May 12, 1925.

J. DAVIDSON, JR

1,537,109

TELEPHONE SYSTEM

Filed Aug. 10, 1920

9 Sheets-Sheet 1

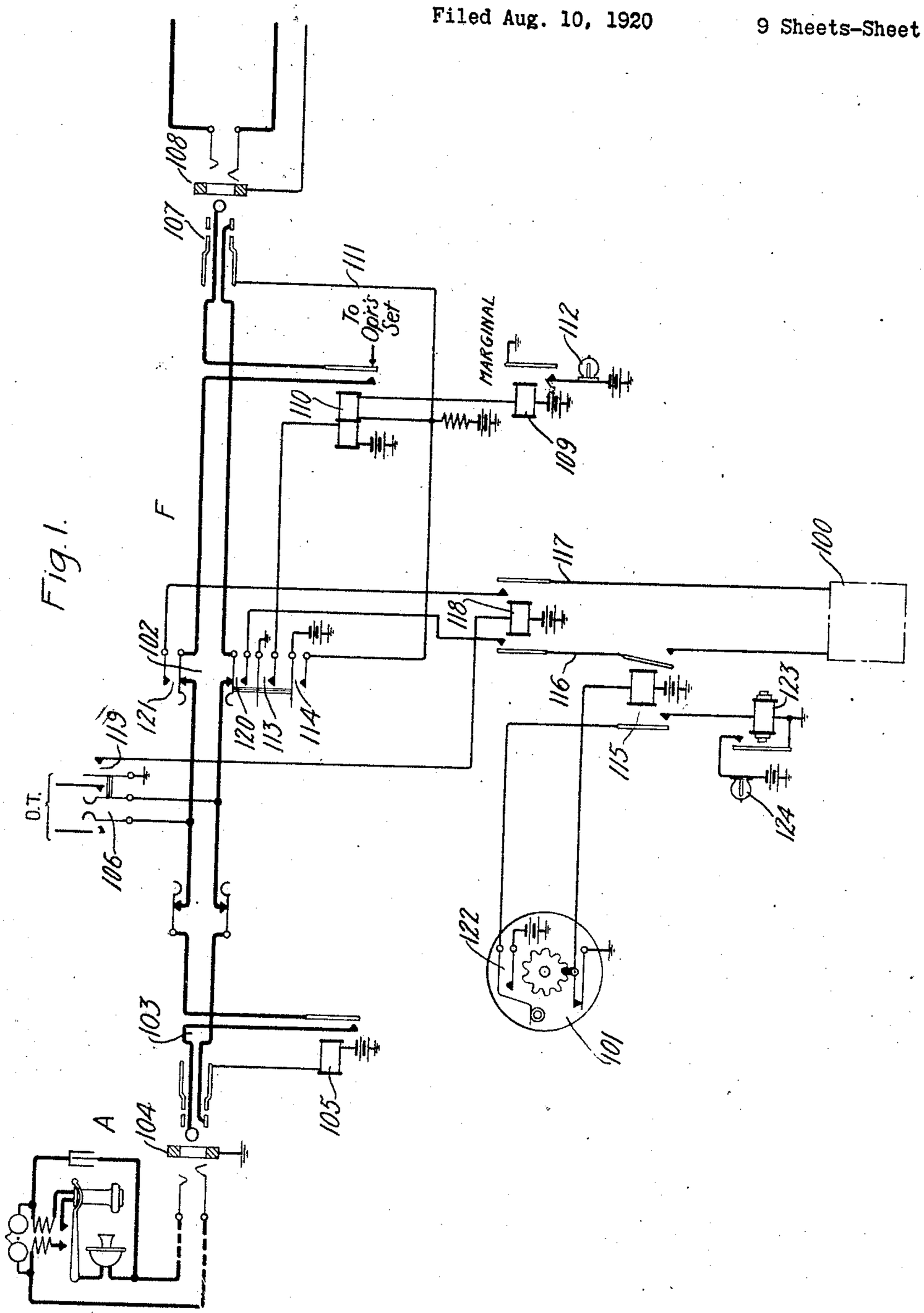

Fig. 1.

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by J. F. Folk Atty.

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1,537,109

TELEPHONE SYSTEM

Filed Aug. 10, 1920

9 Sheets-Sheet 2

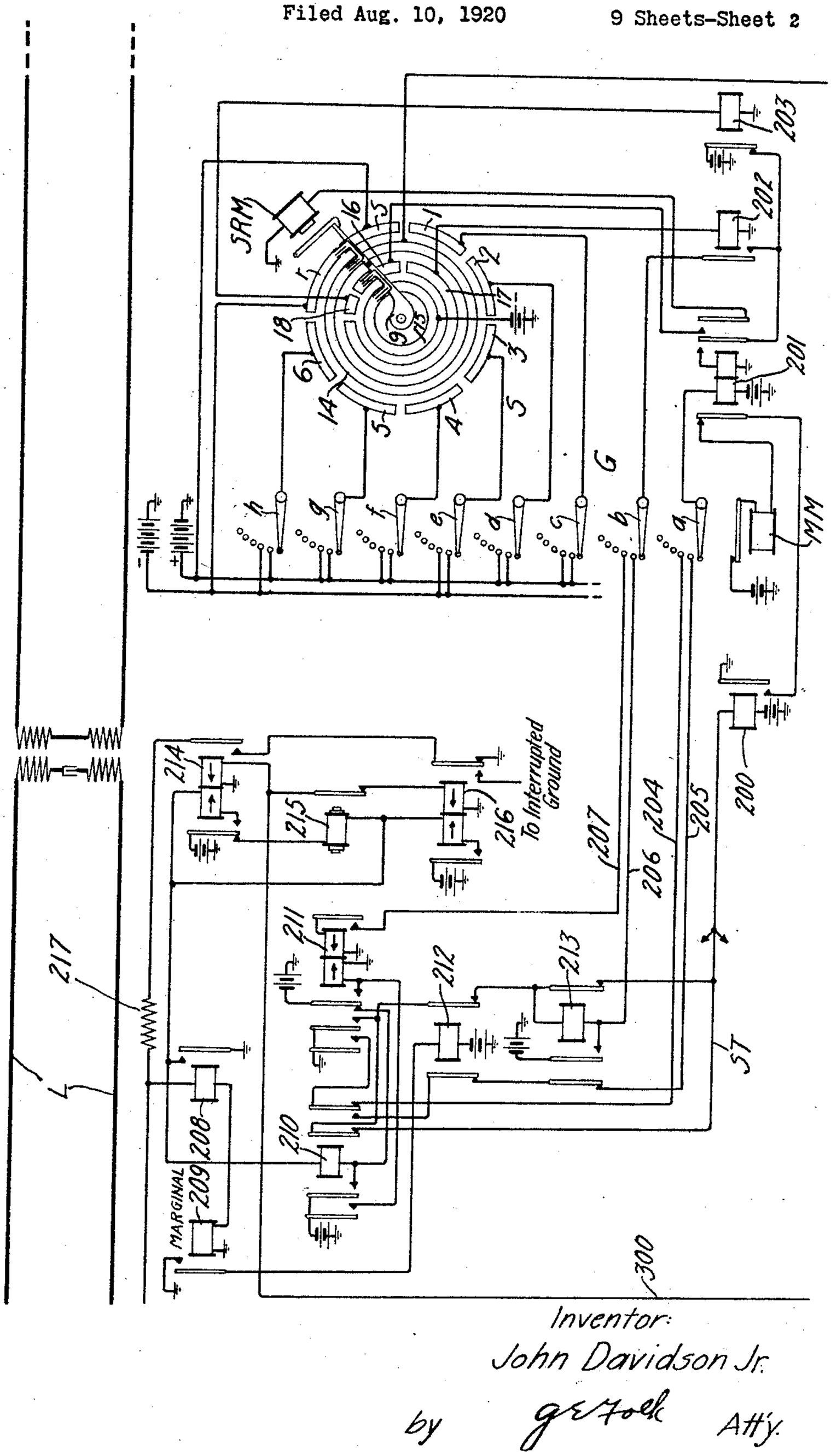

Fig. 2.

X

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1,537,109

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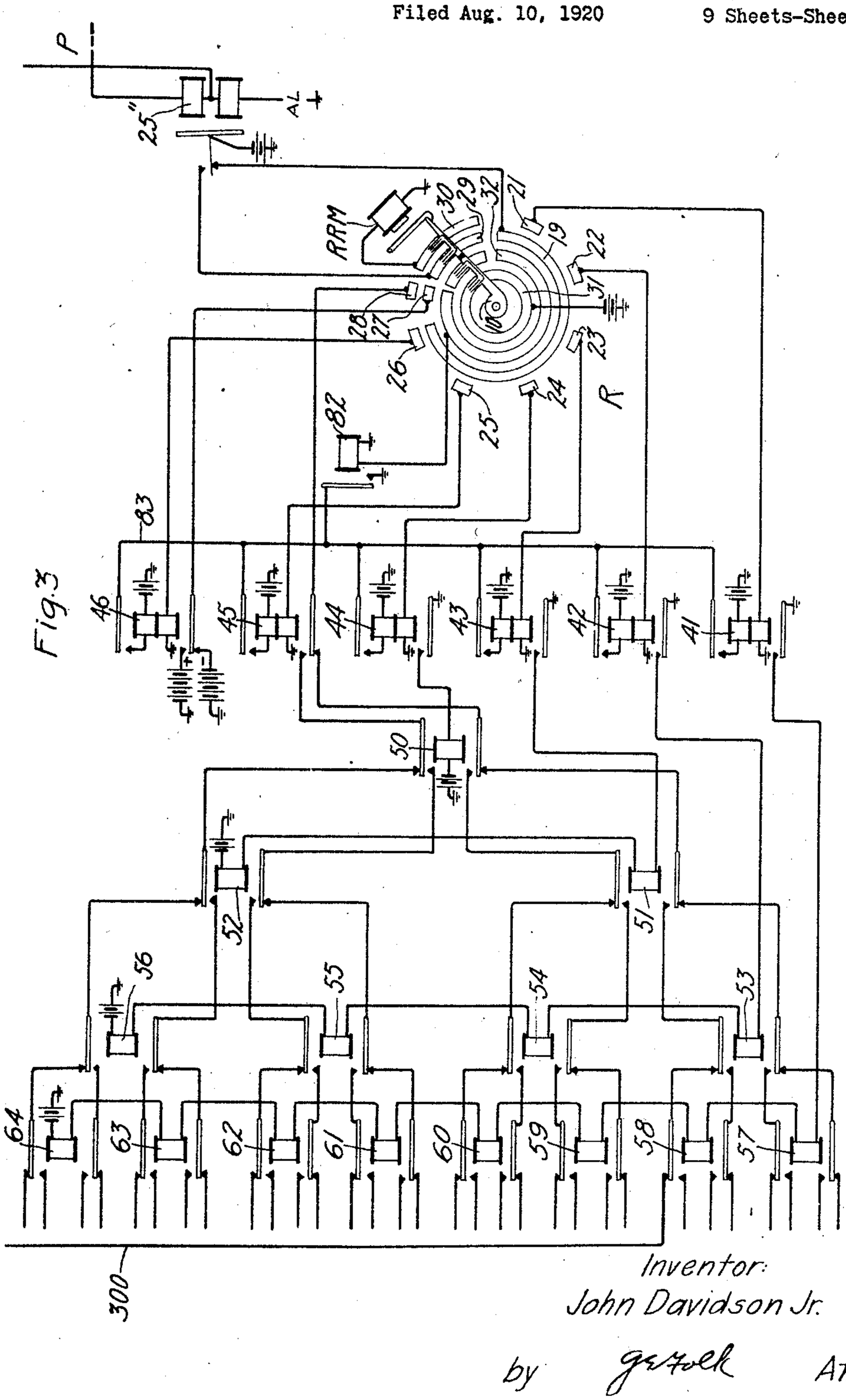
TELEPHONE SYSTEM

Filed Aug. 10, 1920

9 Sheets-Sheet 3

Fig. 3



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TELEPHONE SYSTEM

Filed Aug. 10, 1920

9 Sheets-Sheet 4

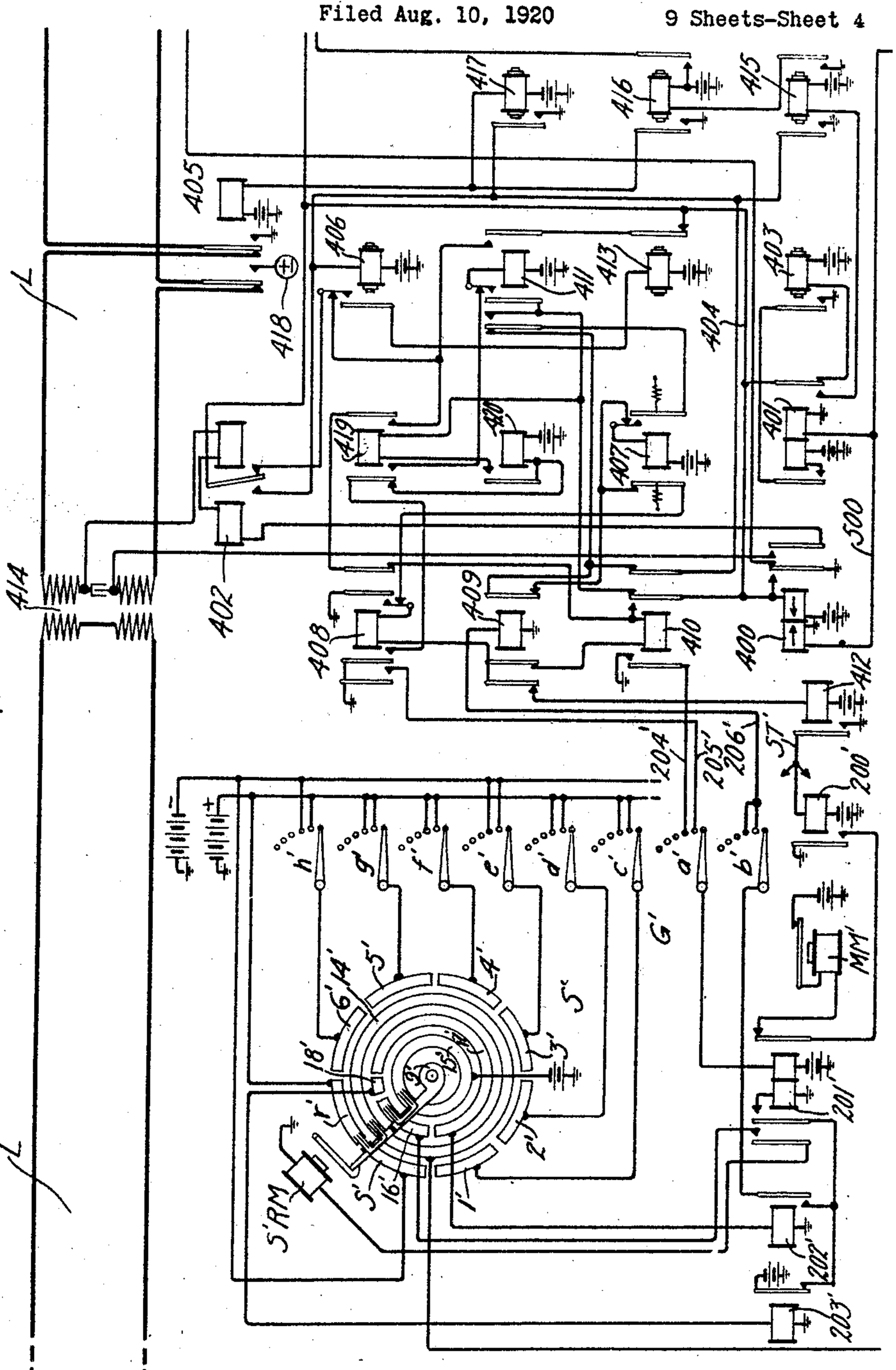

Fig. 4.

