizing the same link, the locking circuit leads through series contact on all the intermediate group relays. Thus if, two or more group relays such as 501, 529 operate simultaneously only one relay 501, can hold. Relay 503 operates group relay 502, which relay in attracting its right armatures removes ground from the group relays corresponding to 501 and grounds the starter wire to initiate the operation of line finder mechanism to extend the calling line to an idle link circuit. The starting circuit includes the following elements: ground, 505, 506, 507, 508, 509, allotter relay 400 to battery. Assuming the allotter control switch AC shown in Fig. 5 to be in position 3, the starter wire will be connected to allotter relay 400 of the third link through the normal contact of the advanced starter wire relay 401. Relay 400, in operating prepares a circuit for relay 504 in the starter circuit, but the latter cannot operate because it is short circuited by the normal contact of relay 401, as is evident from the circuit traced for relay 400. This short circuit will be removed when the calling line has been extended to the link circuit, when relay 504 will operate and unlock the group relays 501, 503 to restore the control of the start circuit to the other lines. Relay 400 in operating, causes the operation of the link holding relays of Fig. 7 as will be described, and connects the group relays of the line finder to the contacts of the group relays in the group circuit to connect the calling line to the seized link. More in detail, the call being traced having originated in group No. 1, group relay 501 having been operated as described causes the operation of group relay 402 corresponding to this group in the line finder shown in Fig. 4 when relay 400 operates as described. This circuit includes the following elements: battery, 402, 403, 510, 511, 512, to ground. Relay 402 connects the ten lines including the calling line to the cross wire multiple shown in Fig. 4. Relay 400, in operating, also operates group relay 513 over the following circuit: battery, 513, 514, 404, 405, 406, 407, 440, 515, 516, 507, 506, 505 to ground. Relay 513 places the units relays in the line finder under the control of the line relays of the calling group and causes the operation of the particular units relay in the line finder which corresponds to the position of the operated line relay 500 in the group. The calling substation 22 being the second line in the first group, relay 408 will be operated, as follows: battery, 408, 409, 410, 560, 517, 518, 519, 565, 566 to ground. It will be noted that when relay 513 operated, it completed an obvious circuit for relay 520.

Resistance 567, connected between battery and the front contact of relay 500, is to prevent the ground applied at the armature 566 from being connected directly to battery when relay 513 operates as described; it is a protective resistance.

Slow to release relay 700 in the link circuit (Fig. 7) operates when relay 400 operates, the circuit being as follows: battery, 700, 701, 600, 300, 411, 412 to ground. Relay 700 operates relay 702. The latter operates relay 703. Relay 702 provides holding ground for all the ordinary circuit relays such as 761 while relay 703 provides holding ground for all the multi-contact relays such as 402, 408. Relay 703 releases after relay 702 when the connection is broken down, so that no circuits will be broken by the wire contacts of the multi-contact relays when the latter release, thus avoiding sparking at the contacts. When the link circuit is connected to the calling line by relays 408, 402, as de-

scribed, relay 401 operates in series with the cut-off relay 522 of the calling line, the circuit being as follows: ground, 401, 413, 301, 601, 703, 704, 602, 302, 414, 415, 416, 417, 522 to battery. Relay 522 cuts off the line relay 500 in the well known manner. Relay 401 transfers the start wire 516 from link 3 which has just been taken for use to conductor 441 leading to link 4, and removes the short circuit from relay 504, which now operates over conductor 527, and in attracting its left armature opens the locking circuit including group relays 501 and 503. Relay 504 in attracting its right armature removes ground from the start wire 516 to prevent this ground from causing the seizure of link 4 to which relay 401 has extended to start wire as described. At its left armature relay 504 transmits an impulse to motor magnet 539 of the allotter control switch AC to advance its brushes a step to vary the point of ingress of the starting conductor 516 with respect to the allotter A, (Fig. 4) in order to distribute the load uniformly among the links. The release of relay 503 releases relay 502 which restores the control of the group relays corresponding to relay 501 to their respective groups. Relay 502, in retracting its armature 505, releases relay 504 reconnecting the start wire 516 to armature 505 of relay 502 which may now be operated by another calling line to cause the seizure of the link to which relay 504 extended the start wire 441. At this time relay 400 also releases, since its locking circuit is opened by the release of relay 502.

Relay 702, in operating, operates slow to release relay 706 to prepare the ringing circuit, and slow to release relay 707 to prepare for testing the called line. The circuit for relay 707 is as follows: battery, 707, 708, 603, 303, 304, 613[a], 709, 710, 766, 711, 712, 713, to ground. The circuit for relay 706 is as follows: battery, 706, 714, 740, 788, 710, 766, to ground over the path traced for relay 707.

Upon the operation of the group and units relays 402, 408, the impulse relay 715 is operated over the subscriber's line circuit, this circuit including the following elements: battery 715, 716, 717, over the talking conductors traced in heavy lines and including contacts of the operated tens and units relays and the telephone set at substation 22, returning over 718, 719, to ground. When the calling line is extended as described to the link circuit, tone is transmitted to the calling line to inform the subscriber that the equipment is ready to receive the impulses from the dial. It will be remembered that relay 702 operated when the calling line was connected to the link. This relay at its inner left armature closed a circuit for the dial tone relay 1322 which in operating energizes relay 1320. This relay interrupts its own circuit, and creates a tone current in the primary of the induction coil 1323, which is transmitted over the following circuit which is the original energizing circuit for relay 1322: ground, 1322, 1323, 528, 433, 373, 374, 609[a], 728[a], 729[a], 775, 720[a], 721[a], 722[a], 710[b], 786, to battery, The tone transformer 716 transfers this tone by induction to the calling line over the circuit traced for the impulse relay 715.

The subscriber at substation 22 now operates the dial 100 to transmit the tens digit of the wanted number. The impulse relay 715 at the first interruption of the line circuit, operates counting relay 800 over a circuit including the following elements: ground at the armature 720 of relay 764, 721, 722, 723, 724, 801, (normal contacts of the upper counting relays) 800, 802, 832, to battery. Relay 800 connects the ground on conductor 801 to the slow releasing relay 803, which in turn, operates relay 804 as follows: battery, 832, 804, 815, 805, 709, 710, 766, 711, 712, 713, to ground. Relay 804 locks to conductor 805. Relay 800 prepares a circuit for relay 806, but this relay cannot operate as long as it is short circuited by the ground applied to conductor 801 by the armature of the impulse relay 715 in its retracted position. When the impulse relay 715 operates at the end of the first interruption, relay 806 operates in series with relay 800 over a circuit including the inner right armature of relay 800 to ground on conductor 805, and these relays lock up to this grounded conductor and relay 806 connects grounded conductor 805 to counting relay terminal 1. When the dial interrupts the impulse circuit the second time and again closes the circuit, relays 807 and 808 operate, releasing relays 800 and 806 and relay 808 connects grounded conductor 805 to counting relay terminal No. 2. When counting relay 809 operates, relay 810 is operated from grounded conductor 805 and holds in series with relay 811 which operates when relay 809 releases. The cycle is then repeated for these counting relays if the digit is larger than 4. If relay 809 operates a second time, the relay 812 operates and holds in series with relay 813 which operates when relay 809 releases, and a third cycle for the counting relays may be started. By means of these relays the impulses received from the impulse relay 715 are recorded. At the end of the series of interruptions for the first digit of the desired number and assuming this digit to be 3, slow relay 803 releases due to ground being permanently removed from conductor 801 by the continued energization of the impulse relay 715. Relay 803 in releasing closes a circuit for the tens relay 305 in the local connector control switch LCCS (Fig. 3). This circuit includes the following elements: grounded

conductor 805, 815, 824, 816, 725, 694, 306, 384, 365, 305 to battery. Relay 305 connects the counting relay terminals of Fig. 8 to the group relays in the local connector circuit LC and the particular group relay, in this case relay 307, the tens digit 1 not being used, operates over 307, 311, 375, 828, 834, 805, to ground, and locks to holding conductor 308 now grounded by relay 703. This locking circuit is as follows: battery, 307, 308, 309, 606, 726, 740[a], 727, 728, 729 to ground. Relay 307 also operates relay 310 over the following circuit: ground, 713, 712, 711, 766, 764[a], 608, 313, 323, 376, 314, 315, 364, 310, battery. The operation of relay 310 removes a short circuit from relay 817 which now operates in series with relay 305, this circuit including the following elements: battery, 305, 388, 312, 607, 730, 818, 817, 824, 815 to grounded conductor 805. The short circuit referred to may be traced as follows: 365, 306, 694, 725, 816, to 824. Relay 817, in operating, releases the counting relays and also release relay 804 which releases relays 817 and 305.

Conductor 306 over which the tens relay 305 was operated is now extended to units relay 316 by the armature 384 of relay 310 so that when slow relay 803 releases at the end of the series of interruptions corresponding to the second digit, relay 316 operates, connecting the counting relay terminals to the units relays in the local connector, and assuming line 31 is being called, relay 317 operates over the following circuit: battery, 317, 318, 319, counting relay terminal 1, to grounded conductor 805. Relay 317 locks to grounded conductor 308 as described for tens relay 307.