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1,537,109

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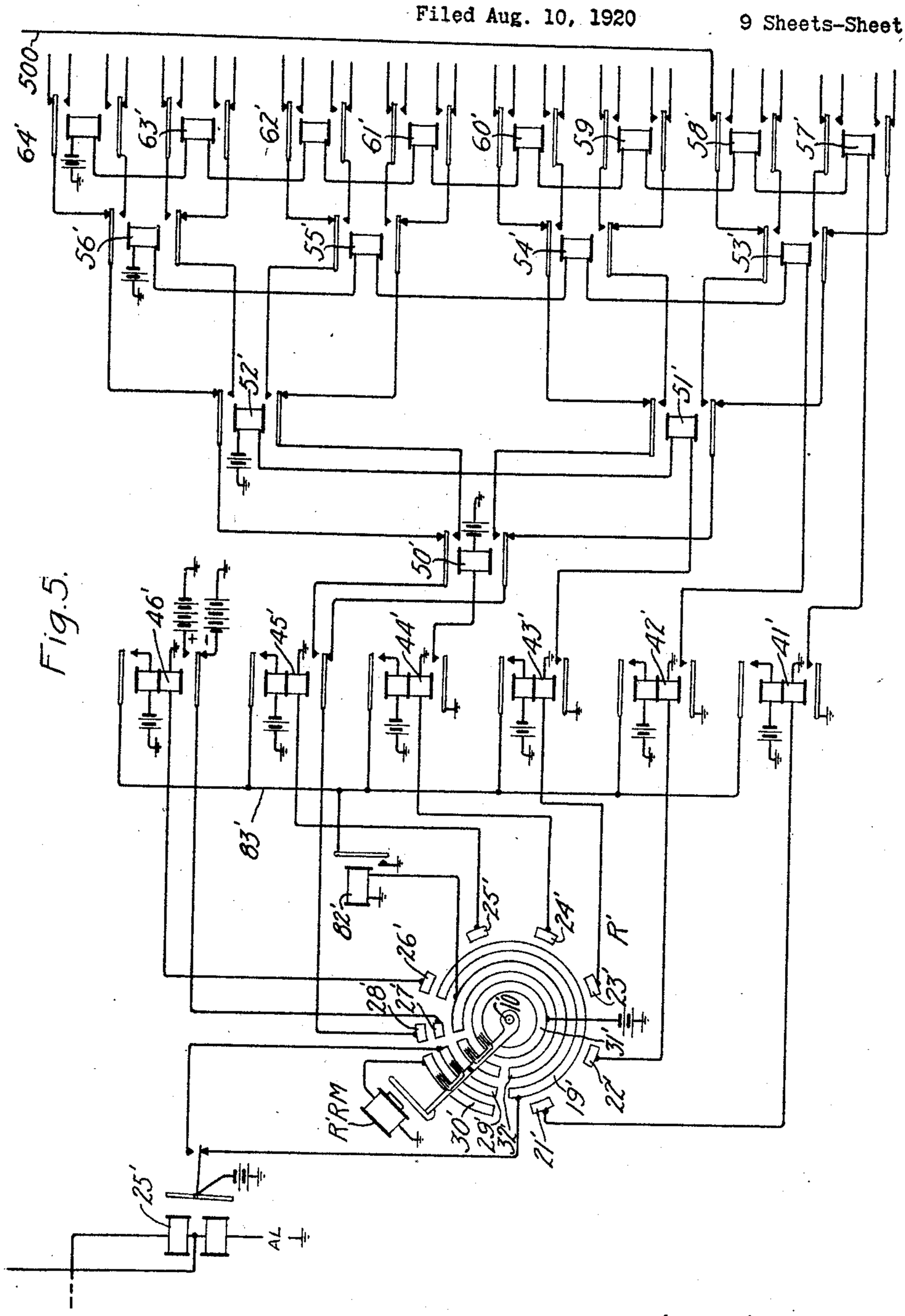
TELEPHONE SYSTEM

Filed Aug. 10, 1920

9 Sheets-Sheet 5

Fig. 5.



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TELEPHONE SYSTEM

Filed Aug. 10, 1920

9 Sheets-Sheet 6

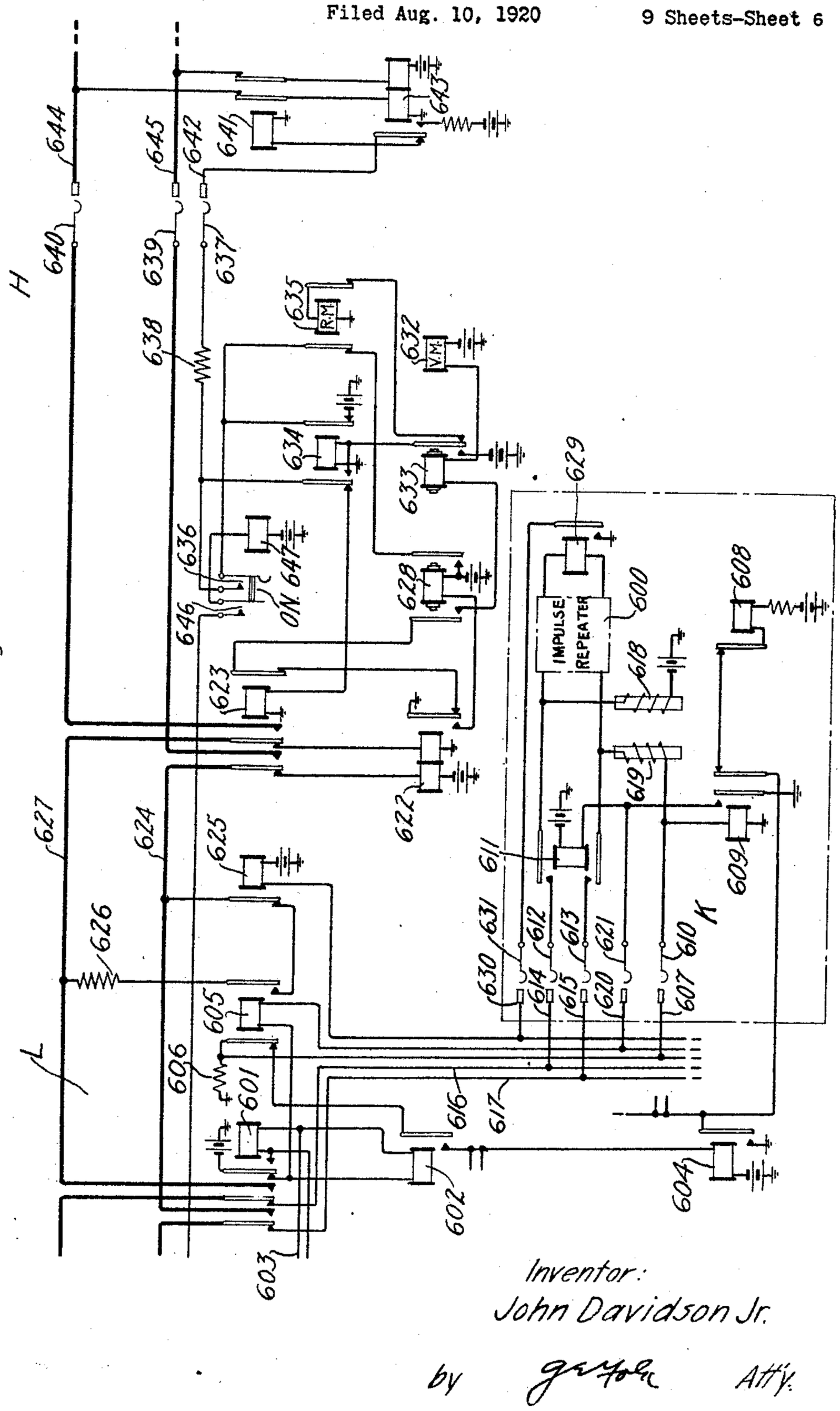

Fig. 6.

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TELEPHONE SYSTEM

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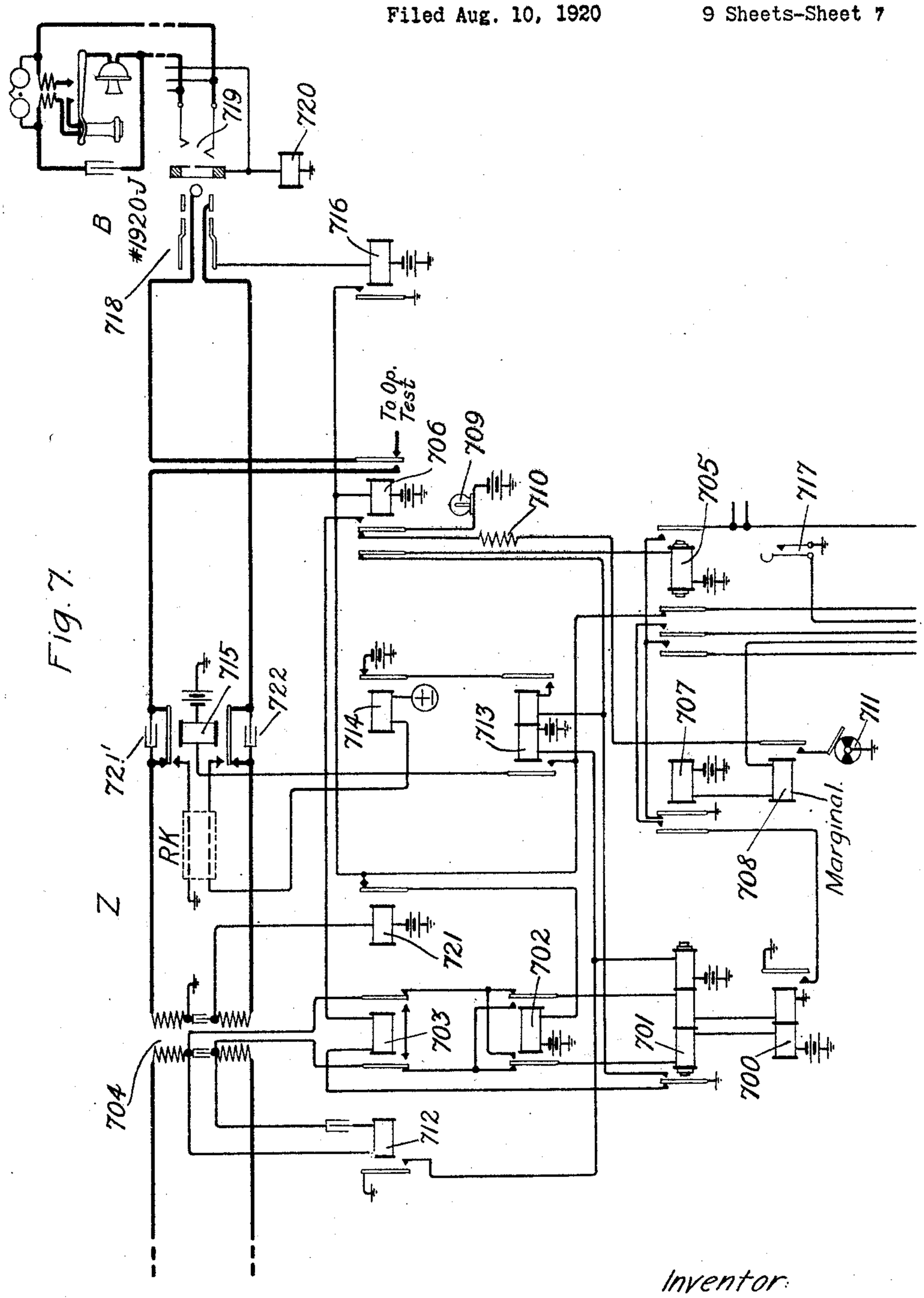

Fig. 7.

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May 12, 1925. 1,537,109

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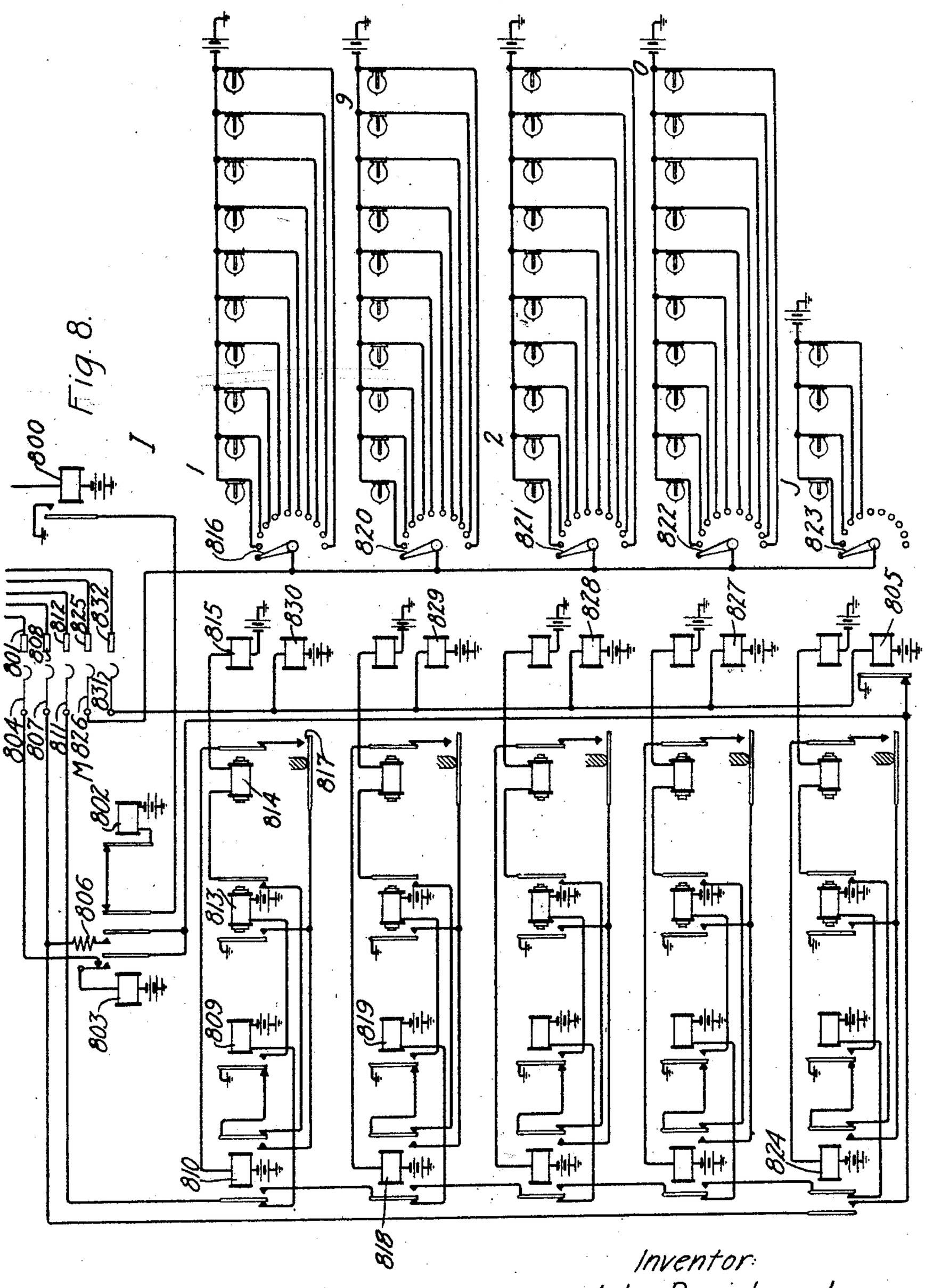
TELEPHONE SYSTEM

Filed Aug. 10, 1920 9 Sheets-Sheet 8

Fig. 8.