The link is now connected to the called line through the operated group and units relays 307, 317 in the connector. When the units relay 317 operated, relay 320 operated over the following circuit: battery, 320, 321, 609, 1000, 610, 322, 377, 323, 313, 608, 764[a], 766, 711, 712, 713, to ground. Relay 320 removes the short circuit from about relay 817, as described, which now operates in series with relay 316 as follows: battery, 316, 389, 312, 607, 730, 818, 817, 824, 815, 805 to ground. Relay 817, in operating, releases the counting relays, and also releases relay 804, which releases relays 817 and 316. The sleeve conductor 324 of the called line No. 31 is now connected through the right winding of relay 731 to battery to test the condition of the called line. If the line is idle or ungrounded this relay will not operate and the link circuit will assume the ringing condition immediately. The cut off relay 523 of the called line now operates in series with sleeve relay 733, the circuit being as follows: battery 523, 418, 324, 366, 327, 367, 612. 734, 772, 763[a], 736, 737, 733, 737[b], 613, 1001, 1006, 1002, 1003, 948, 900, 1004, 614, 703[a], 738, 712, 713, to ground. Relay 707 released when relay 320 operated. The attraction of the left armature of relay 733 operates relay 706[a] over its lower winding to prepare the talking circuit and the attraction of its right armature releases relay 706 to prepare the ringing circuit. Relay 733, in operating, operates relay 739, this circuit being as follows: battery, 739, 714, 740, 788, 710, 766, 711, 712, 713, to ground. When slow relay 706 releases a short interval after its circuit is opened by relay 733 as described, it closes the following circuit to start the ringing generator (Fig. 13) in operation: ground, armature 741 of relay 706, 742, 615, 378, 379, 380, 630, 1200, 1300, start relay 1301, to battery. Relay 1301 at its armature 1314 operates relay 1302, which in turn operates relay 1303. Relay 1303 in turn operates relay 1304. Relay 1301 at its inner right armature also operates relay 1305. Relay 1305 operates relay 1306. Relay 1306, in operating, releases relay 1305 by short circuiting it. Relay 1305, in releasing short circuits relay 1306, thereby releasing it, and this cycle continues. When relay 1306 operated, it operated relay 1307. When relay 1301 originally operated, it closed a circuit through both windings of relay 1307, but these windings are differentially wound and the relay did not operate. Relay 1301, in operating, grounded the upper half of the primary winding of transformer 1308. When relay 1307 operated, it opened the circuit through the upper half of the primary winding and closed a circuit through the lower half, thus reversing the direction of the flow of current in the primary winding and producing alternating current in the secondary winding of the transformer 1308. This operation continues, thus producing current of the proper character to ring an alternating current bell. The alternating current produced in the secondary winding is controlled by brush 1201 connected to conductor 1202. It will be remembered that relay 1304 operated upon the operation of relay 1303. Relay 1304, in operating, opens the circuit of relay 1302, which after an interval retracts its armature, opening the circuit of slow relay 1303, which after an interval retracts its armature. Retraction of the armature of relay 1303 closes the following circuit to operate the magnet 1203 of the first row of brushes of the switch shown in Fig. 12: battery, 1203, 1204, 1309, 1315, 1311, 1312, 1373, 1314, to ground. Magnet 1203, in operating, removes the short circuit from about relay 1205, which operates in series with magnet 1203. Magnet 1203 cannot hold in series with relay 1205, and therefore retracts its armature, advancing the brushes of the first row one step. When magnet 1203 releases, it closes its back contact, and con-

ductor 1204 is now extended to conductor 1206, whereupon magnet 1207 operates and this cycle continues until magnet 1208 operates and releases. When relay 1209 operates on the operation of magnet 1208 and magnet 1208 releases, grounded wire 1247 is extended to conductor 1248 and thence to conductor 1340 to short circuit relay 1304. Relay 1304 thereupon releases, starting a new cycle of operations, this cycle continuing as long as start relay 1301 is operated. The ringing current is interrupted by the brush 1201 in order to avoid continuous ringing of the subscriber's bell. For simplicity of illustration the ringing conductors 1235 and 1236 are shown as terminating in a circle marked A. A similar circle marked A in Fig. 7 indicates these ringing conductors in Fig. 7. They are shown connected to the left armatures of relay 706. The path for ringing current may be traced as follows: (Fig. 7) 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 743. The current in the primary winding 748, 750, of the transformer 789 induces alternating current in the secondary winding 756 and 757 to operate the bell at the called substation 31 (Fig. 1). This circuit is as follows: ground at the right armature of relay 714ª, 771, 756, upper talking conductor shown in heavy lines (Figs. 7, 6, 3, 2, 1) through the bell at substation 31, (Fig. 1) returning over the lower talking conductor (Figs. 1, 2, 3, 6, 7) 769, 757, 758, 759, 760, 792, 761, 762, to battery. A portion of this ringing current flows from the lower talking conductor 769, through condenser 724, conductor 723ª, 720ª, winding 721ª of transformer 716, conductor 722ª, 710ᵇ, 786 to battery. Coil 716 transmits this ringing tone by induction to the calling line over the normal contacts of relay 764. In response to the ringing of the bell, the subscriber at substation 31 removes his receiver, thereby operating the marginal ringing cut-off relay 763 through its right winding 761. Relay 763 in attracting its armature 766 cuts off the ringing current by releasing relay 739, and in attracting its inner left armature locks up to grounded conductor 711. In attracting its armature 766 relay 763 opens the circuits previously traced for relays 310 and 320 in the local connector control switch (Fig. 3). Relay 320 in retracting its armature 379 opens the circuit traced for start relay 1301 in the ringing circuit (Fig. 13) thus stopping the operation of these relays and the ringing control switch, (Fig. 13) to economize on current. In attracting its armature 766, relay 763 operates relay 764 as follows: battery, 764, 765, 766, 711, 712, 713 to ground. Relay 764 connects talking conductors 751 and 747 to 718 and 717, respectively and cuts off the impulse relay bridge. Relay 739 in releasing, connects relay 767 to the lower talking conductor 747 in circuit with the calling line and ground for this circuit is connected at armature 768 of relay 711ª to the upper talking conductor 751. The circuit for feeding talking current to the called line leads from battery at the front contact and armature 759 of relay 763 to the lower talking conductor 769, ground being supplied to the upper talking conductor 770 at armature 771 of relay 714ª. A substitute holding circuit for slow release control relay 700 is closed by relay 767 so as to hold relay 700 operated after relay 715 is cut off due to the operation of relay 764.

Upon the termination of the conversation, the replacement of the receiver by the calling party releases relay 767, which releases slow relay 700, which in turn releases relay 702, which releases relay 703. Relay 702, in releasing its armature 713 removes ground from the locking circuits of the energized circuit relays, whereupon they release, and relay 703 in retracting its armature 729 removes ground from the multi-contact relays 402, 408, and 307, 317, releasing them. Relay 703 releases after relay 702 so that no circuits will be broken by the wire contacts of the multi-contact relays when the latter release, thus preventing destruction due to sparking at the contacts of these relays.

Assuming now that the called line was busy, busy test relay 731 will operate over its right winding from ground, on the sleeve of the called line. This circuit is as follows: battery, 731, 732, front contact and armature 772 of slow to release relay 707, 734, 612, 367, 327, 366 to ground on sleeve wire 324 applied by the armature 713 of relay 703 if the line is busy as a called line, or through a relay such as 401 if the line is busy as a calling line. Relay 731 locks to ground at 713 over its left winding and armature 738 and connects busy tone to the calling line through the medium of the tone transformer shown in Fig. 13. Relay 731 in operating operates 1317 as follows: ground, 1317, 1316, 1210, 616, 773, 774, 775, 720ª, 721ª, 722ª, 710ᵇ, 786 to battery. Relay 1317 operates start relay 1318. The operation of relay 1318 causes a self interrupter relay 1320 to operate, and energizes relays 1302 and 1303 to operate and 1304 to function as described. The operation of relay 1304 operates relay 1319 and causes relays 1302 and 1303 to release one at a time as described. Relay 1319 connects tone from relay 1320 to the busy tone lead 1341. When relay 1303 closes its back contact relay 1304 is short circuited and released, removing the short circuit from the left-hand winding of relay 1321. Relay 1319 holds in series with the left winding of 1321 which operates removing the short circuit from its right

winding. The release of relay 1304 also causes relays 1302, 1303 and 1304 to go through a second cycle of operations. The second operation of relay 1304 short circuits and releases relay 1319 cutting tone off the busy tone lead and when relay 1304 is short circuited and released by the release of relay 1303, relay 1321 is released. This sequence of operations will then be repeated as long as start relay 1318 is operated, causing an interrupted tone to be connected to the busy lead 1341. This tone conductor is connected through tone transformer 716 to battery at 786, and gives a busy tone to the calling line. The calling subscriber will thereupon replace his receiver, releasing relay 715 which by releasing slow relay 700 brings about the releases of the connection as described in the case of a successful call.

Party lines.

If the called number represents a station of a party line, the calling party will dial the tens and units digits of such line, and in addition a third or party line digit, L, M, R or W, which represent digits 6, 7, 8 and 9 respectively. (Fig. 14.) Referring to Figs. 3 and 8, counting relay terminals 6 to 9 inclusive are used in connection with party line signaling. If a station of a party line is called, a ground will be connected to one of the counting relay terminals 6 to 9 due to the transmission of the third digit, which in the present embodiment of the invention is always either 6, 7, 8 or 9 impulses, as stated. It will be remembered that relay 320 operated when the units relay 317 operated in the connection traced. The party line being shown as No. 32, the operating circuit for relay 320 instead of being closed by units relay 317 is closed by units relay 382 since the units digit is 2 instead of 1 as just described in the case of the call to line 31. The circuit for relay 320 is as follows: battery, 320, 321, 609, 1000, 610, 322, 383, 323, 313, 608, 764[a], 766, 711, 712, 713 to ground. Relay 320, at its armature 368, transfers conductor 306 leading from the counting relay circuit, to relay 328. Relay 328 operates upon the termination of the third or party line set of impulses when slow relay 803 releases as described in connection with relays 305 and 316. Its circuit is as follows: battery, 328, 368, 384, 306, 694, 725, 816, 824, 815, 805, 709, 710, 766, 711, 712, 713 to ground. The called number is 32—R, and since R is selected by the transmission of eight impulses, (Fig. 14) party line ringing control relay 618 will be operated over the following circuit due to the operation of relay 328: battery, 631[a], 618, 619, 331, 332, 381, 819, (Fig. 8) to ground on conductor 805, through the operated counting relay contacts as described. Relay 618, in operating, locks over the following circuit: battery, 631[a], 618, 646, 633[a], resistance 655[a], 624, 776, 797, 777, 779, 729 to ground. Relay 618, in operating, operates relay 620 as follows: battery, 620, 621, 333, 385, 334, 622, 623, 641[a], 624, 776, 777, 779, 729, to ground. Relay 620 at its contact 634[a] locks to holding conductor 633[a] through resistance 655[a].