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1,537,109

TELEPHONE SYSTEM

Filed Aug. 10, 1920

9 Sheets-Sheet 9

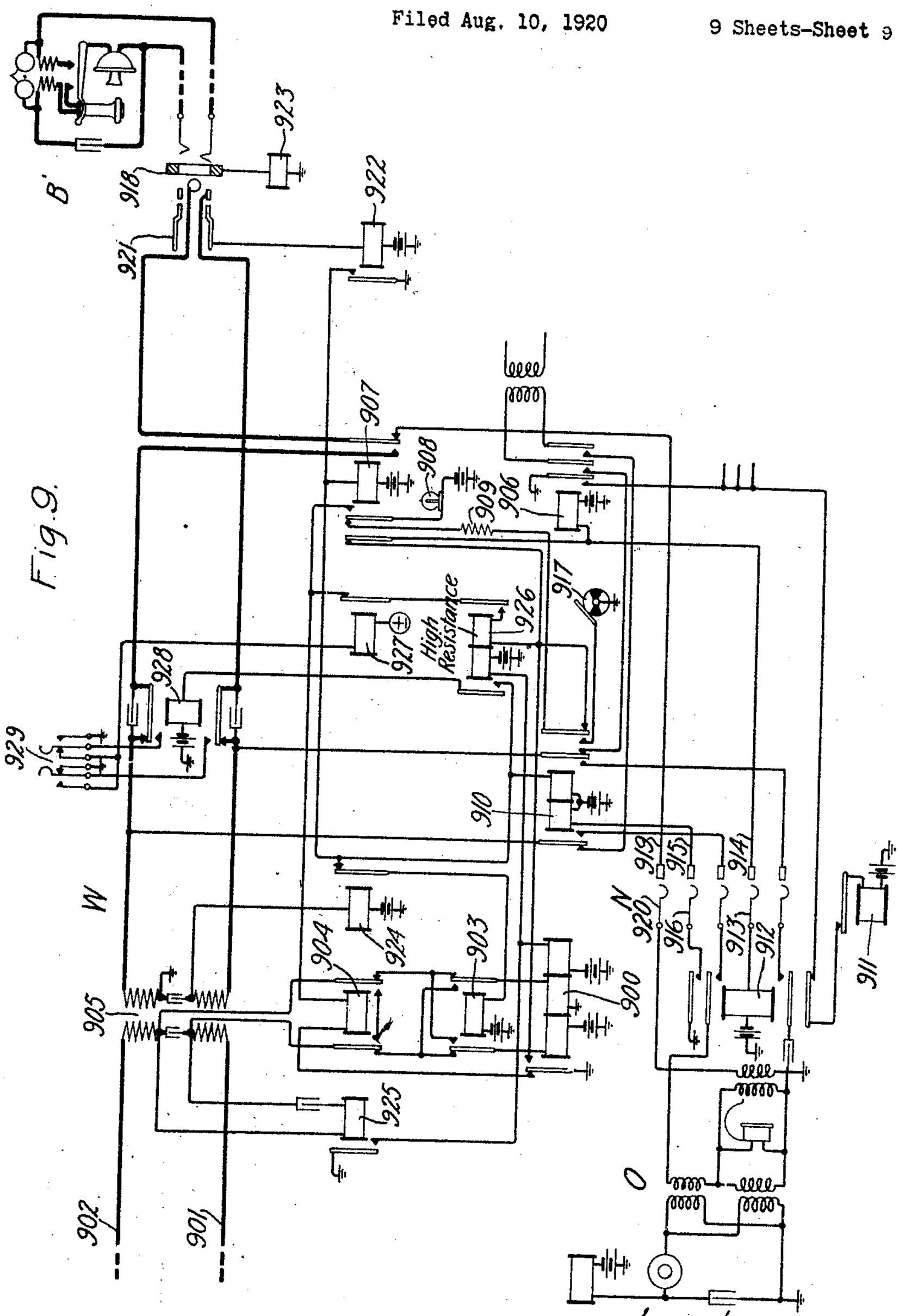

Fig. 9.

Inventor:
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by Gazlek Atty.

Patented May 12, 1925. 1,537,109

UNITED STATES PATENT OFFICE.

JOHN DAVIDSON, JR., OF TRENTON, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONE SYSTEM.

Application filed August 10, 1920. Serial No. 402,632.

To all whom it may concern:

Be it known that I, JOHN DAVIDSON, Jr., residing at Trenton, in the county of Mercer and State of New Jersey, have invented certain Improvements in Telephone Systems, of which the following is a specification.

This invention relates to methods and means for controlling a switching device by a plurality of sets of impulses in particular as applied to telephone systems in which the signals for a plurality of trunk lines extending between widely separated offices are controlled over a single signaling path common to such trunk lines.

In systems of this character it has been proposed to employ, at opposite ends of the signaling path, switching means for temporarily rendering the common signaling path individual to the various trunk lines served thereby, this individualizing apparatus comprising means for translating into code signals the signals initiated by the different trunk lines, means for transmitting over the signaling path the code signals which are individual to the trunk lines, and means for receiving and translating code signals into signals individual to the respective trunks.

Heretofore some systems of this character have been arranged for manual trunking only. It is desirable to arrange the trunk circuits so that the incoming trunk terminals thereof may be extended by automatic switching means to mechanical offices, to manual offices or to manual offices provided with call indicator mechanisms. In this respect the invention is in the nature of an improvement over the arrangement shown in applicant's Patent No. 1,493,109, issued May 6, 1924. In order to accomplish this without sacrificing the efficiency of the trunk circuits for speech transmission, it is desirable to transmit all supervisory signals over a common signaling path, thereby freeing the trunk circuits for the transmission of high frequency switch controlling impulses and for the transmission of speech.

An object of the invention is to control a switching device by a code of impulses and by other impulses. This is done by transmitting a code of impulses over a circuit to associate a switching device with another circuit and transmitting impulses over the latter mentioned circuit to control the switching device.

It is another object of the present invention to provide improved signaling means for systems of this character by means of which code impulses are transmitted over a common signaling path for controlling the association of impulse receiving mechanisms with the incoming ends of a plurality of trunk circuits and for controlling the transmission of all signals required for supervising the establishment of connections.

A further object of the invention is the provision of means for transmitting dialing impulses of relatively high frequency over a toll trunk circuit, and for translating such impulses at the distant end of the trunk circuit into direct current impulses for controlling automatic mechanism associated with the distant or incoming end of the trunk.

For the attainment of these objects of the invention there is provided at the originating end of the trunk lines and associated signaling path, apparatus individual to each trunk line responsive to the seizure of the trunk, for setting up and transmitting a code of impulses over the common signaling path. These impulses are received at the terminating end of the signaling path and translated into a switching impulse for starting up a finder switch for associating impulse receiving mechanism with the trunk taken for use by the originating operator. The apparatus at the originating end of the trunk lines is also arranged to transmit further code impulses over the signaling path for controlling the application of ringing current and for controlling the release of the connection upon disconnection of the originating toll operator's cord circuit from the employed trunk.

Apparatus individual to each trunk line is also provided at the terminating end of the trunk lines and associated signaling path for setting up and transmitting over the common signaling path, codes of impulses which are received at the originating end of the signaling path and translated into signaling impulses for controlling the operation of a supervisory signal associated with the toll operator's cord circuit, which is at that time connected with a particular trunk circuit. This supervisory signal is arranged to give the operator a dialing signal to apprise her that dialing impulses may be transmitted, as soon as the impulse receiving mechanism has been associated with the terminating end of the trunk circuit with

which she has established connection, to give the operator the usual supervisory signals when the connection has been extended to the distant called line, when the called subscriber responds, and when the called subscriber restores his receiver to the switchhook; and to give the operator a flashing signal to indicate that the called partly is busy if connection has been established to a subscriber in a distant mechanical office or that the called subscriber is operating his switchhook for a recall.

For further attaining the objects of the invention there are provided means for transmitting dialing impulses of relatively high frequency for example, 800 cycles, which, because of their relatively high frequency are readily transmitted over the toll trunk talking path without interference with the telegraph facilities of the trunk, and means for translating these impulses at the incoming end of the trunk circuit into direct current switch controlling impulses.

By the employment of the common signaling path for transmitting all supervisory signals in conjunction with means for employing high frequency transmitting and receiving mechanism for transmitting switch controlling impulses over the trunk circuit, it is possible to utilize the talking conductors of the trunk for the connection of telegraph apparatus thereto, to prevent tying up expensive signaling apparatus permanently with a particular toll trunk and thereby obtain a more efficient use of the signaling apparatus, and to permit the use of as many telephone repeaters in the toll trunk as are found necessary for efficient transmission.

The invention may be more readily understood by reference to the following description considered in connection with the accompanying drawings, in which Fig. 1 shows a cord circuit at an originating toll operator's position, a calling subscriber's line which may be associated with the toll operator's position in any well-known manner, and the calling jack of one of the toll trunks appearing before the toll operator's position; Fig. 2 shows relay mechanism individual to the outgoing end of a toll trunk and code impulse sending mechanism associated with the outgoing end of a signaling path common to a plurality of toll trunks; Fig. 3 shows a receiving and translating mechanism for receiving code impulses incoming over the signaling path; Fig. 4 shows a sending mechanism associated with the distant terminating end of the signaling path and common to a plurality of toll trunks, together with relays individual to the incoming end of one of said toll trunks for controlling said sending mechanism; Fig. 5 shows a receiving and translating mechanism associated with the distant terminating end of the signaling path for receiving code impulses incoming over the signaling path from the originating toll operator's position and for controlling the individual relays of the associated group of trunks; Fig. 6 shows one of a plurality of finder switches for associating a high frequency impulse repeating mechanism with a toll trunk which has been taken for use, and a selector switch in which the incoming end of the toll trunk terminates; Fig. 7 shows a terminating operator's cord circuit and the line of a subscriber to which the toll connection may be extended; Fig. 8 shows a lamp indicator for association with the operator's cord circuit shown in Fig. 7, on which indicator a registration of the number of the line desired may be set up by impulses transmitted thereto by the toll operator; and Fig. 9 shows a cord circuit at the position of a terminating operator in an office equipped for extending calls in accordance with oral directions received from the originating toll operator, together with means for automatically associating the operator's head set with the cord circuit taken for use.

Figs. 1 to 8 inclusive, when arranged with Fig. 2 at the right of Fig. 1, Fig. 3 beneath Fig. 2, Fig. 4 at the right of Fig. 2, Fig. 5 beneath Fig. 4, Fig. 6 at the right of Fig. 4, Fig. 7 at the right of Fig. 6, and Fig. 8 beneath Fig. 7, show as much of a complete organization of circuits as is necessary to illustrate the manner in which a connection may be established from a calling subscriber's line in an originating office X to a subscriber's line in a terminating office Z which is equipped for switching in accordance with call indicator line designations. Figs. 1 to 6 and 9 when arranged as above indicated but with Fig. 9 substituted for Figs. 7 and 8 and placed at the right of Fig. 6, show as much of a complete organization of circuits as is necessary to illustrate the method of extending calls to a terminating office W equipped for straight-forward switching through call circuit trunks.

The apparatus disclosed in Figs. 1, 2, and 3 is located at office X, that shown in Figs. 4, 5, and 6 at an intermediate office Y, that shown in Figs. 7 and 8 at a terminating office Z, while that apparatus shown in Fig. 9 is located at a second terminating office W. Like apparatus at the two offices X and Y will be designated by the same reference characters without primes at the office X and with primes at the office Y.

Referring to the drawings there is shown a toll trunk line L comprising two talking conductors extending from the originating office X to the intermediate office Y. At the originating office X there are provided a plurality of toll cords one of which is shown at F, by means of which connection may be

established with the trunk line L. The trunk line L terminates at the office Y in an office selector switch H, by means of which the toll line L may be connected with any one of the terminating offices such as Z or W or with a full mechanical exchange (not shown), and also terminates in multiple terminals appearing before a plurality of finder switches, one of which is shown at K.

At the terminating office Z the trunk lines extending from the bank of selectors H one of which is shown in Fig. 7 terminate in plug terminals by means of which connections may be extended to subscribers' lines in the terminating office, one of which lines is designated as B. Connections are extended at the office Z in accordance with designations set up upon the call indicator shown at I in Fig. 8, which indicator is common to a plurality of terminating trunks and is associated with any one of such trunks by means of a finder switch shown at M.

At the office W, each of the trunk circuits, incoming from the bank of selectors H, terminates in a calling plug by means of which connections may be extended to subscribers' lines, one of which has been designated B'. At this office the operator's set O may be associated with any one of the incoming trunk circuits by means of a finder switch N.

The selector switch H at the intermediate office Y may, in addition to having access to terminating offices Z and W, have access in the well-known manner to trunk circuits extending to full mechanical offices. As the apparatus usually employed in such mechanical offices is well-known, it is not deemed necessary to illustrate such apparatus in the drawings.

While only one toll cord circuit, one toll trunk line, one office selector switch H, one terminating trunk at the office Z, one terminating trunk at the office W, and one subscriber's telephone line at each of the offices Z and W have been shown, it is to be understood that this is for the purpose of convenience only and that as many of such circuits and lines may be provided as are necessary to meet the requirements of the traffic.

The supervisory signals for supervising calls over a plurality of toll trunk lines may be controlled over a single signaling path common to the trunk lines and comprising a conductor P extending from the originating office X to the intermediate office Y, which path is shown as having a grounded return. The signaling path is arranged in a well-known manner for duplex operation, for which purpose there are provided at the ends the artificial balancing lines AL and differentially balanced relays 25'' and 25'. Each end of the common signaling conductor P is connected with a commutator for sending and receiving signals. These commutators are preferably of the well-known start-stop type of distributors employed in connection with printing telegraph systems. Such commutators are disclosed in the patent of MacDougal and MacPherson, No. 1,387,284 issued August 9, 1921.

The commutator at office X comprises a sending distributor S for transmitting signals over the conductor P to the office Y, and a receiving distributor R for receiving signals transmitted over conductor P from office Y, and similarly the commutator at the office Y comprises a sending distributor S' and a receiving distributor R' for transmitting signals to, and receiving signals from, the office X over the conductor P. These commutators at both offices X and Y are of the same construction and a description of one will be sufficient, and for convenience the construction of the sending and receiving distributors S and R will be described. The sending and receiving distributors S and R each comprises a series of stationary rings, some of which are continuous and others segmented. A common shaft for the distributors has brush-arms 9 and 10 mounted thereon and normally held against rotation by the respective armatures of two separately controlled release magnets SRM and RRM. The outer end of each brush arm is insulated from the inner end so that each brush-arm controls two separate groups of circuits. Between the common shaft and each brush-arm there is provided frictional clutch mechanism (not shown) by means of which the constantly rotating shaft causes the rotation of each brush-arm when released. The face of the sending commutator S is stationary and is provided with a common sending ring 14, a restoring segment *r*, a start segment *s*, and individual sending segments 1 to 6 for controlling the signals transmitted over the signaling conductor P, and with a common ring 15 and segments 16, 17, and 18 for controlling local circuits. The face of the receiving distributor R is also stationary and is provided with a common receiving ring 19 and individual receiving segments 21 to 26 for selecting a circuit according to the code of signals received over the signaling conductor P, segments 27 and 28, through which the signal is completed, segments 29 and 30 for controlling the circuit of the associated release magnet and a ring 31 and segment 32 for controlling a local circuit.

At the originating office X the common conductor P is connected to the common sending segment 14, while the normal contact of the differential polarized relay 25'' is connected with the common receiving seg-

ment 19 and the alternate contact is connected with the segment 29. When the relay 25'' is operatively energized the release magnet RRM is energized to release the brush-arm 10. At the intermediate office Y the common conductor P is connected with the common sending segment 14', while the normal contact of the differential polarized relay 25' is connected with the common receiving segment 19', and the alternate contact of this relay is connected with the segment 29'. When the relay 25' is operatively energized, the release magnet R'RM is energized to release the brush-arm 10'.

The codes of signals transmitted over the common signaling conductor P by the sending distributors S and S' are determined by the polarity of current connected with the individual sending segments of the respective sending distributors S and S'. These polarities are determined by the position of the brushes of automatic selector switches G and G' provided at the respective offices X and Y. These automatic selector switches which are common to a plurality of toll trunk lines are alike in structure. The automatic selector switch G is provided with eight brushes *a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h* mounted upon a single shaft driven by a motor magnet MM, initially controlled by a start relay 200 connected to the start conductor or start lead ST common to a group of trunk lines. Brushes *c* to *h*, inclusive, are connected directly with the respective individual sending segments 1 to 6 of the sending distributor S. Brush *a* is connected with one winding of stop relay 201 which controls the circuit of the motor magnet MM and the energization of the release magnet SRM of the sending distributor S. Brush *b* is connected with a contact of relay 202 for the purpose of assisting in the control of the switch, as will more fully appear hereinafter. Relay 202 and a release relay 203, associated with the automatic selector switch G, are controlled by the sending distributor S for reasons which will more fully hereinafter appear. A plurality of contacts, equal to twice the number of toll trunk lines to which the automatic selector switch G is common, is associated with each brush on selector G. The contacts associated with the different brushes are mounted at different levels in position to be engaged by the respective brushes as they are rotated by the motor magnet MM. Two correspondingly positioned contacts of all levels are allotted to each trunk line; for example, the first two contacts may be allotted to trunk line No. 1, the second two to trunk line No. 2, etc. The two contacts of levels *a* and *b* allotted to each trunk line, are connected with relays individual to and associated with the outgoing end of the trunk line. The trunk line L has been shown associated with the first two contacts of each level of switch G. As shown, relays individual to the outgoing end of this trunk line are connected by means of individual signal control leads 204, 205 and restoring leads 206 and 207 with the allotted contacts accessible to brushes *a* and *b*, signal control leads 204 and 205 being connected to the respective first and second contacts of the level to which brush *a* has access and restoring conductors 206 and 207 to the respective first and second contacts of the level to which brush *b* has access. Each trunk line is provided with similar signal control and restoring leads at the office X similarly connected with the selector switch G. The automatic selector switches, shown in the drawing, are provided with sufficient contacts to accommodate thirty trunk lines. To the contact of the levels to which brushes *c* to *h*, have access allotted to the respective trunk lines, are connected current sources of the polarities in combinations as indicated in the following table, there being a different combination for each trunk line and also for the two contacts allotted thereto;

Trunk line	Contact	Level No. 1	2	3	4	5	6	Trunk line	Contact	Level No. 1	2	3	4	5	6
1	1st	+	+	−	+	+	+	16	1st	−	+	+	+	+	+
	2nd	+	+	−	+	+	−		2nd	−	+	+	+	+	−
2	1st	+	+	+	−	+	+	17	1st	−	−	+	+	+	+
	2nd	+	+	+	−	+	−		2nd	−	−	+	+	+	−
3	1st	+	+	+	+	−	+	18	1st	−	+	−	+	+	+
	2nd	+	+	+	+	−	−		2nd	−	+	−	+	+	−
4	1st	+	+	−	−	+	+	19	1st	−	+	+	−	+	+
	2nd	+	+	−	−	+	−		2nd	−	+	+	−	+	−
5	1st	+	+	−	+	−	+	20	1st	−	+	+	+	−	+
	2nd	+	+	−	+	−	−		2nd	−	+	+	+	−	−
6	1st	+	+	+	−	−	+	21	1st	−	−	−	+	+	+
	2nd	+	+	+	−	−	−		2nd	−	−	−	+	+	−
7	1st	+	+	−	−	−	+	22	1st	−	−	+	−	+	+
	2nd	+	+	−	−	−	−		2nd	−	−	+	−	+	−
8	1st	+	−	+	+	+	+	23	1st	−	−	+	+	−	+
	2nd	+	−	+	+	+	−		2nd	−	−	+	+	−	−
9	1st	+	−	−	+	+	+	24	1st	−	+	−	−	+	+
	2nd	+	−	−	+	+	−		2nd	−	+	−	−	+	−
10	1st	+	−	+	−	+	+	25	1st	−	+	−	+	−	+
	2nd	+	−	+	−	+	−		2nd	−	+	−	+	−	−
11	1st	+	−	+	+	−	+	26	1st	−	+	+	−	−	+
	2nd	+	−	+	+	−	−		2nd	−	+	+	−	−	−
12	1st	+	−	−	−	+	+	27	1st	−	−	−	−	+	+
	2nd	+	−	−	−	+	−		2nd	−	−	−	−	+	−
1	1st	+	−	−	+	−	+	28	1st	−	−	−	+	−	+
	2nd	+	−	−	+	−	−		2nd	−	−	−	+	−	−
14	1st	+	−	+	−	−	+	29	1st	−	−	+	−	−	+
	2nd	+	−	+	−	−	−		2nd	−	−	+	−	−	−
15	1st	+	−	−	−	−	+	30	1st	−	+	−	−	−	+
	2nd	+	−	−	−	−	−		2nd	−	+	−	−	−	−

The automatic selector switch G' allotted at the intermediate office Y, is like the switch G in structure and is associated with the sending distributor S' in the same manner as switch G is associated with the sending distributor S, with the similar start relay 200' and motor magnet MM' and with

stopping, control, and release relays 201′, 202′ and 203′. This automatic selector switch G′ is associated with the toll trunk line L, shown in the drawings, by means of the individual signal control leads 204′ and 205′ and restoring lead 206′ and a common start lead ST′, individual conductors 204′ and 205′ being connected with the allotted first and second contacts of level *a′*, individual restoring conductor or lead 206′ with both allotted contacts of the level *b′* and the common start conductor ST′ with the start relay 200′ of the switch G′. The selector switch G′ is associated with each of the other trunk lines through similar signal control and restoring leads. The polarities connected with the individual sending segments 1′ to 6′ of the sending distributor S′ are determined by the position of the brushes *c′* to *h′* of the switch G′, and the different combinations of polarities connected with the allotted first and second contacts of the levels to which brushes *c′* to *h′* have access for the various trunk lines are identical with those connected to the automatic selector switch G, as shown in the preceding table.

In order that the signals transmitted from the originating office X by the sending distributor S and received at the office Y may be utilized, there are provided at the office Y six locking relays 41′ to 46′ inclusive having energizing windings connected with the respective individual receiving segments 21′ to 26′ of the receiving distributor R′. When a negative impulse is transmitted from a particular individual sending segment, the relay connected with the corresponding individual receiving segment will be energized and locked up. Relays 41′ to 44′ control a plurality of receiving and selecting relays 50′ to 64′ inclusive which cooperate with relay 45′ to select a signal control circuit individual to a trunk line, while relay 46′ controls the polarity of current connected with the selected signal control circuit. The individual signal control circuits are connected with contacts of relays 57′ to 64′ inclusive. Similar equipment is provided at originating office X for utilizing the signals transmittted from the intermediate office Y over the common signal conductor P.

The selector switch H, shown at the intermediate office Y, is of the step-by-step type similar to that disclosed in Goodrum Patent 1,231,013, issued June 26, 1917. The finder switch, designated K, is of the well-known rotary step-by-step type and is employed to connect an impulse repeating device indicated by the dotted rectangle 600 with the incoming end of a toll trunk line L. This repeater may be of the type disclosed in Patent to Urie No. 1,202,925 issued October 31, 1916.

The call indicator shown at I in Fig. 8 comprises a plurality of rotary step-by-step switches which, through transfer relays, are connected in succession to a local stepping circuit and are under the control of impulses repeated over the trunk line extending from the terminating office Z to the intermediate office Y by the repeater 600 at the office Y. Each of the step-by-step switches of the register is provided with a bank having ten terminals which are connected with indicating lamps. The indicator I is associated with the trunks terminating in the office Z by means of a step-by-step switch M of the well-known rotary type.

The toll operator's position in office X is provided with a high frequency impulse sending device diagrammatically shown by the dotted rectangle 100 and of the type shown in the patent to C. R. Englund No. 1,245,446 issued November 6, 1917, which is under the control of the operator's impulse sending dial 101. This impulse sending device 100 may be associated with cord circuit F at the operator's position by means of a key 102.

Having in mind this brief description of the apparatus of the system shown in the drawings, it is thought that the invention will be more thoroughly understood from a description of the operation of the system shown, and therefore a description of the method of extending a call from the subscriber's station A, over toll trunk line L, through the intermediate office Y, and to the subscriber's station B in terminating office Z will first be explained.

The subscriber, whose substation is designated A, desiring to establish connection with the subscriber, whose station is designated B, which line terminates in the terminating office Z, will, in any well-known manner, as through an originating operator's position (not shown) and a switching trunk, obtain connection with the toll operator's position at office X, shown in Fig. 1. The operator in response to the call inserts the answering plug 103 of the idle cord circuit F in the jack 104 of the switching trunk, thereby causing the energization of sleeve relay 105. Relay 105 upon energizing closes the tip strand of the answering end of the cord circuit, thereby enabling the toll operator to converse with the calling subscriber A, or with the operator at the originating office, as soon as the toll operator throws her listening key 106 to connect her head set with the answering end of the cord circuit F. Upon ascertaining that the calling subscriber A desires connection with the subscriber in an office which is accessible over the toll trunk L, the toll operator inserts the calling plug 107 of the cord circuit F in the jack 108 of an idle toll trunk L, which is selected by testing in the well-known manner.

A circuit is now established extending from grounded battery through the winding or marginal sleeve relay 109, the right-hand winding of relay 110, over sleeve conductor 111, through the sleeve contact of plug 107, the sleeve contact of jack 108, the winding of relay 208, and thence to ground through the winding of marginal relay 209. Relays 110 and 208 operate but relays 109 and 209 do not operate at this time, owing to their marginal nature. Relay 208, upon energizing, closes a circuit for relay 210, which circuit may be traced from grounded battery through the inner left-hand armature and back contact of relay 211, the winding of relay 210, and thence to ground through the front contact and armature of relay 208. Relay 210, upon energizing, closes a locking circuit for itself extending from grounded battery through its inner left-hand armature and front contact, the winding of relay 210, and thence to ground at the armature and front contact of relay 208. Relay 210 also closes an energizing circuit for relay 211 which may be traced from grounded battery through the outer left-hand front contact of relay 210, and thence to ground through the left-hand winding of relay 211. Relay 211, upon energizing, closes a locking circuit for itself extending through its inner left-hand armature and front contact, and opens at the back contact of this armature the initial energizing circuit of relay 210.

Upon the energization of relay 211, ground is connected to the start conductor ST over the intermediate left-hand armature and front contact of relay 211, the right-hand armature and back contact of relay 212, and the right-hand armature and back contact of relay 213, and ground is connected to signal control conductor 205 over the outer left-hand armature and front contact of relay 211, the outer right-hand armature and front contact of relay 210, the left-hand armature and back contact of relay 212, and the outer left-hand armature and back contact of relay 213.

Relay 200 now energizes over conductor ST and closes a circuit for the motor magnet MM extending from grounded battery through the armature and contact of magnet MM, the left-hand armature and back contact of stop relay 201, and the front contact and armature of relay 200. Motor magnet MM, upon energizing in this circuit, advances the brushes of the distributor switch G over their respective levels of contacts until the brush *a* finds a grounded conductor 205 corresponding to a toll trunk which has been taken for use by the toll operator. Assuming that the conductor 205, corresponding to the toll trunk L, is the first grounded conductor to be encountered by the brush *a*, a circuit is established for the stop relay 201 extending from grounded battery through the left-hand winding of this stop relay, through the brush *a*, over conductor 205, and thence to ground as previously traced at the outer left-hand armature of relay 211. The stop relay 201 upon energizing, opens the circuit of the motor magnet MM and thereby arrests the movement of switch G. Relay 201 also closes a locking circuit for itself extending from grounded battery at the armature and back contact of release relay 203, through the inner right-hand armature and front contact of relay 201, and the right-hand winding thereof to ground. Relay 201 also closes a circuit for release magnet SRM of the sending distributor S, which circuit extends from grounded battery through the ring 15, the inner brushes of the brush-arm 9, segment 16, the front contact and outer right-hand armature of relay 201, and thence to ground through the winding of the release magnet SRM. The attraction of the armature of the release magnet SRM, upon the energization thereof, releases the brush-arm 9, which is thereupon rotated through a complete cycle, at the end of which the brush-arm is stopped in its normal position. The brush-arm 9, in being rotated, first engages start segment *s*, thereby connecting positive current with the common signaling conductor P.

Brush-arm 9 then moves out of engagement with segment 16, thereby opening the energizing circuit of and causing the deenergization of release magnet SRM, which restores its armature to normal position preparatory to stopping the brush-arm when it reaches its normal position. From an inspection of the table of polarities it will be observed that when the switch G stopped with its brushes in engagement with the first of the two contacts in the several levels, allotted to trunk line L, that positive current is connected with such first contacts on levels *c*, *d*, *f*, *g*, and *h*, while negative current is connected with such first contact of level *e*. When the inner brushes on brush-arm 9 engage segment 17, a circuit is closed extending from battery through ring 15, the inner brushes on arm 9, segment 17, and thence to ground through the winding of relay 202. This relay, upon energizing, closes a circuit extending from grounded battery through the armature and back contact of relay 203, the armature and front contact of relay 202, over the brush *b* of switch G, conductor 206, winding of relay 213, right-hand armature and back contact of relay 212, and thence to ground through the left-hand intermediate armature and front contact of relay 211. Relay 213 energizes in this circuit and at its inner left-hand armature establishes a locking circuit for itself independent of the circuit extend-

43′ and thereby the circuit through the windings of relays 51′ and 52′. The circuits of the signal receiver are now in normal position in readiness for the receipt and translation of other code signals. It is to be noted that during the rotation of the receiving distributor, relays 41′, 42′, 44′, 45′, and 46′ were not energized inasmuch as relay 25′ was holding its armature against its alternate contact at the time the brushes on switch arm 10′ were passing over segments 21′, 22′, 24′, 25′, and 26′ connected respectively to these relays.

Relay 400 at the intermediate office Y, upon energizing over the circuit traced through conductor 500, closes a locking circuit for itself extending from grounded battery through its right-hand winding, and to ground through its inner right-hand armature and front contact. The energization of relay 401 is without effect at this time and this relay deenergizes as soon as the receiving distributor R′ reaches normal position and opens the circuit over conductor 500. Relay 400, upon energizing, also bridges the polarized relay 402 across the incoming end of the toll trunk line L, through its outer armature and front contact, and at its inner armature and front contact closes a circuit extending through the right-hand armature and back contact of relay 401, and through the winding of slow-releasing relay 403. The energization of relay 403 is without function at this time. A circuit is also established from battery at the inner armature and back contact of relay 601, the winding of relay 602, conductor 603, conductor 404, and thence to ground at the inner armature and front contact of relay 400.

Relay 602 energizes in this circuit, if relay 601 is at the time deenergized, closing a circuit extending from grounded battery through the winding of starting relay 604, the armature and front contact of relay 602, and thence to ground through the left-hand armature and back contact of relay 605 and resistance 606. Selectable potential is also connected over the circuit above traced to the lowermost bank contact 607 of finder switch K.

Upon the energization of relay 604, a circuit is closed through the motor magnets 608 of all finder switches which are at the time idle. A circuit for the motor magnet of finder switch K, shown in Fig. 6, may be traced from grounded battery through the motor magnet 608, the armature and back contact of this magnet, the armature and back contact of stop relay 609, and thence to ground at the armature and front contact of relay 604. The finder switches which are started up will continue to move their brushes over their respective banks of contacts, which contacts are individual to the thirty trunks of the group to which these finders are assigned, until one of the finders positions its brushes upon the set of bank contacts individual to the seized trunk line L. Assuming that the switch K is the first finder switch to engage these contacts a circuit will be established from grounded battery connected through the circuit previously traced to the contact 607, thence over brush 610, and to ground through the winding of stop relay 609. Relay 609 energizes in this circuit opening at its outer armature and back contact the circuit extending through motor magnet 608, and at its inner armature and front contact closes a circuit extending from grounded battery through the winding of relay 611, and thence to ground at the inner armature and front contact of relay 609.

Relay 611, upon energizing, connects the input side of repeater 600 over its armatures and front contacts, brushes 612 and 613 of finder switch K, contacts 614 and 615 with which they are in engagement, thence over conductors 616 and 617, through the intermediate and outer left-hand armatures and back contacts of relay 601 to the tip and ring conductors of the toll trunk L. A circuit is also closed at this time from grounded battery through retardation coil 618, the upper armature and front contact of relay 611, brush 612, contact 614, conductor 616, the intermediate armature and back contact of relay 601, the inner armature and back contact of relay 405, the upper right-hand winding of repeating coil 414 the windings of polarized relay 402, the outer armature and front contact of relay 400, the lower right-hand winding of repeating coil 414, the outer left-hand armature and back contact of relay 405, the outer left-hand armature and back contact of relay 601, conductor 617, bank contact 615 of finder switch K, brush 613, the lower armature and front contact of relay 611, retardation coil 619, and thence to ground through the winding of relay 609. A circuit is also established at this time for relay 605, which circuit may be traced from grounded battery through the inner armature and back contact of relay 601, winding of relay 605, bank contact 620, brush 621, and thence to ground through the inner armature and front contact of relay 609. Relay 605, upon energizing, opens the circuit of relay 604, which, if there are no other incoming calls on other trunks of the group at this time, will deenergize, opening the starting circuits of all other finder switches which have been started to hunt for the calling trunk. At its right-hand armature and front contact, relay 605 closes a bridge across the conductors of the incoming end of the toll trunk L, thereby causing the energization of line relay 622 of the

ing through brush *b* of switch G, at its outer left-hand armature opens the circuit extending over conductor 205, and at its right-hand armature opens the starting conductor ST.