Relays 618 and 620 cooperate to prepare the link circuit for applying the proper character of ringing current to signal the party line station 32—R, and relays 733 and 739 operate in the manner hereinbefore described. When connection is established with the party line, relay 710[a] operates from ground on the test conductor 556 (Fig. 5) of the line through resistance 555, each party line having a similar resistance included in its test conductor. The test conductors of the individual lines are open, as for example conductor 557. Relay 710[a] operates as follows: battery, 710[a], 714[a] (which is marginal and does not operate in series with said resistance), 726[a], relay 706[a] being operated 745[a], 727[a], 611, 391, 392, 393, 394, 435, 556, 555 to ground. Relay 710[a] closes the following circuit for holding slow relay 706 operated to prevent the application of individual line ringing current to the selected party line: grounded conductor 711, 766, 710, 756[a], 706 to battery. Relay 620 in operating as described operated relay 329 as follows: battery 329, 350, 670, 640[a], 624, 776, 777, 779, 729 to ground. Relay 329 locks over the following circuit: battery, 329, 613[a], 709, 710, 766, 711, 712, 713 to ground. Relay 329 closes the following circuit for ringing start relay 1301: battery, 1301, 1300, 1200, 630, 380, to ground at the armature 395 of relay 329. Relay 1301 starts the ringing circuit of Fig. 13 as described in the case of an individual line. When brush 1211 reaches the eleventh contact 1212, pull-up relay 780 will operate. The circuit is as follows: ground, 1211, 1212, 1237, 636[a], 625, 626, 627, 628, 679, 629, 680, 781, 782, 783, 780, to battery. Relay 780 locks up over the following circuit: battery, 780, 787, 788, 710, 766, to ground on conductor 711. Relay 780 prepares the ringing circuit. When brush 1213 reaches the eleventh contact 1214, relay 784 operates over the following circuit: ground, 1213, 1214, 1238, 637[a], 630[a], 631, 632, 633, 785, 784, 786, to battery. When brush 1215 reaches the twelfth contact 1216, alternating current is applied over the following circuit to the primary of the transformer 789: lower end of the secondary of the transformer 1308, 1202, 1215, 1216, 1232, 638[a], 634, 635, 636, 637, 699, 638, 790, 742[a], 754, 753, 752, 751, 750, 749, 748, 747, 746, 745, 743[a], 791, 639, 640, 641, 642, 643, 644, 645, 1217, to the other side of the secondary of the transformer 1308. This flow of alternating current

through the primary of the transformer 789 induces alternating current in the secondary winding, which flows out over the called line. Relay 784 at its armature 792 connects positive current from source 744ª through the right winding 761 of the ringing cut-off relay 763 to the lower side 769 of the link circuit and armature 771 of relay 714ª connects ground to the upper side 770 of the link. Thus superimposed positive current is impressed upon the called party line to operate the ringer 102 at station 32—R. The alternating current relays at all the stations operate and relay 101 connects bell 102, adapted to respond to positive current only, to the lower side of the line at station R. Relay 784 applies this positive current over the following path: positive pole of the battery 744ª, 792, 761, 762, 760, 759, 758, 757, to the lower side 769 of the link, and to ground through the bell 102. Upon the response of the called party, the marginal cut-off relay 763 operates, opening the ringing circuit by releasing relay 739 as described. In attracting its armature 766 relay 763 opens the locking circuit traced for relay 329 which in retracting its armature 395 opens the circuit traced for start relay 1301 in the ringing circuit to stop the operation of the relays of this circuit and also the operation of the switch of Fig. 13, to economize on current as described. The pull-up relay 780 also releases when relay 763 operates. At armature 786 of relay 763, the circuit of relay 784 is permanently opened. From this point on the operations are exactly the same as described in the case of an ordinary line.

If the station W had been called, nine impulses would have been transmitted, and party line ringing control relay 672 would have operated over conductor 673, 397, 398, 352 to ground, instead of the relay 618 and this would have resulted in the operation of relay 707ª in addition to relay 784 which causes the application of positive current to the upper side of the line since the relay 707ª reverses the tip and ring conductors. The circuit for relay 707ª is as follows: ground, 1218, 1219, 1220, 657, 658, 639ª, 696, of relay 672, 697, 661, 725ª, 707ª, 709, 710ᵇ, 786, to battery.

If station M had been called, only relay 707ª would have been operated, which would result in negative current being applied to the upper conductor.

If station L had been called, the inert condition of both relays 784 and 707ª would have caused the application of negative current to the lower conductor. These circuits are not shown in full for the sake of simplicity. It will be understood that two more party line ringing control relays such as 618, 672 must be provided to operate when L and M are dialed. These relays would be connected to conductors 601ª and 602ª respectively. It is thought that this is sufficiently apparent without further description.

Reverting party line calls.

If the call is for a station on the same line it is known as a "reverting call". In a call of this character the calling party will, in addition to dialing the listed number, also dial the letter suffix of his own station and then hang up his receiver. The bell of his own as well as that of the called station will ring alternately until the called party answers, when the ringing will cease, whereupon the calling party will again remove his receiver from the hook and conversation may proceed. The calling party can readily identify a reverting call by the fact that the desired or called number is the same as his own, the suffix only being different. The operations involved in making a reverting call are the same as those described in the case of making a party line call except that another digit is dialed, which is the suffix of the number of the calling line, as stated. Assuming that station 32—R calls station 32—W, party line ringing control relay 672 is operated due to the transmission of the third set of impulses instead of relay 618 as in the case where party R was called.

Relay 672 in operating operates relay 620 which closes the circuit traced for relay 329 to transfer conductor 306 from relay 328 to relay 330. The fourth set of impulses corresponding to the calling suffix R is now transmitted. At the termination of this set of impulses when slow relay 803 releases as described, relay 330 is operated as follows: battery, 330, through the alternate contacts of relays 329, 320, and 310, conductor 306, to ground over the path previously traced on conductor 805 in the counting relay circuit (Fig. 8). Relay 330 operates one of the four reverting relays, in the present case 647, it being assumed station 32—R is calling. This circuit is as follows: battery, 647, 648, 649, 650, 335, 336, 381, 819, (Fig. 8) contacts of the operated counting relays to ground on conductor 805. Relay 647 at contact 651 locks up to grounded conductor 624. The combination of operated relays 672, 620 and 647 prepares the proper ringing circuits.

Corresponding group relay contacts and corresponding units relay contacts in the line finder (Fig. 3) and connector (Fig. 4) are connected directly to each other. In the case of a reverting call the following circuit is closed for a reverting busy test relay 793: battery, 793, 794, 795, 716ª, 652, 337, 419, 420, 421, 338, 339, 340, 341, 342, 343, 344, 422, 423, 424, 345, 653, 633ª to

grounded conductor 624. This circuit was closed as soon as units relay 382 operated due to the transmission of the second digit. Upon operating relay 793 locks to grounded conductor 728 at its inner left armature. Relay 793, in attracting its armature 774, opens the busy tone lead so that busy tone will not be connected to the calling line when the busy test relay 731 operates. A second reverting busy test relay 795, operates and locks up upon the termination of the set of impulses corresponding to the calling station suffix, that is, on the operation of relay 330. This circuit is as follows: battery, 795, 796, 654, 346, 347, 334, 622, 655, to grounded conductor 624. Relay 795 at its inner right armature locks over 797, 777, 779, 728, 729 to ground. The circuit will remain in this condition, and ringing will not start until the calling party hangs up his receiver which releases relay 715, which operates relay 798 as follows: battery, 798, 799, 700[a], 753[a], 701[a], 752, 722, 721, 720 to ground. Relay 798 locks to grounded conductor 728. Relay 798, in operating connects relay 715 in series with relay 733 causing both these relays to operate. This circuit is as follows: battery 715, 716, 717, 702[a], 733, 737[b], 613, 1001, 1006, 1002, 1003, 948, 900, 1004, 614, 703[a], 704[a], 705[a], to grounded conductor 712. Relay 715 is not released long enough to release the slow holding relay 700. Relay 733, in operating, operates relays 706[a] and 739. The circuit for relay 706[a] leads through its lower winding and the left contact of relay 733 to conductor 737[b] to ground over the circuit traced for relays 715 and 733. The circuit for relay 739 leads over 714, 740, 788, 710, to ground at conductor 711. The operation of relays 706[a] and 739 prepares a circuit for the pull-up relay 780 to prepare the ringing circuit. Assuming the pull-up brush 1211 is approaching contact 1241 when relays 706[a] and 739[a] operate, the circuit of the pull-up relay will be closed as follows when this contact is reached: battery, 780, 783, 782, 781, 680, 629, 628, 678, 677, 655[a], 656[a], 1240, 1241, 1211 to ground. The ringing circuit (Fig. 13) was started in operation when relay 329 operated due to the operation of relay 620 as already described. Relay 780 locks up over 787, 788, 766, to grounded conductor 711. The called station 32—W is signaled as follows. When the brush 1218 reaches the segment 1219, relay 707[a] operates over the following circuit: ground, 1218, 1219, 1220, 657, 658, 639[a], 696, 697, 661, 708[a], 707[a], 710[b], 786, to battery. Brush 1213, in reaching the corresponding contact 1221, operates relay 784 as follows: ground 1213, 1221, 1222, 662, 663[b], 664[a], 665', 633, 785, 784, 786, to battery. Relay 707[a] reverses the tip and ring of the link and relay 784 reverses the battery connections so that positive current flows over the upper talking conductor to operate the bell 106 connected to the upper side of the line 32 at station W. The function of relay 663 is to disconnect the link from the normal party ringing relay, in this case 672, corresponding to the party at the called station W, and connect it to the ringing circuit through the contacts of the reverting party relay 647, in this case the calling station R. This relay 663 is connected on the one hand to battery through armature 786, 710[b], 733[a], and on the other hand to contact 664, now connected to conductor 665[a], which is connected to contact 666, and thence by way of conductor 1223 to the contacts engaged by brush 1224, which is connected to ground. More in detail, the circuit for signaling the calling station R includes the following elements: 1202, 1215, 1216, 1232, 638[a], 634, 635, 698, 699, (relay 663 being operated at this time due to grounded brush 1223 passing over contacts which are connected to relay 663 through contacts 666 and 664 on relays 620 and 647 respectively) 638, 790, 742[a] from which point the circuit is the same as previously traced where 32—R was considered as the called party. The circuit for the calling station W includes the following elements 1202, 1215, 1233, 1234, 600[a], 682, 683, 637, 699, (transfer relay 663 being now inert due to brush 1224 passing over contacts which are not at this time connected to relay 663) 638, 790, 742[a] from which point the circuit is as previously traced in calling station 32—R. The bells of both stations are rung intermittently as described until the party at the called station 32—W answers, when the tripping relay 763 operates, releasing relay 739 to cut off the ringing current as described, and opening the circuit of the pull-up relay 780. Relay 761 also removes battery from relays 784, 707[a], and 663, and operates relay 764, the circuit being battery 764, 765, 766, to grounded conductor 711. Relay 764 causes the release of relays 715, 733, 739, 706[a], 798, 795, the multi-contact connector relays 307, 317, and the ringing control relays 672, 620 and 647 and also causes the operation of relay 767, through which transmitter current is furnished to the stations W and R on line 32, ground being supplied at armature 768 of relay 711[a]. Relay 767 provides a substitute holding circuit for slow relay 700 to hold relays 702 and 703 operated. Upon replacement of the receivers by the parties, relay 767 releases and causes the release of relays 700, 702, and 703, which brings about the release of the finder equipment, as hereinbefore described.