As the brush arm 9 successively moves its brushes over the individual sending segments 1 to 6, current sources of the polarity connected with these segments are successively connected with the conductor P. When the brush-arm 9 moves its brushes out of engagement with segment 17, the energizing circuit of relay 202 is opened, and upon the engagement of the inner brushes on brush-arm 9 with segment 18, a circuit is established for release relay 203, which extends from grounded battery through ring 15, the inner brushes on arm 9, segment 18, and thence to ground through the winding of relay 203. Relay 203, upon its energization, opens the locking circuit of relay 201, whereupon this relay releases. As the brushes on arm 9 move out of engagement with segment 18, release relay 203 is deenergized. When the brushes on brush-arm 9 engage the restoring segment *r*, current of negative polarity is connected with the common signaling conductor P, and the automatic selector switch G is now in condition to be seized by another trunk since the trunk line L is now disconnected therefrom and the sending distributor S is in normal condition.

The connection of positive current from segment *s* with conductor P does not affect differential polarized relay 25'' in office X, but causes the operation of the differential polarized relay 25' at the intermediate office Y over a circuit extending from positive battery through segment *s*, the outer set of brushes on arm 9, the common sending ring 14, and the junction point between the windings of differential polarized relay 25'', then by one path through the lower winding of relay 25'' and artificial line AL to ground, and by another path through the upper winding of relay 25'' conductor P, both windings of the differential polarized relay 25' and the artificial line to ground. The operation of relay 25' establishes a circuit extending from grounded battery through the alternate contact of relay 25', segment 29', the outer set of brushes on arm 10' of the receiving distributor switch R, segment 30' and thence to ground through the winding of release magnet R'RM. The attraction of the armature of the release magnet upon the energization thereof releases the brush-arm 10', which is thereupon rotated through a complete cycle at the end of which the brush is stopped in its normal position. As the brush-arm 10' moves its brushes out of engagement with the segments 29' and 30', the circuit extending through the release magnets R'RM is opened, and the magnet deenergized, permitting the restoration of its armature to normal position preparatory to stopping the brush-arm when it reaches its normal position. When the brush-arm 10' moves its inner set of brushes into engagement with the segment 32', a circuit is established extending from grounded battery through the ring 31', the inner set of brushes on the brush-arm 10', segment 32', and thence to ground through the winding of relay 82'. Relay 82' thereupon energizes, connecting at its armature and front contact a holding ground to the conductor 83', which is common to the locking circuits of relays 41' to 46' inclusive. The armature of the polarized relay 25' remains in its alternate position as long as positive current is connected with the other end of conductor P and moves to its normal position whenever negative current is connected with the other end of conductor P.

The brush-arms 10' and 9 are rotated synchronously, and while brush-arm 9 positions its brushes in engagement with segment 3 of the sending distributor S, to which negative current is connected, the armature of relay 25' moves to its normal position and brush-arm 10' positions its brushes in engagement with the receiving segment 23'. Relay 43' is thereupon energized over a circuit extending from grounded battery through the normal contact of relay 25', segment 19' of the distributor R', the outer set of brushes on brush-arm 10', segment 23', and thence to ground through the lower winding of relay 43'. This relay, upon energizing, locks itself to the grounded conductor 83', through its upper winding and its upper armature contacts. At its lower armature and front contact, relay 43' closes a circuit extending from grounded battery through the windings of relays 52' and 51', which thereupon energize. When the brush-arm 10' positions its brushes upon segments 27' and 28', just prior to reaching its normal position, a circuit is established extending from grounded negative battery through the lower armature and back contact of relay 46', through segment 27', the outer set of brushes on brush-arm 10', segment 28', the lower armature and back contact of relay 45', the lower armature and back contact of relay 50', the lower armature and front contact of relay 51', the upper armature and back contact of relay 53', the upper armature and back contact of relay 58', thence over conductor 500 which is individual to the toll trunk L, and to ground through the left-hand winding of relay 400 and the right-hand winding of relay 401. As soon as brush-arm 10' moves its brushes beyond the segments 27' and 28', the circuit existing through the winding of relay 82' is opened, and this relay deenergizes opening the locking circuit of relay

office selector switch H, this circuit extending from grounded battery through the left-hand winding of relay 622, the outer left-hand armature and back contact of switching relay 623, the lower talking conductor 624 of the trunk L, the armature and back contact of relay 625, the right-hand armature and front contact of relay 605, resistance 626, the upper conductor 627 of trunk L, the inner left-hand armature and back contact of relay 623, and thence to ground through the right-hand winding of relay 622. Relay 622, upon energizing, closes a circuit for slow-release relay 628, which may be traced from grounded battery through the winding of this relay, and thence to ground through the armature and front contact of relay 622. The circuits of the repeater 600 and of the office selector switch H are now in condition to receive directive impulses for causing the selection of the desired terminating office.

When relay 611 energized and established a circuit through the winding of polarized relay 402, said relay energized in such a manner as to move its armature into engagement with its left-hand contact, thereby closing a circuit for slow-releasing relay 406, slow operating relay 407, and relay 408, and causing the energization of these relays. A circuit for relay 406 may be traced from grounded battery through the winding of this relay, the armature and left-hand contact of relay 402, and thence to ground at the inner armature and front contact of relay 400. The circuit of relay 407 may be traced from grounded battery through the winding of this relay, the normally closed make-before-break armature contacts of this relay, the right-hand armature and back contact of relay 409, the outer right-hand armature and back contact of relay 410, the armature and left-hand contact of relay 402, and thence to ground at the armature and contact of relay 400. Relay 407, upon energizing, closes a locking circuit for itself through its right-hand armature and make contact, the outer left-hand armature and back contact of relay 411, and thence to ground over the circuit previously traced, through the armature and left-hand contact of relay 402. Relay 407 thus remains under the control of relay 402 until relay 411 is operated. The circuit of relay 408 may be traced from grounded battery through the winding of relay 412, the outer left-hand armature and back contact of relay 409, the winding of relay 408, the break contacts of its inner right-hand armature, the left-hand armature and back contacts of relay 407, the right-hand armature and back contact of relay 409, and thence to ground over the circuit previously traced, through the armature contacts of relay 402. Since relay 407 is slightly slow to energize, the circuit of relay 408 is established before relay 407 energizes to open its left-hand armature contacts. Relay 408, upon energizing in the circuit previously traced, closes a locking circuit for itself, extending through the winding of relay 412 left-hand armature and back contact of relay 409, its own winding and the make contacts of its inner right-hand armature to ground.

The energization of relay 406 prepares a circuit for the slow-releasing relay 413, which circuit extends to the right-hand armature contact of polarized relay 402, and is closed as soon as the direction of current flow is reversed through the winding of relay 402. Relay 408, upon energizing, closes a circuit for relay 420 extending from grounded battery through the winding of relay 420, the left-hand armature and back contact of relay 419, and thence to ground at the inner left-hand armature and front contact of relay 408. Relay 420 energizes in this circuit and closes a locking circuit for itself, extending through its armature and front contact, the winding of relay 419, the inner right-hand armature and back contact of relay 410 to ground at the inner armature and front contact of relay 400. Relay 419, however, does not energize in this circuit since its winding is shunted by ground at the armature and contact of relay 408. Relay 412, which energized in series with relay 408 upon energizing, closes a circuit for the start relay 200′ of the selector switch G′, which, upon energizing, closes a circuit for the motor magnet MM′ of this switch, which circuit extends from grounded battery through armature and back contact and winding of the motor magnet, through the right-hand armature and back contact of stop relay 201′, and thence to ground through the armature and front contact of relay 200′. The switch G′ is thereupon started to move its brushes over their respective levels of contacts, until the brush *a′* engages the contact connected by conductor 205′ to ground at the outer left-hand armature and front contact of relay 408, this conductor being individual to the incoming end of the trunk line L, when a circuit is established through the right-hand winding of stop relay 201′. This stop relay, energizing in this circuit, opens the circuit of the motor magnet MM′, and closes a locking circuit for itself, extending from grounded battery through the armature and back contact of relay 203′, through the inner left-hand armature and front contact and left-hand winding of relay 201′ to ground. At its outer left-hand armature and front contact, stop relay 201′ closes a circuit extending from grounded battery through the ring 15′, the inner brushes on brush-arm 9′, segment 16′, the outer left-

hand armature and front contact of relay 201′, and thence to ground through the winding of release magnet S′RM of the sending distributor S′.

The sending distributor S′, upon being released, rotates through a complete cycle and in the manner previously described in connection with the sender distributor S, transmits a code of signals comprising two positive, a negative, and three positive impulses, which are received by the receiving distributor R at the originating office X to lock up relays 43, 51 and 52 in the same manner as previously described in connection with the receiving distributor R′. The sending distributor S′, after leaving its normal position, closes a circuit for relay 202′, extending from grounded battery through the ring 15′, the inner set of brushes of the brush-arm 9′, segment 17′ and winding of relay 202′ to ground. Relay 202′, upon energizing, closes a circuit extending from grounded battery through the armature and back contact of relay 203′, the armature and front contact of relay 202′, over the brush *b*′ having access to the second level of selector G′, conductor 206′, and thence to ground through the winding of relay 409. Relay 409, upon energizing, opens the circuit of relay 408, causing the deenergization of this relay. The shunt around the winding of relay 419 is now opened and relay 419 energizes in the locking circuit of relay 420 for a purpose to be described hereinafter.

The receiving distributor R, it will be understood, is started at the time sending distributor S is started and rotates in synchronism therewith, and just before reaching its normal position closes a circuit extending from grounded negative battery through the lower armature and back contact of relay 46, the segment 27, the outer set of brushes of the brush-arm 10, segment 28, the lower armature and back contact of relay 45, the lower armature and back contact of relay 50, the lower armature and front contact of relay 51, which together with relay 52, was energized by the operation of relay 43, the upper armature and back contact of relay 53, the upper armature and back contact of relay 58, thence over conductor 300 to ground through the right-hand winding of relay 214. Relay 216 does not operate at this time over conductor 300, since its circuit, which is normally in parallel with the winding of relay 214, is opened at this time through the armature and back contact of slow-releasing relay 215 this relay having been previously energized by the operation of relay 208. Relay 214, upon energizing in this circuit, closes a locking circuit for itself extending from grounded battery through its left-hand armature and front contact, its left-hand winding, and thence to ground at the armature and front contact of relay 208, and at its left-hand armature and back contact opens the circuit of slow-releasing relay 215. Relay 215, however, being slow to release, does not close the circuit extending through the right hand winding of relay 216 until after the momentary impulse of battery is removed from conductor 300. A circuit is closed from ground at the right-hand armature and back contact of relay 216, through the right-hand armature and front contact of relay 214, through resistance 217, and thence over the sleeve conductor of the trunk circuit L, through the sleeve of jack 108, sleeve of plug 107, conductor 111, winding of relay 110, and winding of marginal relay 109 to grounded battery. The connection of resistance 217 in parallel with the windings of relays 208 and 209 changes the resistance of the sleeve circuit sufficiently to permit the operation of marginal relay 109 of the toll cord circuit F, which relay, upon energizing, closes the circuit of the lamp 112, which at this time serves to give the toll operator a dialing signal to apprise her of the fact that the finder switch K has associated an impulse repeating device 600 with the incoming end of the toll trunk line L, and that she may now proceed to dial the digits required to set the switch H on the terminals of the trunk line extending to the desired terminating office Z, and the digits required to set up the number of the desired line in this office upon the lamp indicator I.

It will be assumed that the calling subscriber desires connection with the line of the called subscriber B, whose directory number is 1920–J. The toll operator will thereupon throw her dialing key 102 to connect the impulse sending device 100 to the strands of the cord circuit F. Upon throwing the key 102 a circuit is closed from ground through contacts 113 of the key, and through the left-hand winding of relay 110 for holding this relay positively energized during the transmission of the dialing impulses to insure that the tip strand of the calling end of the cord circuit is maintained closed. At its lowermost alternate contact 114, the key 102 closes a circuit extending from grounded battery directly to the sleeve conductor 111, in parallel with the windings of relays 109 and 110, which so increases the flow of current over the sleeve conductor that marginal relay 209 now becomes energized. Relay 109 releases while the dialing key 102 is operated, and extinguishes lamp 112. Relay 209, upon energizing, closes a circuit for relay 212, extending from grounded battery through the winding of relay 212, and thence to ground through the armature and front contact of relay 209. Relay 212, upon energizing, opens the locking circuit of relay 213, permitting relay 213 to deenergize, thereby connecting start conductor ST and the impulse control conductor 205 to the back contacts of the

armatures of relay 212 for a purpose to be described hereinafter.

The toll operator now proceeds to set the sending dial 101 in accordance with the office designation of the desired line for setting the office selector switch H. When the dial is released after its initial setting and returns to normal, the circuit of relay 115 is intermittently opened, thereby causing the association of the impulse sending device 100 with the impulse conductors 116 and 117, a number of times corresponding to the setting of the dial, and since at the time the operator listened in on the connection by throwing the listening key 106, the relay 118 was energized over a circuit extending from battery through the winding of this relay and the alternate contacts 119 of key 106, the impulse conductors 116 and 117, are now connected over contacts 120 and 121 of the dialing key 102, through the tip and ring strands of the cord circuit F, over the tip and ring contacts of the plug 107 and the jack 108, and thence to the tip and ring conductors of the toll trunk line L. Upon the movement of the dial 101 off normal, the off normal contacts 122 of the dial close a circuit extending from grounded battery through these contacts, the left-hand armature and front contact of relay 115, and to ground through the winding of slow-releasing relay 123, which, due to its slow-releasing character, maintains a circuit for the lamp 124 so long as the dial 101 is off normal.

The sending device 100 is designed for transmitting high frequency alternating current impulses out over the toll trunk, these impulses having a frequency of preferably 800 cycles. These impulses are repeated through the several repeating coils of the trunk circuit L and flow through the input circuit of the repeating device 600 at the intermediate office Y. These impulses, through the well-known construction of the repeating device 600, cause the intermittent operation of the repeating relay 629. Upon each energization, relay 629 closes a circuit extending from grounded battery through the winding of relay 625, over bank contact 630 of the finder switch K, wiper 631, and thence to ground at the armature and front contact of relay 629. Upon each energization, relay 625 opens the bridge of the incoming end of the trunk circuit L, extending through the resistance 626, thereby causing the deenergization of line relay 622 of the selector switch H. Upon each deenergization a circuit is closed from grounded battery through the winding of vertical stepping magnet 632, winding of the slow-releasing relay 633, the left-hand armature and front contact of slow-releasing relay 628 which, because of its slow-releasing character, does not deenergize upon short openings of its circuit at the armature and front contact of relay 622, thence through the right-hand armature and back contact of relay 623 to ground at the back contact of line relay 622. In response to each deenergization of line relay 622, vertical magnet 632 steps the switch shaft of the selector switch H up one step. Slow-releasing relay 633, which energizes in series with stepping magnet 632, upon its initial energization close a circuit extending from grounded battery through its armature and front contact, and thence to ground through the winding of private relay 634. This circuit is maintained until the stepping impulses cease, and since on the first step off normal of the switch the off normal contacts ON were closed, the relay 634 is now maintained energized over a locking circuit extending from grounded battery through the right-hand armature and front contact of relay 628, the left-hand armature and back contact of the rotary magnet 635, contacts 636 of the off normal switch ON, the left-hand armature and front contact and winding of relay 634 to ground. The relay 634 is therefore maintained energized after the vertical movement of the selector switch shaft has been completed and the relay 633 has released its armature.