As in the case of the party line ringing control relays 618, 672, two of the revertive party line ringing control relays, corresponding to 647 and 605[a], for stations L

and M, are not shown. They would in practice be connected to conductors 603[a] and 604[a] respectively.

Rural lines.

If the called number represents a rural line, the calling party will dial the tens and units digits of the called line and in addition two more digits. The first of these additional digits must in the present embodiment of the invention be 1, 2, 3, 4, or 5, and the second 6, 7, 8 or 9. Station 21—18 (Fig. 1) indicates one of the rural line stations. There may be twenty stations per line, and the ringing arrangement referred to provides for twenty different code rings, due to dialing numbers having for their last two or code digits the following combinations, 16, 17, 18, 19, 26, 27, 28, 29, 36, 37, 38, 39, 46, 47, 48, 49, 56, 57, 58 and 59. Fig. 12 shows a code switch for ringing these stations according to a code. Due to the length of these lines and to their character the signaling circuits are simplexed; that is to say, the line relay 525 (Fig. 5) of rural line 21—18 is operated upon the initiation of the call over both sides of the line in parallel to ground at contact 104 (Fig. 1). When the line 21—18 is extended by the finder to the link circuit (Fig. 7) marginal relay 711[a] operates and simplexes the link. This circuit is as follows: battery, 711[a], 712[a], 713[a], 667, 348, 426, 427, 428, 434, 561, 526, to ground. Conductors corresponding to 561 of all rural lines are connected directly to ground to operate marginal relay 711[a]. In the case of party lines, resistance 555 prevents this relay from operating and in the case of individual lines lead 557 is open. The operations involved in transmitting the first two digits are similar to those already described, except that the dial 103 in restoring interrupts a circuit including both sides of the calling line and connected link in parallel and impulse relay 715. Due to transmitting the third digit, which as stated in the case of rural lines is always either 1, 2, 3, 4 or 5, ground will be connected to one of the counting relay terminals 1 to 5 (Figs. 3 and 8). Assuming the called number is 23—19, one of the code relays 607[a], 617 (of which there are five, three not being shown) will be operated over the following circuit when relay 328 operates at the termination of the third set of impulses: battery, 631[a], 617, 668, 349, 319, to ground counting relay conductor 820. Relay 617 locks to grounded conductor 624 at contact 669, and operates relay 329 from battery, 329, 350, 670, 671 to grounded conductor 624. Relay 329 transfers the conductor 306 leading from the counting relays to relay 330. Relay 330 operates upon the termination of the fourth digit as described and this digit being 9, relay 672 is operated as follows: battery, 672, 673, 674, 675, 350, 351, 352, 821, 822 to grounded conductor 820. The combination of operated relays 617 and 672, there being five of the former and four of the latter, effects the selection of one of twenty code brushes and associated arcs shown in Fig. 12, in the present instance No. 1. The other three code ringing control relays corresponding to 617 and 607[a] would be connected to contacts 370, 371, 372, of relay 328. Relay 672 in operating operates relay 620 as follows: battery, 620, 621, 333, 385, 334, 622, 655, 641[a] to grounded conductor 624. As described in connection with party line calls, relay 710[a], operates from ground on conductor of the called line corresponding to conductor 561 shown in Fig. 5, to close a circuit for relay 706 to prevent this relay from releasing and applying individual line ringing current from source A, and as described in connection with party line calls relay 620 operated relay 329, to operate ringing start relay 1301. Marginal relay 714[a] operates in series with relay 710[a] when the called line is selected and simplexes the link. The circuit for relay 710[a] and 714[a] is as follows: battery, 710[a], 714[a], 726[a], 745[a], 727[a], 611, through contacts of the operated connector tens and units relays to grounded conductor corresponding to 561. When brush 1226 of the code switch reaches terminal 1227 pull-up relay 780 operates to prepare the ringing circuit. The circuit for relay 780 is as follows: ground, 1226, 1227, 1228, 676, 677, 678, 679, 629, 680, 781, 782, 783, 780 to battery. Relay 780 locks as before described to prepare the ringing circuit, and when brush 1229 reaches segment 1230, the ringing circuit is closed as follows: lower terminal of the secondary of the transformer 1308, 1202, 1229, 1230, 1231, 681, 682, 683, 637, over the circuit previously traced including the front contact of relay 780 and the primary of transformer 789 returning over 639, 640, 684, 642, 685, 645, 1217, to the upper side of the secondary winding of transformer 1308. Relay 714[a] being operated, its armature 771 connects coils 756 and 757 in series in circuit with the called station bell. All the bells on the rural line No. 23—19, are now given three short rings, followed by a pause, then three more, followed by a pause, etc. Upon the removal of the receiver by the called party, the ringing cut-off relay 763 operates, cutting off the ringing current as described and stopping the operation of the ringing generator relays. Each of the rural stations is provided with a local talking battery 105. The connection is released by the calling party replacing his receiver which opens the circuit of relay 767, which causes the release of the holding relays 700, 702, and 703 which release the equipment as previously described.

Reverting calls on rural lines.

In making these calls the calling party will not have to dial his own suffix as in the case of reverting party line calls, but will dial the listed number only and then hang up his receiver. All the bells on the line will ring the code of the called station and will stop when the called party answers which will be the signal for the calling party to remove his receiver from the hook and conversation may proceed.

It is not thought necessary to describe in detail these operations since they are similar to the call just described, except that the revertive relays 793 and 795 operate as in the case of a revertive party line call. On a revertive rural line call, relay 711[a] being operated as described when the line is extended to the link, this relay short circuits a resistance 755[a] so that when the calling subscriber replaces his receiver to start the ringing operation, releasing relay 715 and operating relay 798 as described, relay 714[a] operates as follows: battery, 710[a], 714[a], 726[a], 745[a], 766[a], 712, 713, ground. Relay 714[a] simplexes the calling end of the link to adapt the link circuit for code ringing as described, and relay 710[a] operates to hold relay 706 operated. From this point on the operations are the same as those traced in connection with a reverting party line call, the connector multi-contact relays being released on the operation of relay 764 due to the ringing cut off relay 763 operating upon the response of the called party.

Outgoing trunk calls.

In case the zero digit, which is the trunk code, is dialed, relays 1005 and 706[a] operate. The circuit of relay 1005 is as follows: battery, 1005, 1008, 200, 353, 354, 823, 825, to ground on conductor 805. Relay 1005 locks up over the following circuit: battery, 1005, 1003, 900, 984, 1004, 614, 703[a], 738, 712, 713, to ground. The circuit for relay 706[a] is as follows: battery, 706[a], 686, 1007, 200 to ground over the circuit traced for energizing relay 1005. Relay 706[a] locks up over the following circuit: battery, 706[a], 686, 1007, 1008, 1003 to ground at 713. The operation of relay 1005 operates relay 310 over the following circuit: battery, 310, 355, 687, 1006, 1002 to ground over the path traced for locking relay 1005. If no other connections are being established at this time, ground from the back contact of relay 1009 will operate relay 1010, which will then hold in series with relay 1011. The circuit for relay 1010 is as follows: battery, 1010, 1012, 1013, 1034, to ground at the armature 1035 and back contact of relay 1009. Relay 1010 locks up over the following circuit in series with 1011: battery, right winding of relay 1010, 688, 356, 357, 689, 1015, 1011 to ground at the armature 1035 and normal contact of relay 1009. Relay 1011 energizes and opens the operating circuit for the relays corresponding to 1010 of other trunks. Conductor 1011[a] leads to these relays. The operation of relay 1010 connects the windings of relays 901 and 902 associated with link No. 1 in all the trunk groups to the contacts of relay 316. Upon the termination of the second series of impulses relay 316 operates as previously described, and ground from the counting relay circuit operates relay 901 in the selected group, assuming the second digit is 1. The circuit for relay 901 is as follows: grounded conductor 805 of the counting relay circuit, 820, 319, 318, 360, 690, 1016, 1017, 903, 901, to battery. Relay 901 locks up to ground at the armature 713 of holding relay 702 as follows: battery, 901, 950, 951, 952, 953, 954, 955, 900, 1004, 614, 703[a], 738, 712, 713, to ground. Relay 901 connects the starter wire ground to the allotter relay 904 of the first idle trunk in the selected group. The circuit of relay 904 is as follows: battery, 904, 905, 906, 907, 908, 1018, normal contact of relay 1019, alternate contact of armature 1034 to ground at the armature 1035 and normal contact of 1009. A multiple of the group and units multi-contact relays identifying conductors from the line finder to the connector is extended to the trunk connector group and units relays by the operation of the relays 901 and 904. The group and units relays in the trunk corresponding to the group and units relays of the calling line in the line finder will now be operated. Assuming relays 402 and 408 in the finder are operated, that is, that line 22 is calling, the corresponding relays 201 and 202 will operate in the trunk connector. The circuit for relay 201 is as follows: battery, 201, 203, 1020, 909, 910, 911, 912, 913, 1021, 204, 361, 429, 430, 424, 345, 653, 624, 776, 797, 777, 779, 729, to ground. The circuit for relay 202 is as follows: battery, 202, 205, 1022, 915, 916, 917, 918, 1023, 206, 362, 338, 421, 420, 419, 337, 652, 716[a], 795, armature 794 and its front contact 717[a], 797, 777, 779, 729 to ground.

Upon the operation of relays 901 and 904, trunk holding relays 1100 and 1101 operate. The circuit for relay 1100 is as follows: battery, 1100, 1102, 1024, 919, 943, 920, 921, 922, 923, 924, 1025, 691, 718[a] to ground. The circuit for relay 1101 is as follows: battery, 1101, 1103, 1026, 925, 944, 923, to ground over the path traced for relay 1100. Relay 1101 locks to holding conductor 1104. Relay 1100 at its left hand armature connects ground to the holding lead 1104 to operate relay 926 which at its left hand armature connects ground to the holding lead 941, 1036, 217, to maintain the trunk connector multiple contact relays 201 and 202 operated,

these relays locking to this grounded lead at contacts 224 and 267 respectively. Relay 926 also advances the trunk starter wire 906 to the next idle trunk by attracting its right hand armature. The allotter relay 956 of this trunk corresponds to allotter relay 904. Relay 926 in attracting its right hand armature removes a short circuit from about relay 1019 so that this relay now operates in series with the allotter relay 904 as follows: ground, 1035, 1034, 1019, 960, 958, 959, 961, 904 to battery. This relay in opening its back contact prevents the starting ground from the back contact of relay 1035 from being extended to the next trunk to which relay 926 advances the start wire 906. This circuit is very similar to that already described in connection with the link circuit. When the relays 201, 202, 901, and 904 operated, the following circuit was closed to operate relay 798 to release the link circuit: battery, 798, 799, 692, 1039, 927, 945, 928, 929, 1027, 207, 208, 209, 210, 211, 233, 1028, 1050. 1105, 1106, 1104 to ground at the left hand armature and front contact of holding relay 1100. Relay 798 in operating operates relay 1009 over the following circuit: ground, lowermost armature of relay 798, 718[a], 693, 1029, 930, 946, 931, 932, 1030, 1009 to battery. Relay 1009 locks over the following path: battery, 1009, 957, 954, 955, 900, 1004, 614, 703[a], 738, 712, 713 to ground. In attracting its armature 1035, relay 1009 releases relays 1011, 1019 and 904. The operation of relay 798 also releases relay 715 which in turn releases slow relay 700. This relay in releasing relays 702 and 703 causes the release of the link circuit so that it may be available for other connections. The release of armature 713 of relay 702 opens the locking circuit of relay 1009 in the start circuit (Fig. 10) to restore the start circuit to the control of the other lines.

Referring now to the trunk circuit Fig. 11, sleeve relay 1107 now operates in series with the cut-off relay 522 of the calling line. This circuit is as follows: grounded holding conductor 1104, 1107, 1108, 1154, 1109, 1031, 212, 213, 214, 215, 216, 363, 417, 522 to battery. Relay 1107 in operating energizes relay 1110 which connects the trunk to the calling line. Relay 1120 only operates, if the calling line is a rural line, from ground on the fourth conductor as described. The ringing trip relay 1112 now operates through the telephone set at the calling station as follows: battery, 1113, 1112, 1114, 1115, 1116, over the lower talking conductor returning over the upper talking conductor to ground at the normal contact of relay 1120. Relay 1112 in attracting its armature 1115 operates relay 1117 over the substation loop. Relay 1117 in turn operates relay 1118 which locks to ground on the holding conductor 1104. The attraction of the outer left armature of relay 1118 keeps the holding relay 1100 operated. The attraction of the inner left armature of relay 1118 operates relay 1119 through the alternate contact of relay 1101, and a normal contact of relay 1181. Relay 1119 operates relays 1121 and 1181, from ground on the holding conductor 1104. Relay 1118 does not release at this time because it is held up by relay 1117 in the calling line circuit. Relay 1181 locks to holding conductor 1104 and opens the circuit of relay 1119 which will release slowly. At its armature 1183 relay 1121 closes the following circuit to start the ringing current generator relays working: ground, 1183, 1180, 1010[a], 1200 (Fig. 12) 1300, 1301 to battery. The operation of relay 1121 connects this ringing current from the source 1122 (B) Figs. 12 and 11, to the outgoing end of the trunk to cause the line lamp 1126 to light at the central office. Relay 1121 releases when slow relay 1119 releases to disconnect the ringing current from the trunk. The momentary connection of the ringing current to the trunk causes relay 1123 at the main office to operate, in turn operating relay 1124 which locks to ground at the normal contact of relay 1125 and extends this ground to the calling lamp 1126 to light the same. The insertion of the plug 1184 by the operator into jack 1129 operates relay 1128 from battery in the cord circuit. Relay 1128 applies ground to both sides of the trunk in parallel to operate relay 1127. This circuit leads to relay 1127 from the middle point of the right hand winding of coil 1153. Battery on the sleeve of the plug operates relay 1125 which at its right armature opens the locking circuit of relay 1124 which opens the circuit of the lamp 1126 to extinguish the same and causes the supervisory lamp to be extinguished. The connection is held up under the control of relays 1127 and 1117, the former being controlled by the operator and the latter by the calling subscriber.

When the calling party restores his receiver, relay 1117 releases operating relay 1119, which releases 1118. This causes the operation of relay 1121 to momentarily apply ringing current to the trunk to operate relay 1123 as described. Relay 1123 in this instance by operating relay 1137 short circuits the left high resistance winding of relay 1125, which causes the answering supervisory lamp 1135 in the cord circuit to light as a disconnect signal. Relay 1186 is marginal and does not operate in circuit with relay 1128. Relay 1119 released when its operating circuit was opened by the release of relay 1118. When the central office operator disconnects, relay 1127 releases, releasing the holding relay 1100 which releases the trunk circuit relays and releases relay 926 which causes the release of the tens and units relays 201 and 202.

In case all the trunks in the selected group are busy the following circuit is closed for busy tone relay 731, Fig. 7: battery, left winding of relay 731, 730ᵃ, 611ᵃ, 1032, 933, 934, 935, 936, alternate contact and armature 937 of the relay 938 of the last trunk, 939, 906, 907, 908, 1018, 1033, 1034, 1035, to ground. Busy tone relay 731 operates as described in the case of a busy ordinary line and applies a tone to the calling line to inform the subscriber that all the trunks are busy.

Outgoing trunk calls from rural lines.

In this class of calls the marginal relay 1120 operates when relay 1110 operates due to ground being present on conductor 526 of the calling rural line. Relay 1120 removes ground from the upper talking conductor and extends the lower talking conductor to the upper talking conductor so that upon the extension of the calling line to the trunk ringing trip relay 1112, this relay operates over both talking conductors in parallel to ground at contact 104 of the substation sender. Relay 1117 is also operated over this simplex circuit due to the operation of the ringing cut-off relay 1112. The remaining operations are the same as in the case of the outgoing trunk call just described.

Incoming trunk calls.

When the central office operator inserts plug 1184 into jack 1129, relay 1128 operates relay 1127 as described in the case of an outgoing call. Relay 1127 operates the holding relay 1100 which in turn operates relay 926. Relay 926 advances the starter wire to the next trunk as described. Relay 1100 operates relay 1136 as follows: battery, 1136, 1143, 1144, 1145, 1146, 1147, 1106, 1148, to grounded conductor 1104. The operator now dials the number of the wanted line by means of her calling dial 1187 in the cord circuit, the impulses being received by relay 1127 over the trunk conductors in parallel. Each trunk circuit, like each link circuit, has individual thereto, counting relay equipment such as shown in Fig. 8. The impulses pass from ground at the back contact of the armature 1150 of relay 1118, armature 1151 of the impulse relay 1127, 1152, 1153, 1132, to a conductor corresponding to 801 and thence to the counting relays. Conductor 1133 connects with a conductor corresponding to 805. Conductor 1133 is connected to grounded conductor 1104 over 1106 and 1148. Conductors 1134, 1135 connect with conductors corresponding to 818, 816 respectively. In short, the circuits used on an incoming trunk call would be as follows: Fig. 11 above Fig. 8, Fig. 9 above Fig. 10, Fig. 10 above Fig. 12, Fig. 12 above Fig. 13, and Fig. 1 above Fig. 2. It is not thought necessary to duplicate the showing of this equipment.