Upon the deenergization of slow-releasing relay 633 following the termination of the first group of impulses, a circuit for the rotary magnet 635 is closed extending from grounded battery through the right-hand armature and front contact of relay 628, the left-hand armature and back contact of rotary magnet 635, contact 636 of off normal switch ON, left-hand armature and front contact of relay 634, armature and back contact of relay 633, right-hand armature, back contact and winding of rotary magnet 635 to ground. Rotary magnet 635 energizes in this circuit and interrupts its own circuit at its armature contacts, thereby stepping the switch shaft one step in the rotary direction. Rotary magnet 635 also opens the holding circuit of the private relay 634 at its left-hand armature contacts, and private relay 634 deenergizes unless the test wiper 637 of the selector switch is at that time in engagement with the test terminal of a busy trunk extending to the desired office, in which event this test terminal will be connected to grounded battery. Thus, so long as the test wiper 637 engages the terminals of busy trunk lines, private relay 634 will be maintained energized and rotary magnet 635 will continue to step the wipers of the switch over the selected row of trunk terminals, until the terminals of an idle trunk line are found when relay 634 deenergizes, permanently opening the stepping circuit of the rotary magnet 635.

When the test wiper 637 stops on a contact associated with an idle trunk, which trunk

will be assumed to be the one shown in Fig. 6, and the private relay 634 releases, battery is connected through the right-hand armature and back contact of relay 634, through contact 636 of off normal switch ON, through resistance 638, to the test wiper 637 and the multiple contacts of the trunk, thus making that trunk busy and preventing other switches from obtaining access thereto. When the private relay 634 deenergizes, a circuit is also completed from battery through the right-hand armature and back contact of relay 634, contact 636 of off normal switch ON, left-hand armature and back contact of relay 634, and thence to ground through the winding of relay 623. Relay 623, energizing in this circuit, disconnects the windings of line relay 622 from conductors 624 and 627 of trunk circuit L, and connects the conductors of the trunk circuit through to the wipers 639 and 640 of the selector switch H.

The placing of battery potential upon the test wiper 637 causes the energization of relay 641 over the circuit previously traced to the wiper 637, and thence over the test contact 642, the back contact and armature of relay 643, and through the winding of relay 641 to ground. Relay 641, upon energizing, disconnects the windings of relay 643 from the conductors 644 and 645 of the trunk circuit extending to the terminating office Z, which has been selected by the selector H. The disconnection of the windings of relay 643 from the conductors of the trunk circuit permits the energization of line relay 700 and slow-releasing relay 701 at the terminating end of the trunk circuit over a circuit which may be traced from grounded battery, through the left-hand winding of relay 700, left-hand winding of relay 701, the left-hand armature and back contact of reversing relay 702, the left-hand armature and back contact of relay 703, the lower left-hand winding of repeating coil 704, trunk conductor 645, wiper 639 of selector switch H, the outer left-hand armature and front contact of relay 623, the armature and back contact of relay 625, the right-hand armature and front contact of relay 605, resistance 626, trunk conductor 627, the inner left-hand armature and front contact of relay 623, wiper 640, trunk conductor 644, the upper left-hand winding of repeating coil 704, the right-hand armature and back contact of relay 703, the right-hand armature and back contact of relay 702, the intermediate winding of slow-releasing relay 701, and thence to ground through the right-hand winding of line relay 700. Both relays 700 and 701 energize in this circuit, relay 701 closing a circuit for slow-releasing relay 705, extending from grounded battery through the winding of this relay, the outer left-hand armature and back contact of relay 706, and thence to ground at the armature and front contact of relay 701. Relay 705, operating in this circuit, closes a circuit for the starting relays of all call indicator finder switches which are associated with the group of trunks terminating at a position in the office Z, and which are at the time idle. Assuming that the finder switch M, shown in Fig. 8, associated with the indicator I which is common to the trunks of the position is the finder switch which at this time makes connection with the trunk circuit which has been taken for use, a circuit is established for the start relay 800 which may be traced from grounded battery through the winding of this relay, through the right-hand armature and front contact of relay 705, and thence to ground through the back contact and inner left-hand armature of relay 707. At its outer left-hand armature, relay 705 also connects ground potential to the upper test contact 801 of the bank of finder switch M.

Starting relay 800, upon energizing, closes a circuit for the motor magnet 802 of finder switch M, this circuit extending from grounded battery through the winding and armature contacts of this magnet, the outer right-hand armature and back contact of stop relay 803, and thence to ground through the armature and front contact of relay 800. Stepping magnet 802 causes the rotation of the wipers of switch M over the bank terminals associated therewith, until the test wiper 804 encounters the grounded test contact 801, when a circuit will be established from grounded battery through the winding of stop relay 803, the normally closed break contacts of the inner right-hand armature of this relay, thence over wiper 804 and contact 801 to ground at the inner left-hand armature and back contact of relay 707. Relay 803, upon energizing, closes a locking circuit for itself through its inner armature and make contact, and thence to ground at the armature and back contact of release magnet 805 of the stations register of indicator I. At its outer right-hand armature, relay 803, opens the circuit of motor magnet 802 to arrest the movement of the wipers of switch M, and at its intermediate armature and front contact connects ground from the back contact and armature of relay 805 through resistance 806, over switch wiper 807, contact 808, and thence through the windings of relays 708 and 707 to grounded battery. Relay 707 operates in this circuit but relay 708, being marginal in its action, does not operate at this time. Relay 707, upon energizing, opens the circuit extending through the start relay 800 and, at its outer left-hand armature and front contact, closes a circuit extending from grounded battery through the stepping relay 809 of the thousands register of the indicator,

through the left-hand armature and back contact of switching relay 810, over wiper 811, contact 812, the intermediate left-hand armature and front contact of relay 705, the outer left-hand armature and front contact of relay 707, and thence to ground at the armature and front contact of line relay 700. The operation of stepping relay 809 closes a circuit for the slow-releasing relay 813, extending from battery through the winding of this relay, and thence to ground through the armature and front contact of relay 809. The thousands register of the call indicator is now in condition to receive impulses for indicating the thousands digit of the desired number.

It having been assumed that the number of the desired line is 1920–J, the toll operator will proceed to dial the digits of this number. In response to the dialing of digit 1, the repeater 600 at the intermediate office Y will cause the bridge across trunk conductors 624 and 627 to be opened once, thereby causing a single deenergization of line relay 700 at the terminating office Z. Relay 701, being slow to release, does not release its armature during the short opening of the trunk circuit. Upon the deenergization of relay 700, in response to the single impulse, the circuit of stepping relay 809 of the thousands register is opened, thereby causing the transmission of a single stepping impulse, through the winding of slow release relay 814, and through the winding of stepping magnet 815. This circuit may be traced from grounded battery through the windings of magnet 815 and relay 814, the armature and front contact of slow-release relay 813, the right-hand armature and back contact of relay 810, and thence to ground through the armature and back contact of relay 809. In response to the single energization of magnet 815, the wiper 816 of the thousands register is moved into engagement with the first contact in the bank of contacts to which it has access. Relay 814, which energized in the series with stepping magnet 815, maintains its armature attracted during the transmission of stepping impulses through magnet 815, and, soon as the impulses cease, deenergizes, thereby closing a circuit for the switching relay 810, which circuit may be traced from grounded battery through the winding of relay 810, the armature and back contact of relay 814, off normal contacts 817, which were closed upon the first step of the thousands register off normal, and thence to ground through the left-hand armature and front contact of relay 813. The energization of relay 810 opens the circuit of stepping magnet 815 and, at its left-hand armature and back contact, opens the circuit extending from the winding of stepping relay 809 to the back contact of line relay 700 and transfers this control circuit through its left-hand armature and front contact, the left-hand armature and back contact of switching relay 818 to the winding of stepping relay 819 of the hundreds register. As soon as relay 809 deenergizes, following the disconnection of its winding from the control circuit, this relay closes a locking circuit for switching relay 810, which may be traced from the winding of relay 810, the armature and back contact of relay 814, off normal contacts 817, right-hand armature and front contact of relay 810, and thence to ground through the armature and back contact of relay 809. The circuits of the hundreds register are now in condition to receive impulses in accordance with dialing of the second digit of the desired number and in a manner similar to that described in connection with the thousands register, causes the positioning of wiper 820 of the hundreds register on the ninth contact of its bank. In response to the third, or tens, digit 2, the fourth, or units, digit O, and the fifth, or station's digit J, the wipers 821, 822, and 823 of the tens, units, and station's registers are in a similar manner selectively positioned with relation to their respective banks of contacts.

When the party designation of the desired number has been registered, switching relay 824 becomes energized in the manner described in connection with switching relay 810, and closes a circuit extending through the windings of relays 707 and 708, contact 808 through wiper 807, and thence through the outer left-hand armature and front contact of switching relay 824 to ground at the armature and back contact of magnet 805. Since this new circuit, through the windings of relays 707 and 708 leads directly to ground in shunt of resistance 806, marginal relay 708 now energizes closing a circuit for flashing the guard lamp 709, which circuit may be traced from grounded battery through this lamp, the inner left-hand armature and back contact of relay 706, resistance 710, the armature and front contact of relay 708, and thence to ground through the interrupter 711. The flashing of this lamp indicates to the terminating operator that a connection is to be completed over the trunk circuit with which this lamp is associated, and that the number of the desired subscriber has been registered on the call indicator.

As soon as the originating toll operator has finished dialing the number of the desired subscriber, she releases key 102, which disconnects the sending device 100 from the strands of cord circuit F and closes a talking circuit over the strands of the cord circuit between the line of the calling subscriber and the toll trunk L. Release of key 102 also opens key contacts 114 in the circuit,

previously traced, extending through marginal relay 209. Relay 209 thereupon deenergizes opening the circuit of relay 212, which, upon deenergizing, connects the starting conductor ST and the impulse controlling conductor 205 to ground, as previously described. In response to grounding of start conductor ST, the selector switch G is started to find the trunk line which is in use and the sending distributor S is started to send a code of impulses over the common signaling path P in exactly the same manner as described in connection with the original seizure of toll trunk L. At the intermediate office the code of impulses is received by the receiving distributor R′, and translated into a momentary impulse of negative current over conductor 500, individual to the incoming end of toll trunk L for causing the energization of relay 401. Since at this time relay 400 and slow relay 403 are already energized, relay 401, at its left-hand armature and front contact, closes a locking circuit for itself extending through its left-hand winding, and to ground at the armature, and front contact of slow relay 403. At its right-hand armature and back contact, relay 401 opens the circuit of slow-releasing relay 403, but relay 403, being slow to release, does not open the locking circuit of relay 401 until sufficient time has elapsed for a circuit to be extended from grounded battery through the winding of slow release relay 415, right-hand armature and front contact of relay 401, and thence to ground at the right-hand armature and front contact of relay 400. The operation of slow relay 415 closes a circuit for slow-release relay 416, which, in turn, closes a circuit for slow-release relay 417 and ringing relay 405. The purpose of employing slow relays 403, 415 and 416 is to prolong the interval during which ringing relay 405 is energized in order that ringing responsive apparatus, shown in Fig. 7 and later to be described, may operate properly.

The energization of relay 416 also closes a circuit extending from grounded battery through its right-hand armature and front contact, through the winding of relay 601, thence over conductor 603 to ground at the inner right-hand armature and front contact of relay 400. Relay 601, upon energizing, closes a locking circuit extending from grounded battery through its inner left-hand armature and front contact, through its winding, and thence to ground over conductor 603. At its intermediate and outer left-hand armatures, relay 601 disconnects the toll trunk line finder K and its associated repeater 600, and connects the toll trunk L over wipers 639 and 640 of selector switch H, to the switching trunk at the terminating office Z. Relay 601 also opens the circuit of relays 602 and 605, causing these relays to release. The release of relay 605 opens the bridge across conductors 624 and 627 of the trunk. Relays 601 and 602 also open the circuit of relay 609, which, in turn, opens the circuit of relay 611, releasing the toll line finder K rendering this finder free to be used in building up other connections.

The energization of relay 417 connects ground through its left-hand armature and front contact to the windings of signaling relays 406, 407, and 408 to prevent any signal from being sent back to the originating toll operator by the release of relay 402 during the time that the ringing relay 405 is energized. At the time the toll line finder K was disconnected from the toll trunk line L by the energization of relay 601, relay 402 is operated to close its right contacts by reversed current flowing over the conductors of trunk L and through the windings of relay 700. After an interval of time, during which time the slow release relay 406 releases, a circuit is closed through the winding of relay 410, which may be traced from grounded battery, through the winding of relay 412, the left-hand armatures and back contacts of relay 409, the winding of relay 410, the outer right-hand armature and back contact of relay 408, the right-hand armature and front contact of relay 419, the break contacts of relay 406, the right-hand contact and armature of relay 402, and thence to ground at the inner armature and front contact of relay 400. The operation of relay 412, as has already been described, starts the selector switch G′ and the sending distributor S′ for transmitting a code of impulses over the signaling path P. The energization of relay 410, through its left-hand armature and front contact, connects ground to the conductor 204′ for stopping the brushes of the selector switch G′ upon the second contacts of the banks to which they have access. The energization of relay 410 also opens the locking circuit, which has heretofore existed, from battery through the winding of relay 420, the armature and front contact of relay 420, the winding of relay 419, the inner right-hand armature and back contact of relay 410, and thence to ground at the inner armature and front contact of relay 400. As soon as the code of signals have been transmitted over conductor P, an impulse is received over the conductor 206′, as hereinbefore described, for energizing the relay 409, which relay opens the circuit of relay 410, leaving the circuits at the incoming end of the trunk line in condition for the transmission of other signals.

The receiving distributor R, which was started up in synchronism with the sending distributor S′, causes the locking up of relays 43 and 46 since the code of impulses

which was transmitted thereto comprises two positive, a negative, two positive and a negative impulse. Consequently with relays 43, 46, 51 and 52 energized, a positive impulse is transmitted from grounded battery, through the lower armature and front contact of relay 46, segment 27, outer set of brushes of brush-arm 10, segment 28, lower armature and back contact of relay 45, lower armature and back contact of relay 50, lower armature and front contact of relay 51, upper armature and back contact of relay 53, upper armature and back contact of relay 58, conductor 300, and thence to ground through the right-hand winding of relay 214. The current flowing through the right-hand winding of relay 214 now opposes the current flowing through the locking winding of relay 214, causing the deenergization of this relay and the disconnection of the shunt resistance 217 from the sleeve conductor of the trunk. Marginal relay 109 of cord circuit F thereupon deenergizes to extinguish the lamp signal 112 to give the toll operator a signal that the toll line finder K has been disconnected from the incoming end of the toll line L and that the toll trunk has been cut through to the terminating office.

Relay 405 which was energized upon the release of dialing key 102 connects a source of ringing current such as sixteen cycle ringing current, to the conductors of toll trunk L, for the purpose of energizing the ring-down relay 712 in the switching trunk at the terminating office Z. This circuit may be traced from the source of sixteen cycle ringing current 418, through the outer left-hand armature and front contact of relay 405, through the outer left-hand armature and front contact of relay 601, conductor 624, the outer left-hand armature and front contact of relay 623, brush 639, trunk conductor 645, the lower left-hand winding of repeating coil 704, the winding of ring-down relay 712, the upper left-hand winding of repeating coil 704, conductor 644, brush 640, the inner left-hand armature and front contact of relay 623, conductor 627, the intermediate left-hand armature and front contact of relay 601, and thence to ground through the inner left-hand armature and front contact of relay 405. In response to the flow of ringing current through the winding of relay 712, this relay energizes, closing a circuit extending from grounded battery through the left-hand winding of relay 713, and thence to ground at the armature and front contact of relay 712. A holding circuit is also closed through the slow-releasing relay 701 to maintain this relay energized during the ringing interval, or during the period in which ringing relay 405 maintains the direct current circuit through relay 701 open. Relay 713, upon energizing, closes a locking circuit for itself, extending from grounded battery through the armature and back contact of ringing cut-off relay 714, through the right-hand armature, front contact and right-hand winding of relay 713, and thence to ground at the armature and front contact of relay 701. At its left-hand armature and front contact, relay 713 prepares a circuit for ringing relay 715, which may be traced from grounded battery through the winding of this relay to the left-hand armature and front contact of relay 713.