Upon the termination of the first series of impulses slow relay 803 releases as described, closing the following circuit for the tens relay 220 of the trunk connector control switch TCCS (Fig. 2). Grounded conductor 1104 (Fig. 11) 1148, 1106, 1147, 1133, 805, (Fig. 8) 815, 824, 816, 1135, 1040, 221, 245, 220 to battery. Relay 220 operates closing the following circuit for the trunk connector group relay 201, assuming two impulses were transmitted by the operator: battery, 201, 203, 222, 223, 825, 826, 827, to grounded conductor 805. Relay 201 in closing its contact 224 locks itself up over the following circuit: battery 201, 224, 217, 1036, 941, 947, to ground. Relay 201 in closing contact 270 operates relay 225 to transfer the lead 221 from the counting relay circuit to units relay 226. The circuit for relay 225 leads from contact 270, 211, 1007ᵃ, 1059, 1050, 1105, 1106, 1148, 1104 to ground. Relay 225 in operating removes a short circuit from about relay 817 as described in the case of a local call and relay 817 now operates in series with relay 220 this circuit including the following elements: battery, 220, 227, 228, 1041, 1134, 818, 824, 815 to grounded conductor 805. Relay 817 in operating releases the counting relays and also releases relay 804 which releases relays 817 and 220. Conductor 221 over which the tens relay 220 was operated is now extended to units relay 226 so that when relay 803 releases at the end of the units series of impulses as described relay 226 operates, connecting the counting relay terminals to the units relays in the trunk connector, and assuming line 22 is called, relay 202 operates over the following circuit: battery, 202, 229, 223, 825, 826, 827 to grounded conductor 805. Relay 202 at its contact 267 locks to grounded conductor 217. Relay 202 closes the following circuit for relay 230: battery, 230, 231, 232, 233, 1028, 1050, 1105, 1106, 1148, to grounded conductor 1104. Relay 230 at its right armature removes a short circuit from about relay 817 as described so that relays 226 and 817 operate over the following circuit: battery, 226, 234, 228 through the right winding of relay 817 over the circuit previously traced. Relay 817 operates and releasing the counting relays and also releases relays 817 and 226. The trunk is now connected to the called line 22 through the operated group and units relays 201, 202, of the trunk connector, whereupon sleeve relay 1107 operates in series with the cut-off relay 522 of the called line, assuming the line to be idle as follows: grounded conductor 1104, 1107, 1108, 1109, 1031, 212, 213, 214, 215, 216, 363, 417, 522 to battery. Relay 1107 extends the grounded conductor 1104 to relay 1110 which operates. At its armature

1143 it releases relay 1136, which prepares the ringing circuit. The attraction of this armature operates relay 1138. Relay 1138 operates relay 1140 from ground on conductor 1104. Relay 1140 at its armature 1178 connects ground to conductor 1179 to operate the start relay 1301 in the ringing circuit (Fig. 13). This circuit is as follows: ground, 1178, 1179, 1180, 1010[a], 1200 (Fig. 12) 1300, 1301 to battery. Relay 1140 at its upper armatures applies ringing current to the selected line through the windings of induction coil 1153 from A through armatures 1171, 1166 as described. When the called party answers relay 1112 operates by its right winding and locks over its left winding to grounded conductor 1148. Relay 1117 now operates over the called line circuit, its circuit being closed at armature 1115 of relay 1112, ground being supplied at a normal contact of relay 1120 which only operates when the called line is a rural line. Relay 1117, operates relay 1118 which locks to holding conductor 1104. Relay 1118 operates relay 1181. When the called party hangs up his receiver, relay 1117 releases operating relays 1119 and 1121 which gives the disconnect signal to the central office operator as described in the case of an outgoing trunk call.

If the desired line is busy relay 1142 operates over the following circuit: battery, 1142, 1154, 1109 to the grounded sleeve wire of the selected line. Relay 1130 started to release when relay 230 operated at the end of units selection. Relay 1130 was operated when the trunk was taken for use, the circuit being as follows: battery, 1130, 1155, 1042, 235, 236, 1043, 1145, 1146, 1147, 1106, 1148, 1104, to ground at the left armature of relay 1100. Relay 1130 being of the slow release type relay 1142 operates in the circuit traced to ground on the sleeve wire of the busy line before armature 1154 releases. In attracting its outer left armature relay 1142 closes the following circuit to give a busy signal to the operator: battery, primary winding of transformer 1156, 1157, 1158, 1044, 1210, 1316, 1317 to ground. This is transmitted by induction coil 1139 to the trunk and thence to the cord and operator's head set. The circuit includes relay 1127, the secondary windings of coil 1153, the trunk conductors in parallel to ground at the front contact of relay 1128. The repeating coil 1141 transfers this tone to the cord circuit and thence to the head set. Upon hearing this tone the operator withdraws the plug releasing the equipment as already described.

Incoming trunk calls to party lines.

In calls of this character the operations are the same as those just traced up to the point where the tens relay 220 operates. The party line shown in Fig. 1 being No. 32, the tens relay in operating, connects ground from the counting relay circuit as described to relay 236 instead of 224 as follows: battery, 236, 237, 238, 239, 240, 828, to ground on conductor 805 as described. Relay 236 at its contact 241 locks to grounded holding conductor 217. The units relay 202 is now operated as described, connecting the trunk to the party line 32. Assume now that the desired party line station is station R. This station, it will be remembered, is selected by the transmission of eight impulses. Upon the termination of these impulses, which are transmitted by the impulse relay 715 to the counting relays as described for the first two digits of the number, slow relay 803 releases, operating relay 242 as follows: battery, 242, 243, 244, 245, 221, 1040, 1135, 816, 824, 815, 805, to ground. Relay 242 in operating operates relay 1045 as follows: battery, 1045, 1095, 247, 248, 249, 819 to grounded conductor 805. Relay 1045 locks at contact 1051 to ground over 1052, 1050, 1105, 1106, 1148, 1104, and operates relay 1053 as follows: battery, 1053, 1054, 250, 251, 252, 1055, 1096, 1097, 1050, to ground. Relay 1053 at contact 1056 locks to conductor 1050. Relay 1053 operates relay 253 as follows: battery, 253, 254, 1057, 1058, 1050 to ground. Relay 253 at 243 removes the short circuit from about relay 817, whereupon this relay operates in series with relay 242 as follows: battery, 242, 255, 228, 1041, 1134, 818, 824, 815 to grounded conductor 805. Relay 817 in operating releases the counting relays and also releases relay 804 which releases relays 817 and 242. The operation of relays 1045 and 1053, which correspond to relays 618 and 620 in the link ringing control circuit (Fig. 6) causes the application of positive current to the lower side of the trunk to operate bell 102 at station R. Relay 1176 is similar to relay 710[a] in the link and operates when connection is made to the called line to provide a holding circuit to prevent relay 1136 from releasing and applying individual line ringing current to the line. Relay 1140 at its armature 1178 starts the ringing circuit relays in operation as described, and when brush 1121 reaches segment 1212, pull up relay 1159 operates as follows: ground, 1211, 1212, 1237, 1060, 1061, 1062, 1063, 1064, 1160, 1159, 1161, battery. Relay 1159 locks to grounded conductor 1105 and prepares the ringing circuit. When brush 1213 reaches the eleventh contact 1214 relay 1162 operates as follows: ground, 1213, 1214, 1238, 1065, 1066, 1067, 1068, 1069, 1163, 1162, 1161, battery. When brush 1215 reaches the contact 1216 alternating current is applied over the following circuit to the primary of the transformer 1153: lower end of the secondary of transformer 1308, 1202, 1215, 1216, 1232, 1070, 1071, 1072, 1073, 1074, 1164, 1165, 1166, 1167, 1168, 1169, 1170, 1171, 1172, 1173,

1075, 1076, 1077, 1079, 1080, 1217, to the upper end of the secondary of the transformer 1308. This flow of current through the primary of the transformer 1153 induces current in the secondary winding, as described in the case of a local call, which current flows out over the called line. Relay 1162 at its armatures connects positive current from source 1174 through the right winding of relay 1112 to the lower side of the trunk, and the armature of relay 1120 connects ground to the upper side of the trunk. This superimposed positive current is impressed upon the called party line to operate the ringer 102 at substation 32—R as described in the case of a local call. Upon the response of the called party marginal ringing cutoff relay 1112 operates, opening the ringing circuit by releasing relay 1138 as described in the case of an ordinary line. From this point on, the operation is the same as described in connecting to individual line 22.

Incoming trunk calls to station M, L and W it is thought need not be traced in detail it being sufficient to state that on calls to station W relay 1175 operates in addition to relay 1162 to apply positive current to the upper side of the trunk; that on calls to station M only relay 1175 operates to apply negative current to the upper side of the trunk, and that on calls to station L neither of these relays operate resulting in the application of negative current to the lower side of the trunk as described in the case of local calls to these stations.

Incoming trunk calls to rural lines.

In calls of this class, a relay, such as 1081, similar to 617 of Fig. 6, there being five of these relays, and a relay such as 1045, similar to 618 of Fig. 6, there being four of these relays, are operated under control of the operator to pick out the proper code ringing combination as described in the case of a local call.

Assuming station 21—18 is called, the operator dials the tens and units digits as described which causes tens and units relays 224 and 258 to extend the trunk to the rural line 21. Upon the termination of the third series of impulses, relay 242 operates as described to connect the counting relay ground to operate relay 1081, assuming the third digit is 1. This circuit is as follows: battery, 1081, 1082, 259, 260, 261, 820 to grounded conductor 805.

Relay 1081 at contact 1083 locks to grounded holding wire 1050. Relay 1081 at contact 1083 operates relay 253 whereupon relay 817 operates in series with 242, the former releasing the counting relay circuit as described. Relay 253 at its armature 243 advances the conductor 221 to relay 266 which operates upon the termination of the fourth series of impulses, in the present case, 8. Relay 266 closes the following circuit to operate relay 1045: battery, 1045, 1095, 247, 248, 249, 822 to grounded conductor 805. Relay 1045 locks to grounded holding conductor 1050 at contact 1051. The combination of operated relays 1081 and 1045 effects the selection of one of twenty code brushes and associated arcs shown in Fig. 12, in the present instance No. 2.

When the line was connected to, relay 1120, similar to relay 714[a] (Fig. 7), operates as follows: battery, 1176, 1120, 1177, 1086, 262, 263, 264, 265, 390, 434, 526 to ground. Relay 1176 operates to prevent relay 1136 from releasing as described. Relay 1120 connects the left hand coils of induction coil 1153 in series with the called line bell 108. When brush 1226 reaches terminal 1242 pull up relay 1159 operates as follows: ground, 1226, 1242, 1243, 1098, 1099, 1001[a], 1063, 1064, 1160, 1159, 1161, battery. Relay 1159 locks as before described and when brush 1244 reaches contact 1245 the ringing circuit is closed as follows: lower terminal of the secondary of transformer 1308, 1202, 1244, 1245, 1246, 1002[a], 1003[a], 1004[a], 1073, 1074, 1164, 1165, 1166, 1167, 1168, 1169, 1170, 1171, 1172, 1173, 1075, 1105[a], 1006[a], 1007[a], 1080, 1217, to the other terminal of the transformer.

All the bells in the line are now given one long ring and two short rings followed by a pause. Upon the removal of the receiver the ringing cut-off relay 1112 operates as described, releasing relays 1140, 1159, 1136, 1138, and 1140. Relay 1112 substitutes relay 1117 for itself in the line circuit. Relay 1117 now operates over the line circuit operating relay 1118 which in turn operates relay 1181. When the called party restores his receiver relay 1117 releases operating relay 1119 which causes the disconnect signal to be given to the central office operator as described.