The terminating operator, noting the flashing of guard lamp 709, depresses the indicator key 717, associated with the guard lamp, thereby closing a circuit extending from grounded contact of this key over bank contact 825, wiper 826, and through the wipers 816, 820, 821, 822 and 823 of the registers of the call indicator, and thence through the lamps connected to the bank contacts upon which these wipers are respectively resting, to grounded battery. Under the assumption that the several registers have been set to indicate 1920–J, the No. 1 thousands lamp, No. 9 hundreds lamp, No. 2 tens lamp, No. 0 units lamp, and the J stations lamp will be lighted. The operator, noting the number indicated, makes the busy test of the desired line in the usual way, and if the line is idle, inserts the calling plug 718 of the trunk circuit, with which the flashing guard lamp 709 is associated, in the jack 719 of the line indicated. This results in the energization of sleeve relay 716 over a circuit extending from grounded battery, through the winding of relay 716, sleeve of plug 718, sleeve of jack 719, and through the winding of cut-off relay 720 of the called line to ground. The energization of sleeve relay 716 completes the circuit previously traced, through the winding of ringing relay 715, which energizes, closing a circuit for applying ringing current to the called line. This circuit may be traced from the source of machine ringing current, through the winding of relay 714, the party ringing key, the lower armature and front contact of relay 715, over the ring contacts of plug 718 and jack 719, through the bell at the called subscriber's station, over the tip contacts of the jack and plug, through the right-hand armature and front contact of relay 706, which energized in parallel with ringing relay 715, and thence to ground through the upper armature and front contact of relay 715. Ringing tone is transmitted back to the calling subscriber through the condensers 721′ and 722.

When the terminating operator extended the call, and sleeve relay 716 energized, a circuit was also established in parallel with relays 706 and 715 for reversing relay 702 this circuit extending from grounded bat-

tery, through the winding of relay 702, the armature and back contact of relay 721, and to ground at the armature of relay 716. Relay 702 reverses the direction of current flow back over the trunk circuit and through the winding of polarized relay 402 which operates to close the left contacts. This latter relay energizes over the circuit, previously traced, through the winding of line relay 700 associated with the incoming end of the switching trunk, and upon energizing, causes the transmission of a code of signals over the common signaling path P in exactly the same manner as previously described in connection with the transmission of a code of signals for giving the operator an indication that the trunk was ready to receive dialing. This code of signals at the outgoing end of the toll trunk causes the operation of relay 109 to light the lamp 112 to give the operator a signal that connection has been established through to the switching trunk at the terminating office Z and that the called subscriber has not responded.

Relay 706, which was energized upon the energization of sleeve relay 716, opens the circuit previously traced, through the guard lamp 709, and at is left-hand armature and back contact opens the circuit previously traced through relay 705. Relay 705, upon deenergizing, closes a circuit through the release magnets of the registers of the call indicator, which circuit may be traced from grounded battery, through the windings of release magnets 805, 827, 828, 829 and 830 in parallel over wiper 831 of finder switch M, contact 832, the inner left-hand armature and back contact of relay 705, and thence to ground at the armature and front contact of sleeve relay 716. The energization of the release magnets of the registers causes the restoration of all of the registers to normal position the energization of release magnet 805 opening the locking circuit of relay 803 of the finder switch M, and removing ground potential from wiper 807 of the finder switch, permitting the release of relays 707 and 708. The call indicator circuits are now in condition for registering other numbers in response to other incoming calls.

In response to the application of ringing current to the line of the called subscriber, the called subscriber removes his receiver from the switchhook, thereby reducing the resistance at the substation to such an extent that ringing cut-off relay 714 energizes. This relay, upon energizing, opens the locking circuit of relay 713, which, upon deenergizing, opens the circuit of ringing relay 715. A circuit is now established from grounded battery, through the winding of relay 721, the lower right-hand winding of repeating coil 704, the lower armature and back contact of relay 715, the ring contacts of plug 718 and jack 719, over the subscriber's line loop, the tip contacts of jack 719 and plug 718, the right-hand armature and front contact of relay 706, the upper armature and back contact of relay 715, and thence to ground through the upper right-hand winding of repeating coil 704. Relay 721, upon energizing, opens the circuit of relay 702 to restore the normal direction of current flow over the trunk circuit.

The flow of current over the trunk circuit now causes polarized relay 402 to attract its armature towards its right-hand contact and causes the transmission of another code of signals over the common signaling path of the same character as transmitted at the time the toll trunk finder K was disassociated from the trunk line. This code of impulses causes the lamp 112 at the toll operator's position to be extinguished, giving the toll operator a signal that the called subscriber has responded.

When the call has been completed and the called subscriber has returned his receiver to the switchhook, thereby giving the toll operator a disconnect signal in the same manner as described for giving the toll operator a dialing signal, the toll operator, in response to the signal removes the plug 107 of the cord circuit F from the jack 108 of the toll trunk. The sleeve relay 208 is now released opening the locking circuit of relay 210, which, upon deenergizing, connects ground to the start lead ST for starting the selector G. Ground is also connected to the signal control conductor 204 from the outer left-hand armature of relay 211, over the outer right-hand armature and back contact of relay 210, and the selector switch G will therefore be arrested with its brushes positioned upon the second contacts of the levels to which they have access. The sending distributor therefore will transmit a code of impulses over the signal path P comprising two positive, a negative, two positive and a negative impulse. The above impulses are received by the receiving distributor R′, causing the energization of relays 43′, 46′, 51′, and 52′ in the same manner as previously described.

Just prior to the return of the brush-arm 10′ of the receiving distributor R′ to normal position, a circuit will be closed from positive grounded battery, through the lower armature and front contact of relay 46′, segment 27′, outer set of brushes on brush-arm 10′, segment 28′, lower armature and back contact of relay 45′, lower armature and back contact of relay 50′, lower armature and front contact of relay 51′, the upper armature and back contact of relay 53′, the upper armature and back

contact of relay 58′, conductor 500, and thence to ground, through the winding of relay 400. The current flowing over this circuit and through the left-hand winding of relay 400 is flowing in such a direction as to oppose the current flowing through the right-hand locking winding of this relay, and relay 400 will therefore be deenergized. Upon deenergizing, relay 400 opens the locking circuit of relay 601 at its inner right-hand armature and front contact, and at its inner right-hand armature and back contact, closes a circuit extending through contacts 646 of off-normal springs ON, and through the winding of release magnet 647 of the selector switch H. Release magnet 647, upon energizing, causes the restoration of selector switch H, in the well known manner. The toll trunk is now entirely released and available for use in establishing other connections.

Upon the deenergization of relay 601 and the release of selector switch H, the circuit through relays 700 and 701 of the toll switching trunk, at office Z is opened and these relays deenergize. Relay 701, upon deenergizing, closes a circuit extending from battery through guard lamp 709, the inner left-hand armature and front contact of relay 706, winding of relay 703, and thence to ground at the left-hand armature and back contact of relay 701. Relay 703, upon energizing, connects a direct bridge across the incoming end of the toll switching trunk for causing the energization of relay 643, which was bridged across the outgoing end of the toll switching trunk by the release of relay 641 when the selector switch H was restored to normal position. Relay 643 is energized at this time to connect battery to the test contact 642 to mark the toll switching trunk busy until after the terminating operator has withdrawn the terminal plug 718 from the jack of the called line.

Guard lamp 709 was lighted in the circuit extending from relay 703, and the operator, noting the illumination of this lamp, withdraws the plug 718 from jack 719 of the called line. Relays 716, 706, 703, and 643 now deenergize and the circuits of the toll switching trunk at the terminating office Z are now in normal condition.

If the called subscriber, before the release of the connection, flashes for a recall, relay 402 will operate to move its armature back and forth between its left-hand and right-hand contacts through the reversal of current through its windings by the action of relay 702. This action of relay 402 will result in the energization of relay 406 when the armature of relay 402 engages its left-hand contact, and in the energization of relay 413 when the armature of relay 402 engages its right-hand contact, and both relays will be held operated because they are slow releasing relays. Upon the attraction of the armature of relay 402 to its left-hand contact, relay 407 is operated, and relay 408 is operated in the manner previously described to cause the transmission of a code of signals over the common sending path P, which is exactly similar to those transmitted for giving the toll operator a dialing signal, and relay 408, upon deenergization, following the momentary operation of relay 409, and the transmission of the code of impulses, causes the energization of relay 419 in series with relay 420. Upon the movement of the armature of relay 402 against its right-hand contact, immediately following its attraction towards its left-hand contact, relay 407 releases, and since relay 413 is energized at this time, there will be no circuit for relay 410, and, therefore upon a second attraction of the armature of relay 402 against its left-hand contact, and the subsequent second operation of relay 408, a circuit is established from grounded battery, through the winding of relay 411, the break contacts of its inner left-hand armature, the left-hand armature and front contact of relay 419, and thence through the inner left-hand armature and front contact of relay 408 to ground. Relay 411, upon energizing, closes a locking circuit for itself, extending through its inner left-hand armature, the inner right-hand armature and back contact of relay 410 to ground at the armature contacts of relay 400. Relay 408 upon its second energization, causes a second signal to be transmitted over the common signaling path, of the same character as the first signal. At office X, Fig. 3, the first signal causes a negative impulse to be transmitted over lead 300, as previously described, to operate and lock up relay 214. The operation of relay 214 releases relay 215. The second signal mentioned above, causes a second negative impulse to be transmitted over lead 300, to operate and lock up relay 216. With relays 214 and 216 operated, resistance 217 is connected to an interrupted ground and thereby flashes the supervisory lamp 112, in the toll operator's cord circuit, F, Fig. 1.

Relay 407 upon a second energization locks over a circuit traced from grounded battery, winding, right-hand armature and make contacts of relay 407, left outer armature and front contact of relay 411, right armature and back contact of relay 410, front contact and right inner-armature of relay 400 to ground. At the left armature and back contact of relay 407, the circuit of relay 408 is opened, so that any further re-

versals of relay 402 do not continue to operate relay 408 and thereby send out signals similar to the above.

At this time relays 419, 420, and 407 are locked up under the control of relay 410. If the called subscriber stops flashing and keeps his receiver off the switchhook, relay 402 remains energized in such a manner as to keep its armature against its right-hand contact. This results in the energization of relay 410, as previously described, and the transmission of a signal over the common signaling path P for releasing both relays 214 and 216 as previously described in the case of the release of relay 214 for extinguishing the lamp 112 at the toll cord F to indicate that the called subscriber's receiver is off the switchhook. If the called subscriber stops flashing with the receiver on the hook, two signals will be sent back to the outgoing end. The first signal would discontinue the flashing supervisory lamp 112 in the toll operator's cord circuit F, Fig. 1. It would leave the supervisory lamp extinguished, which would indicate that the subscriber had not hung up his receiver. This signal would be established as follows: Relay 402 would be operated to close its left contact. Relay 406 would be held operated. Relay 408 cannot operate because relay 407 is operated through the make contact of relay 411. Relay 413 releases. Ground from relay 400 at its right inner-armature and front contact is connected through the back contact and right armature of relay 413, right armature and front contact of relay 411, front contact and right armature of relay 419, right outer armature and back contact of relay 408, winding of relay 410, back contacts and left armatures of relay 409, winding of relay 412 to grounded battery. The operation of relays 410 and 412 sends a code of signals to the originating operator, as previously described, and extinguishes lamp 112 in the cord circuit F, Fig. 1. The operation of relay 410 releases relays 407, 411, 419 and 420. When these relays release, ground through the left contact of relay 402 operates relays 406, 407 and 408 and thereby causes a code of signals to be transmitted to the originating operator, as previously described, to light lamp 112 in the cord circuit F, Fig. 1. This will indicate to the outward operator that the called subscriber's receiver is on the hook.

It the office selector switch H had been selectively positioned upon the terminals of a switching trunk leading to the office W, which is arranged for straight forward switching without the employment of a call indicator, a circuit would have been established for relay 900 as soon as the wipers 639 and 640 of selector switch H were positioned upon the terminals of the switching trunk conductors 901 and 902. This circuit may be traced from grounded battery, through the left-hand winding of relay 900, the left-hand armature and back contact of relay 903, the left-hand armature and back contact of relay 904, the lower left-hand winding of repeating coil 905, conductor 901, brush 639, the outer left-hand armature and front contact of relay 623, the armature and back contact of relay 625, the right-hand armature and front contact of relay 605, resistance 626, inner left-hand armature and front contact of relay 623, brush 640, conductor 902, the upper left-hand winding of repeating coil 905, the right-hand armature and back contact of relay 904, the right-hand armature and back contact of relay 905, and thence to ground, through the intermediate winding of relay 900. Relay 900, upon energizing, closes a circuit for relay 906, extending from grounded battery, through the winding of this relay, the outer left-hand armature and back contact of relay 907, and thence to ground, through the armature and front contact of relay 900. A circuit is also closed at this time from grounded battery, through the lamp 908, the inner left-hand armature and back contact of relay 907, through resistance 909, the outer right-hand armature and back contact of relay 910, and thence to ground at the armature and front contact of relay 900. The illumination of lamp 908 signals the terminating operator that a call is waiting to be connected to her telephone set. If several lamps are lighted at the same instant, and the cords with which these lighted lamps are associated have not yet been connected to subscribers' lines, it will indicate to the terminating operator that several calls are waiting to be connected to her telephone set.

Relay 906, upon energizing, closes a circuit for motor magnet 911 of the finder switch N, this circuit extending from grounded battery, through the winding and armature contacts of motor magnet 911, the lowermost armature and back contact of relay 912, and thence to ground at the inner right-hand armature and front contact of relay 906. Motor magnet 911 causes the step-by-step movement of the wipers of finder switch N in search of the terminals individual to the switching trunk, which has been taken for use. Relay 906, upon energizing, also connects a source of tone current to the conductors of the switching trunk for indicating to the originating operator at the distant end of the toll trunk that the switching operator's telephone has not yet been connected to the trunk circuit. This tone current is supplied over a circuit extending through the outer right-hand armatures of relay 906, and the left-hand and inner right-hand armatures of relay 910. As soon as

the brushes of finder switch N engage the contacts of the selected trunk circuit, a circuit is established for relay 912, extending from grounded battery, through the winding of this relay, over wiper 913, contact 914, the outer left-hand armature and back contact of relay 907, and thence to ground at the armature of relay 900. Relay 912, upon energizing, opens the circuit of stepping magnet 911, and at its upper-most armature and front contact closes a circuit extending through the left-hand winding of relay 910, over contact 915, brush 916, and thence to ground at this armature contact. Relay 910, upon energizing, disconnects the tone current from the trunk circuit and connects the operator's set O through the inner armatures and front contacts of relay 912, and the left-hand armature and front contact and inner right-hand armature and front contact of relay 910, to the conductors of the switching trunk. The discontinuance of the tone signifies to the originating operator that the switching operator's telephone set is connected to the trunk circuit and that she can proceed to pass the necessary information regarding the details of the desired connection. The operation of relay 910 also disconnects ground from the circuit of guard lamp 908, and connects the guard lamp in a circuit through the interrupter 917 for flashing the lamp. By means of this flashing lamp signal the switching operator is apprised of the trunk to which she is connected, and consequently the trunk which is to be employed in completing the connection.

The switching operator, upon receiving instructions from the originating operator, tests the jack 918 of the called line, which, it will be assumed, is the line B′, to ascertain if the line is free, and if the line is busy will receive a click, or pulse of battery, over a circuit extending from the tip of plug 921, through the right-hand armature and back contact of relay 907, over contact 919 and brush 920 of the finder switch N, and thence to ground through the testing winding of her set O.

Assuming that the line is free, the operator will insert the plug 921 in the jack of the line, thereby establishing a circuit from grounded battery, through the winding of sleeve relay 922, over the sleeve contacts of plug 921 and jack 918, and thence to ground through the cut-off relay 923 of the called line. Sleeve relay 922, upon energizing, closes a circuit for relays 907 and 903 in parallel, the circuit of relay 903 extending from grounded battery, through the winding of relay 903, the armature and back contact of relay 924, and thence to ground at the armature and front contact of sleeve relay 922. At this time the originating operator will have restored her dialing key 102 to its normal position, which has been used in this case only for dialing the desired office, thereby causing the transmission of a code of signals over the common signal path P to cause the application of ringing current from the source of ringing current 418, over the incoming end of the trunk circuit L and the conductors 901 and 902 of the switching trunk to cause a momentary energization of ring-down relay 925. This relay, upon energizing, closes a locking circuit extending through the right-hand winding of relay 900 to maintain this relay energized during the ringing period, while its circuit is opened at the armature contacts of ringing relay 405, and also closes a circuit through the left-hand winding of relay 926.