Excess digits.

Provision is made for preventing a calling subscriber from dialing more digits than required. If the called line is busy, busy test relay 731 operates as described. In attracting its outer left armature it opens the impulse circuit and remains locked up as described until the receiver is replaced and the equipment is released.

If an individual line is called and found idle relay 706 releases as described when the line is selected and at its inner right armature closes the following circuit for relay 817: ground, armature 729 of relay 703, 728, said armature, 748[a], 612[a], inner left armature and front contact of the operated units relay 320, 644[a], 645[a], 750[a], 830, left winding of relay 817 to battery. Relay 817 operates and removes battery from the counting relays thus preventing their further operation.

If a party line is called, relay 620 operates as described due to the third digit being dialed and closes the following circuit for relay 817: battery, 817, 830, 750ᵃ, 645ᵃ, 646ᵃ, 647ᵃ, 751, 752ᵃ, 797, 779, 729, to ground.

If a rural line is called, the operation of a relay, such as 618 and a relay, such as 617, operates relay 817. This circuit is as follows: battery, 817, 830, 750ᵃ, 645ᵃ, 644ᵃ, lower armatures and front contacts of 617, and 618, 653, 728, 729, to ground.

On a reverting call, relay 793 operates when connection is made with the line and by attracting its armature 752ᵃ opens the circuit which would otherwise operate relay 817 at the end of the third digit, and by attracting its armature 752 permits two more digits to be dialed. At the end of the fourth digit, relay 795 operates as described and in attracting its armature 753ᵃ opens the impulse circuit, to prevent additional impulses from operating the counting relays.

Defective links.

In case for any reason the brush 508 of the allotter control switch should be resting on a defective link circuit the circuit arrangement is such that the allotter control switch AC (Fig. 5) will move the brush 508 and the remaining brushes one step on to the next link which it will test. If this link is defective or busy it will pass on and test the next link, etc., stopping only in case an idle link in operative condition is found. In case no such link is found an alarm will be given to notify the attendant of the trouble. The circuit is so arranged that in case the calling line is not connected to a link circuit by the line finder relays in Fig. 4 within a definite predetermined interval, the allotter control switch will advance as stated. More in detail when the group relay 502 operates upon the initiation of a call it closes the following circuit for slow-to-release timing relay 531: ground, 505, 506, 507, 532, 533, 534, 535, 531 to battery. Relay 531 extends the grounded conductor 533, to a second slow-to-release timing relay 536. This relay in turn connects grounded conductor 533 to relay 537. Relay 537 locks to grounded conductor 533 and opens the circuit of the first timing relay 531. Relay 531 after an interval releases, opening the circuit of the second slow-to-release timing relay 536. Relay 536 after an interval releases and closes a circuit to advance the allotter control switch AC one step. In the normal operation of the system the calling line is extended to the link circuit before the slow-to-release timing relays have time to go through their operations. In that event relay 504 operates as hereinbefore described disconnecting the grounded armature 505 from the conductors 507 and 533 before the relay 537 can close the circuit for the motor magnet 539. In case, however, this interval of time is exceeded, slow-to-release relay 536 in releasing closes the following circuit for relay 538 and the motor magnet 539 of the allotter control switch to advance the brushes of the allotter control switch on to the next link. This circuit is as follows: battery, 538, 540, 541, 542, 543 to grounded conductor 533. Relay 538 unlocks relay 537 and closes a locking circuit for itself including an armature and normal contact of the motor magnet 539, and also by attracting its lower armature closes an operative circuit for said magnet. When the magnet 539 completed its stroke it unlocks relay 538 which causes said magnet to release and on the back stroke of the armature the allotter control brushes are advanced one step. If this link is idle and operative, relay 401 operates as described, removing the short circuit from about the right winding of relay 504, which now operates in series with relay 400, over conductor 527, as described in detail, relay 504 in attracting its right armature removes ground from conductor 533 preventing any further operation of the timing relays. If the relay 401 does not operate within a predetermined interval after the brush 508 engages its associated link, ground remains on conductor 533 from the armature 505 of relay 502, causing these relays to go through another cycle of operations. These operations continue as long as busy or defective links are tested and when brush 544 reaches position 2, relay 545 operates as follows: battery, 545, 547, 548, 544, 507, 505 to ground. Relay 545 at its inner lower armature locks to grounded conductor 507 and in attracting its upper armature places the timing relays under control of the brush 549. The allotter switch AC will now continue to step under control of the time measure relays until position 1 is reached. The attraction of the lowermost armature of relay 545 closes one break in the alarm circuit so that when brush 550 closes the other break in position 1 of the switch the following circuit is closed for alarm relay 1324: ground, 1324, 551, 550, 553, 554, 1325, lamp 1326 to battery. Relay 1324 closes a circuit for bell 1334 which now rings to indicate to the attendant this condition of the circuit. The lamp 1326 serves as a visual signal for the same purpose.

Delay in dialing.

A signal is also provided to indicate when a subscriber removes his receiver, but does not operate his dial within the usual interval. It will be recalled that upon the extension of the calling line to an idle link circuit the relay 1322 operated. This relay at its outer left armature operates a relay 1327. Relay 1327 in attracting its

outer left armature opens the circuit of the holding coil 1332 of a timing device which may be in a form of a self-winding clock work mechanism which permits a plunger to fall under control of an escapement. In attracting its inner left armature, relay 1327 locks to conductor 1338 independently of contact 1339 by way of which it was operated and which opens as the plunger begins to fall. If relay 1327 remains operated long enough, say three or four minutes, the plunger of the timing device 1329 will reach the bottom of its travel, closing at contact 1335 the circuit of the lamp 1330 as follows: battery, right armature of relay 1327, contact 1335 of the timing device 1329, closed only at the end of the descent of the plunger, lamp 1330, relay 1324 to ground. Relay 1324 causes the bell 1334 to ring as in the case where the allotter control switch fails to find an operative idle link circuit. If relay 1327 on the other hand is released by the release of relay 1322 before the plunger has reached the bottom of its travel, a circuit is closed through the winding up coil 1329 of the timing device at the outer left armature of relay 1327 and contact 1336. When the plunger reaches the top of its travel this circuit is broken by the opening of contact 1336 and the plunger is held by the holding winding 1332.

Abandoned calls.

Provision is made to release the starting circuit (Fig. 5) if the call is abandoned before the link has been connected to the calling line. Upon the initiation of a call, relay 520 is operated by its right winding from ground at the front contact and armature 521 of relay 502, armature 519 and front contact of group relay 501, armature 518 and front contact of line relay 500 to battery, as described. If the calling party replaces his receiver before the link is connected to the calling line relay 520 is released due to the opening of its circuit at the armature of the line relay 500 and prepares a circuit for relay 504. In the meantime due to the attraction of the armature 505 of relay 502 the timing relays 531, 536 and 537 operate in succession as described. Relay 537 at its upper armature locks to grounded conductor 534 and opens the circuit of relay 531 which in turn opens the circuit of relay 536 as described. The retraction of the lower armature of relay 536 closes the following circuit for relay 520: battery, left winding of relay 504, right armature of relay 520, lower armatures of relays 537 and 536, conductor 533, normal contact of relay 545, conductors 532, 516, 507, 506, 505 to ground. Relay 504 in attracting its left armature opens the locking circuit including relays 501 and 503, the latter relay releasing relay 502 which in retracting its armature 505 opens the starting circuit, which releases relay 504.

What is claimed is:

1. In a telephone system, telephone lines, automatic switching means including metallic members forming link circuits common to said lines and contacts adapted to be moved into engagement with said members, means for controlling said switching means to interconnect said lines by causing said contacts to engage said members, means for supplying current for talking purposes to said lines through said contacts and members, means for disengaging said contacts from said members, and means for disconnecting said current supply means from said members and contacts before they are disengaged.

2. In a telephone system, telephone lines, automatic switching means including wires of base metal forming link circuits common to said lines and contacts adapted to be moved into engagement with said wires, senders for controlling said switching means to interconnect said lines by causing said contacts to engage said wires, means for supplying current for talking purposes to said lines through said contacts and wires, means for disengaging said contacts from said wires upon the disestablishment of the connection, and means for removing current from said members and contacts before they are disengaged.

3. In a telephone system, telephone lines, link circuits common to said lines comprising a number of sets of parallel conducting members, multiple sets of contacts located in proximity to said members, automatic switching means including magnets for moving said sets of contacts into engagement with said members to establish talking circuits including said lines, a source of current for said circuits, means for causing said magnets to disengage said sets of contacts from said members, and means for removing current from said sets of contacts and members before they are disengaged.

4. In a telephone system, telephone lines, link circuits common to said lines comprising a number of sets of parallel conducting members, said lines having multiple sets of calling and called contacts located in proximity to said members, automatic switching means including magnets for moving the calling line contacts into engagement with an idle set of parallel members upon the initiation of a call, and including magnets adapted to be selectively operated to extend said members into engagement with multiple called contacts of lines, means for causing the operated magnets to disengage said sets of contacts from said members, and means for removing current from said sets of contacts and members before they are disengaged.

5. In a telephone system, telephone lines, link circuits common to said lines comprising multi-contact relays, senders for said lines for controlling said relays to establish telephonic circuits including said lines and contacts of said relays, means for supplying current for talking purposes to said lines through said contacts, means for disconnecting current from the contacts of said relays, and means for subsequently releasing said multi-contact relays.

6. In a telephone system, subscribers' lines, link circuits common to said lines comprising multi-contact relays for interconnecting said lines, means for energizing certain of said relays to establish telephonic circuits including said lines and contacts of said relays, means for opening said circuits, and means for subsequently releasing the operated multi-contact relays.

7. In a telephone system, subscribers' lines, link circuits comprising multi-contact relays for interconnecting said lines, means for energizing certain of said relays to extend a calling line to an idle link circuit, a source of talking current, a battery control relay associated with said link circuit and adapted to connect said battery in circuit with the calling line through contacts of said operated multi-contact relays, a holding relay, means for operating the same, a circuit for said battery control relay controlled thereby, a second holding relay operated upon the operation of said first holding relay, a circuit for supplying current to hold said multi-contact relays operated closed upon the operation of said second holding relay, and means actuated upon the breaking down of the connection for releasing said first holding relay to release said battery control relay and to release said second holding relay which in turn releases said multi-contact relays.

8. In a telephone system, subscribers' lines, link circuits comprising multi-contact relays for interconnecting the same, means for energizing certain of said relays to extend a calling line to an idle link circuit, a source of talking current, a battery control relay associated with said link circuit adapted to connect said battery in circuit with the calling line through contacts of said operated multi-contact relays, means for selectively operating certain of said multi-contact relays to extend the link to a called line, a second battery control relay for said link adapted to connect said battery in circuit with the called line through contacts of the operated multi-contact relays, a holding relay, means for operating the same, circuits for said battery control relay controlled by said holding relay, a second holding relay operated upon the operation of said first holding relay, circuits for holding said multi-contact relays operated closed upon the operation of said second holding relay, and means actuated upon the breaking down of the connection for releasing said first holding relay to release said battery control relays to disconnect said battery from the wire contacts of the multi-contact relays before the second holding relay releases said multi-contact relays.

9. The method of revertive calling in automatic telephone systems which consists in transmitting impulses characteristic of the designation of the wanted station and then transmitting impulses characteristic of the suffix of the calling station.

10. In an automatic telephone system, party lines, senders therefor, said party lines being designated by a plurality of numbers and a suffix, and means for building up a revertive call by transmitting impulses according to the number of the wanted station and then transmitting impulses characteristic of the suffix of the calling station.

11. In an automatic telephone system, party lines, automatic means adapted to interconnect said lines, said lines being designated by a number of figures and a letter suffix, and a sender for controlling said automatic means to build up a revertive call by transmitting impulses according to the number and suffix of the called station and then transmitting impulses characteristic of the suffix of the calling station.

12. In a telephone system, a calling line, called lines of different classes, automatic switching means comprising multicontact relays for interconnecting said lines, register means for recording sets of impulses, means for completing connections from said calling line to called lines of different classes in accordance with the number of sets of impulses recorded, and means effective when the proper number of sets of impulses have been recorded for disconnecting said register means to render the same ineffective to record further sets of impulses.

13. In a telephone system, individual subscribers' lines, party lines, rural lines, dials therefor, automatic switching means for interconnecting said lines under control of said dials, said individual lines being selected by the transmission of two sets of impulses, said party lines by the transmission of three sets of impulses, said rural lines by the transmission of four sets of impulses, and means for removing the control of said automatic switching means from the calling party when the required number of sets of impulses have been transmitted to build up a given connection.

14. In a telephone system, individual subscribers' lines, party lines, rural lines, dials therefor, automatic switching means for interconnecting said lines under control of said dials, said individual lines being selected by the transmission of two sets of impulses,

party lines by the transmission of three sets of impulses, revertive party line connections by the transmission of four sets of impulses, and rural lines by the transmission of four sets of impulses, and means for removing the control of said automatic switching means from the calling party when the required number of sets of impulses have been transmitted to build up a given connection

15. In a telephone system, subscribers' lines, senders for said lines, link circuits comprising multi-contact relays for interconnecting the same, main offices, trunk circuits comprising multi-contact relays for extending calling lines to said main offices, said trunks being divided into groups each group bearing a different numerical designation, means for selecting a group of said trunk circuits under control of the calling line sender, means for automatically selecting an idle trunk in said group, and a signal associated with the said trunk at the main office operated upon the seizure thereof.

16. In a telephone system, party telephone lines, link circuits comprising multi-contact relays for interconnecting said lines, said relays being grouped as finder relays and connector relays, means for automatically operating certain of said finder relays upon the initiating of a call to extend the calling line to a link circuit, means for selectively operating certain of said connector relays to connect said link to the called line terminals, and means automatically operated in case the calling and called stations are on the same line for releasing the connector relays and for maintaining the finder relays operated.

17. In an automatic telephone system, subscribers' lines, link circuits for interconnecting the same, trunk lines, main offices wherein said lines terminate, senders associated with said subscribers' lines for controlling the interconnection of said lines by means of said links and for selecting one of said trunks, means automatically actuated upon the selection of the trunk for applying ringing current thereto for a definite interval, a relay at the main office responsive to said current, a signal operated thereby, and means for maintaining said signal operated independently of said relay, a second signal at the main office, means for again momentarily applying ringing current to the said trunk when the calling party replaces his receiver, said relay being again responsive to said current to operate said second signal, and means for maintaining said second signal operated independently of said relay.

18. In a telephone system subscribers' lines, link circuits comprising multi-contact relays for interconnecting said lines, means for automatically extending a calling line to an idle one of said link circuits, means automatically operated in case said line is not extended to an idle link circuit within a predetermined interval for substituting another link circuit, and a signal automatically operated in case all of said link circuits are busy.

19. In a telephone system, subscribers' lines, link circuits comprising multi-contact relays for interconnecting said lines, means automatically actuated upon the initiation of a call to select an idle link and to energize certain relays thereof to extend the calling line to said link, means automatically operated in case said relays do not properly operate in a predetermined interval for substituting another link and energizing the corresponding relays, and a signal automatically operated in case all of said links are either busy or defective.

20. In a telephone system, subscribers' lines, link circuits comprising multi-contact relays for interconnecting said lines, means actuated upon the initiation of a call to select an idle link circuit, means in said link circuit thereupon actuated to operate certain of said relays to connect the calling line to said link, a switch, and means actuated by a defective condition of the selected link to advance said switch over busy or defective links and stop the same on an idle operative link, and means thereupon actuated to operate certain of said relays to extend the calling line to the said idle link.

21. In a telephone system, subscribers' lines, link circuits comprising multi-contact finder and connector relays, said finder relays being actuated upon the initiation of calls to extend calling lines to said links, and means effective when two or more lines are calling simultaneously to extend said lines to said links in a predetermined order.

22. In a telephone system, telephone lines, a plurality of stations on each line, a link circuit, for interconnecting said lines, a multi-position ringing code switch, magnets for operating the same, a ringing current generator, connections between said generator, switch and link for applying current from said generator to said lines to signal the stations thereon, a battery and means for operating said switch magnets in sequence from said battery.

23. In a telephone system, telephone lines, a plurality of stations on each line, a link circuit for interconnecting said lines, a multi-position ringing code switch, magnets for operating the same, a battery, a ringing current generator consisting entirely of relays and operated from said battery, connections between said generator, switch and link for applying current from said generator to said lines to signal the stations thereon, and means for operating said switch magnets in sequence from said battery.

24. In a telephone system, telephone lines, a plurality of stations on each line, ringers brached off to ground at said stations, a pair of said ringers being connected to one side of the line and a pair to the other side of the line, one of the pair connected to one side being biased to respond to positive current and the other to negative current, a link circuit for interconnecting said lines, a ringing current generator consisting entirely of relays for generating alternating current, means for setting the same in operation when the link is taken for use, and means associated with said link and controlled by the calling subscriber for applying positive or negative current superimposed on said alternating current to selectively signal said stations.

25. In a telephone system, telephone lines, a plurality of stations on each line, ringers branched off to ground at said stations, a pair of said ringers being connected to one side of the line and a pair to the other side of the line, one of the pair connected to one side being biased to respond to positive current and the other to negative current, a link circuit comprising multi-contact relays for interconnecting said lines, a ringing current generator consisting entirely of relays for generating alternating current, means for setting the same in operation when the link is taken for use, and means associated with said link and controlled by the calling subscriber for applying positive or negative current superimposed on said alternating current to selectively signal said stations.

26. In a telephone system, telephone lines, a plurality of stations on each line, a plurality of ringers connected to each line, a link circuit for interconnecting said lines, a ringing current generator consisting entirely of relays, a code switch, and connectors between said generator, code switch and link for applying current from said generator to said lines to signal said stations.

27. In a telephone system, telephone lines, a plurality of stations on each line, a plurality of ringers connected to each line, a link circuit for interconnecting said lines, a ringing current generator consisting entirely of relays, means for setting the same in operation when the link is taken for use, a code switch, and connections between said generator, code switch and link for applying current from said generator to said lines to signal the stations thereon.

28. In a telephone system, telephone lines, a plurality of stations on each line, a plurality of ringers connected in bridge of each line, a link circuit comprising multi-contact relays for interconnecting said lines, a ringing current generator consisting entirely of relays for generating alternating current, means for setting the same in operation when the link is taken for use, a code switch, and connections between said generator, code switch and link for applying current from said generator to said lines to signal the stations thereon.

29. In a telephone system, subscribers' lines, link circuits comprising multi-contact relays for interconnecting said lines, means, including a starting circuit, automatically operated upon the removal of the receiver at the calling station for extending the calling line to an idle one of said link circuits, means thereupon operated for removing the control of the starting circuit from the calling line and maintaining the same closed, means automatically actuated when the calling line is extended to the link for opening the start circuit, and means automatically actuated in case the calling subscriber replaces his receiver before his line is extended to the link for opening said start circuit.

30. In a telephone system, subscribers' lines, link circuits comprising multi-contact relays for interconnecting said lines, a group relay operated due to the removal of the receiver at the calling station, a start circuit, for causing an idle link circuit to be connected to the calling line, closed by said relay, a locking circuit for said group relay independent of the energizing circuit for said relay, means automatically operated when the calling line is extended to the link for opening said locking circuit, and means automatically operated in case the calling subscriber replaces his receiver before the line is extended to the link for opening said locking circuit to restore the start circuit to normal.

31. In a telephone system, telephone lines, dials therefor, automatic switching means for interconnecting said lines under control of said dials, some of said lines being selected by the transmission of two sets of impulses, others by the transmission of three sets of impulses, and others by the transmission of four sets of impulses, and means for removing the control of the automatic switching means from the calling party when the required number of sets of impulses to build up a given connection have been transmitted.

In witness whereof, we hereunto subscribe our names this 1st day of September A. D., 1922.

SAMUEL B. WILLIAMS, JR.
EARL S. GIBSON.