The energization of relay 907, at its right-hand armature contacts, closes the tip strand of the trunk circuit, at its inner left-hand armature contacts opens the flashing circuit of lamp 908, and at its outer left-hand armature contacts opens the circuit of relays 912 and 906 to disconnect the head set O from the trunk circuit and to disconnect ground from the stepping magnet 911, thus leaving the head set O free to be connected to any other trunk. Relay 903, which operated at the time sleeve relay 922 was energized, causes the reversal of current back over the switching trunk and through relay 402 at the intermediate office for the purpose of causing the lamp 112 at the originating office to light in the manner previously described it having been extinguished when the trunk was cut through to the terminating operator, to signify to her that the connection has been completed to the subscriber's line and that his receiver is on the hook.

Upon the energization of relay 926, this relay closes a locking circuit through its right-hand winding extending from grounded battery, through guard lamp 908, through the inner left-hand armature and front contact of relay 907, through the armature and back contact of ringing cut-off relay 927, the right-hand armature and front contact and right-hand winding of relay 926, and thence to ground at the left-hand armature and front contact of relay 900, and at its left-hand armature and front contact closes a circuit for ringing relay 928, extending from grounded battery through the winding of this relay, the left-hand armature and front contact of relay 926, and thence to ground at the armature and front contact of relay 922. The resistance of the right-hand winding of relay 926 is high to prevent the glowing of the guard lamp 908. Relay 928, upon energizing, connects a source of machine ringing current to the called subscriber's line over a circuit extending through the winding of relay 927, contacts of key 929, the upper armature and

front contact of ringing relay 928, the right-hand armature and front contact of relay 907, the tip contacts of plug 921 and jack 918, through the subscriber's bell, back through the ring contacts of jack 918 and plug 921, the lower armature and front contact of relay 928, and to ground at the contacts of key 929.

Upon the response of the called subscriber, the resistance at the substation is decreased to such an extent that relay 927 energizes, opening the locking circuit of relay 926, which thereupon deenergizes, opening the circuit of ringing relay 928. A circuit is now established through the winding of relay 924 and over the subscriber's line loop. Relay 924, upon energizing, opens the circuit of relay 903 which restores the direction of the current flowing over the trunk circuit through the windings of polarized relay 402 causing thereby the transmission of a code of impulses over the common signaling path P for causing the extinguishing of lamp 112 at the toll operator's position, signifying to the operator that the called subscriber has responded to the call.

Upon the termination of the conversation the release of the toll trunk and selector switch H take place in the manner previously described. Upon the release of selector switch H, the circuit existing through relay 900 at the terminating operator's position is opened and this relay deenergizes, closing at its armature and back contact a circuit which may be traced from grounded battery, through lamp 908, the inner left-hand armature and front contact of relay 907, the winding of relay 904, and to ground at the armature contact of relay 900. The lamp 908 is illuminated and signifies to the terminating operator that she may take down the connection. Relay 904 energizes in this circuit and at its armatures and front contacts connects a direct bridge across conductors 901 and 902 of the switching trunk, and causes the energization of relay 643 for holding the outgoing terminal of the switching trunk busy until the terminating operator has taken down the connection.

In response to the disconnect signal the terminating operator withdraws the plug 921 from jack 918, opening the circuit of relay 922, which, in turn, releases relays 907 and 903. The circuits at the terminating operator's position are now in normal condition and may be employed for establishing other connections.

If the originating toll operator had desired to establish a connection with a subscriber in a full mechanical office, the office selector switch H would have been set upon the terminals of a trunk line leading to such office, and the remaining digits dialed by the originating operator would have set the automatic switches in such mechanical office in the well-known manner. The transmission of supervisory signals from the mechanical office would control supervisory lamp 112 at the originating office in substantially the same manner as hereinbefore described in connection with connections in the offices Z and W. By employing a connector switch of any well known type, for example, as shown in Patent No. 1,308,740 to T. G. Martin, issued July 1, 1919, provided with means for repeatedly reversing current over the circuits incoming thereto upon testing a busy line, the supervisory lamp 112 at the originating operator's position may be flashed in the same manner as hereinbefore described in connection with the transmission of a flashing recall signal.

What is claimed is:

1. In a telephone system, in combination, an originating office, a distant office, a plurality of trunk lines and a signaling path common thereto extending between said offices, automatic switching mechanisms at said distant office in which said trunk lines terminate, means at said originating office for controlling said mechanisms over said trunk lines, means at one of said offices for transmitting over the signaling path code signals individual to the different trunk lines, a normally inactive switching device common to the trunk lines for determining the codes of the signals to be transmitted, and means controlled by a change in condition on any one of the trunk lines for rendering the switching device active.

2. In a telephone system, in combination, an originating office, a distant office, a plurality of trunk lines and a signaling path common thereto extending between said offices, automatic switching mechanisms at said distant office in which said trunk lines terminate, means at said originating office for controlling said mechanisms over said trunk lines, means at each of said offices for transmitting over the signaling path code signals individual to the different trunk lines, normally inactive switching devices at each office common to the trunk lines for determining the codes of the signals to be transmitted, and means controlled by a change in condition in any one of the trunk lines for rendering the switching devices active.

3. In a telephone system, in combination, an originating office, a distant office, a plurality of trunk lines and a signaling path common thereto extending between said offices, automatic switching mechanisms at said distant office in which said trunk lines terminate, an impulse repeater at said distant office common to said trunk lines, means for associating said repeater with any one of said trunk lines, impulse transmitting means at said originating office for transmitting

impulses over any one of said trunk lines through said repeater for controlling the switching mechanism in which said trunk line terminates, and means at said originating office for transmitting over the signaling path code signals individual to the different trunk lines for controlling the association of said repeater with a particular trunk line.

4. In a telephone system, in combination, an originating office, a distant office, a plurality of trunk lines and a signaling path common thereto extending between said offices, automatic switching mechanisms at said distant office in which said trunk lines terminate, an impulse repeater at said distant office common to said trunk lines and responsive to impulse of relatively high frequency for retransmitting direct current impulses of low frequency to said switching mechanisms, means for associating said repeater with any one of said trunk lines, impulse transmitting means at said originating office for transmitting impulses over any one of said trunk lines for controlling the switching mechanism in which said trunk line terminates, and means at said originating office for transmitting over the signaling path code signals individual to the different trunk lines for controlling the association of said repeater with a particular trunk line.

5. In a telephone system, in combination, an originating office, a distant office, a plurality of trunk lines and a signaling path common thereto extending between said offices, automatic switching mechanisms at said distant office in which said trunk lines terminate, an impulse repeater at said distant office common to said trunk lines and responsive to impulses of relatively high frequency for retransmitting direct current impulses of low frequency to said switching mechanisms, means for associating said repeater with any one of said trunk lines, impulse transmitting means at said originating office for transmitting impulses over any one of said trunk lines for controlling the switching mechanism in which said trunk line terminates, means at said originating office for transmitting over the signaling path code signals individual to the different trunk lines for controlling the association of said repeater with a particular trunk line, a normally inactive switching device common to the trunk lines for determining the codes of signals to be transmitted, and means controlled by a change in condition on any one of the trunk lines for rendering the switching device active.

6. In a telephone system, in combination, an originating office, an intermediate office, terminating offices, a plurality of trunk lines and a signaling path common thereto extending between said originating and intermediate offices, automatic selector switches at said intermediate office in which said trunk lines terminate for extending connection to any one of said terminating offices, an impulse repeater at said intermediate office common to said trunk lines, means for associating said repeater with any one of said trunk lines, impulse transmitting means at said originating office for transmitting impulses over any one of said trunk lines through said repeater for controlling the selector switch in which said trunk line terminates, and means at said originating office for transmitting over the signaling path code signals individual to the different trunk lines for controlling the association of said repeater with a particular trunk line.

7. In a telephone system, in combination, an originating office, an intermediate office, terminating offices, a plurality of trunk lines and a signaling path common thereto extending between said originating and intermediate offices, automatic selector switches at said intermediate offices in which said trunk lines terminate for extending connection to any one of said terminating offices, switching mechanisms at said terminating offices, an impulse repeater at said intermediate office common to said trunk lines, means for associating said repeater with any one of said trunk lines, impulse transmitting means at said originating office for transmitting impulses over any one of said trunk lines through said repeater for controlling the selector switch in which said trunk line terminates to select a desired terminating office and for controlling the switching mechanism in said terminating office, and means at said originating office for transmitting over the signaling path code signals individual to the different trunk lines for controlling the association of said repeater with a particular trunk line.

8. In a telephone system, in combination, an originating office, a distant office, a plurality of trunk lines extending between said offices, automatic switching mechanism at said distant office in which said trunk lines terminate, an impulse repeater at said distant office responsive to alternating current impulses of relatively high frequency for retransmitting direct current impulses of low frequency to said switching mechanisms, means for associating said repeater with any one of said trunk lines and impulse transmitting means at said originating offices for transmitting impulses over any one of said trunk lines for controlling the switching mechanism in which said trunk line terminates.

9. In a telephone system, in combination, an originating office, a distant office, a plurality of trunk lines and a signaling path

common thereto extending between said offices, automatic switching mechanisms at said distant office in which said trunk lines terminate, an impulse repeater at said distant office common to said trunk lines, means for associating said repeater with any one of said trunk lines, impulse transmitting means at said originating office for transmitting impulses over any one of said trunk lines through said repeater for controlling the switching mechanism in which said trunk line terminates, means at said distant office for transmitting over the signaling path code signals individual to the different trunk lines, a normally inactive switching device at said distant office common to the trunk lines for determining the codes of the signals to be transmitted, means responsive to the association of said impulse repeater with one of said trunk lines for rendering said switching device active, and means at said originating office responsive to said code of impulses for producing a dialing signal.

10. In a telephone system, in combination, an originating office, a distant office, a plurality of trunk lines and a signaling path common thereto extending between said offices, automatic switching mechanisms at said distant office in which said trunk lines terminate, an impulse repeater at said distant office common to said trunk lines, means for associating said repeater with any one of said trunk lines, impulse transmitting means at said originating office for transmitting impulses over any one of said trunk lines through said repeater for controlling the switching mechanism in which said trunk line terminates, means at said distant office for transmitting over the signaling path code signals individual to the different trunk lines, a normally inactive switching device at said distant office common to the trunk lines for determining the codes of the signals to be transmitted, means responsive to the association of said impulse repeater with one of said trunk lines for rendering said switching device active, and a supervisory lamp at said originating office responsive to said code of impulses for producing a dialing signal.

11. In a telephone system, in combination, an originating office, an intermediate office, a terminating office, a plurality of trunk lines and a signaling path common thereto extending between said originating and intermediate office, automatic switching mechanisms at said intermediate office for extending connections to said terminating office, means at said intermediate office for transmitting ringing current to said terminating office, a cord circuit at said originating office for connection with any one of said trunk lines, a key associated with said cord circuit, means at said originating office for transmitting over the signaling path code signals individual to the different trunk lines, a normally inactive switching device common to the trunk lines for determining the codes of signals to be transmitted, means controlled by said key for rendering the switching device active, and means at said intermediate office responsive to said code of impulses for controlling said ringing current transmission means.

12. In a telephone system, in combination, an originating office, an intermediate office, a terminating office, a plurality of trunk lines and a signaling path common thereto extending between said originating and intermediate office, automatic switching mechanism at said intermediate office in which said trunk lines terminate for extending connection to said terminating office, means at said intermediate office for transmitting ringing current to said terminating office, a cord circuit at said originating office for connection with any one of said trunk line, an impulse sending device associated with said cord circuit for transmitting impulses over said trunk lines for controlling said switching mechanisms, a key for associating said impulse device with said cord circuit, means at said originating office for transmitting over the signaling path code signals individual to the different trunk lines, a normally inactive switching device common to the trunk lines for determining the codes of signals to be transmitted, means controlled by the release of said key for rendering the switching device active, and means at said intermediate office responsive to said code of impulses for controlling said ringing current transmission means.

13. In a telephone system, in combination, an originating office, a distant office, called subscriber's lines, a plurality of trunk lines and a signaling path common thereto extending between said originating and distant office, automatic switching mechanisms at said distant office in which said trunk lines terminate for extending connections to said called lines, a cord circuit at said originating office for connection with any one of said trunk lines, a supervisory signal associated with said cord circuit, means at said distant office for transmitting over the signaling path code signals individual to the different trunk lines, a normally inactive switching device common to the trunk lines for determining the codes of signals to be transmitted, means responsive to the extension of a connection to a called line for rendering said switching device active, and means responsive to said code signals to operate said supervisory signal.

14. In a telephone system, in combination,

an originating office, a distant office, called subscribers' lines, a plurality of trunk lines and a signaling path common thereto extending between said originating and distant offices, automatic switching mechanisms at said distant office in which said trunk lines terminate for extending connections to said called lines, a cord circuit at said originating office for connection with any one of said trunk lines, a supervisory signal associated with said cord circuit, means at said distant office for transmitting over the signaling path code signals individual to the different trunk lines, a normally inactive switching device common to the trunk lines for determining the codes of signals to be transmitted responsive to the response of a called subscriber for rendering said switching device active, and means responsive to said code of signals to operate said supervisory signal.

15. In a telephone system, in combination, an originating office, a distant office, called subscribers' lines, a plurality of trunk lines and a signaling path common thereto extending between said originating and distant offices, automatic switching mechanisms at said distant office in which said trunk lines terminate for extending connections to said called lines, a cord circuit at said originating office for connection with any one of said trunk lines, a supervisory signal associated with said cord circuit, means at said distant office for transmitting over the signaling path code signals individual to the different trunk lines, a normally inactive switching device common to the trunk lines for determining the codes of signals to be transmitted, means responsive to the intermittent opening and closing of a called subscriber's line for rendering said switching device active, and means responsive to said code of signals to flash said supervisory signal.

16. In a telephone system, in combination, an originating office, a distant office, called subscribers' lines, a plurality of trunk lines and a signaling path common thereto extending between said originating and distant offices, automatic switching mechanism at said distant office in which said trunk lines terminate for extending connections to said called lines, a cord circuit at said originating office for connection with any one of said trunk lines, a supervisory signal associated with said cord circuit, means at said distant office for transmitting over the signaling path two codes of signals individual to each of the different trunk lines, a normally inactive switching device common to the trunk lines for determining the codes of signals to be transmitted, means responsive to the intermittent opening and closing of a called subscriber's line for rendering said switching device active, and means responsive to said codes of signals to flash said supervisory signal.

17. In a telephone system, in combination, an originating office, a distant office, a plurality of trunk lines and a signaling path common thereto extending between said offices, automatic switching mechanisms at said distant office in which said trunk lines terminate, means at said originating office for transmitting impulses over any one of said trunk lines for controlling the switching mechanism in which said trunk line terminates, and means at said originating office for transmitting over the signaling path codes of signals individual to the different trunk lines for controlling the release of said switching mechanisms.

18. In a telephone system, in combination, an originating office, a distant office, a plurality of trunk lines and a signaling path common thereto extending between said offices, automatic switching mechanisms at said distant office in which said trunk lines terminate, a cord circuit at said originating office for connection with any one of said trunk lines, an impulse transmitting mechanism associated with said cord circuit for transmitting impulses over said trunk lines for controlling said switching mechanisms, means at said originating office for transmitting over the signaling path codes of signals individual to the different trunk lines, a normally inactive switching device common to the trunk lines for determining the codes of signals to be transmitted, means controlled by the disconnection of said cord circuit from a trunk line for rendering the switching device active, and means at said distant office responsive to said code of impulses for controlling the release of said switching mechanisms.

19. In a switching system, a transmission circuit extending between two stations, a signaling path independent of said transmission circuit extending between said stations, an automatic switching mechanism, means responsive to a change in the condition of said transmission circuit to transmit a code combination over said signaling path, means responsive to the received code combination to associate said automatic switching mechanism with said transmission circuit, means at one station for sending impulses over a portion of said transmission circuit, and means associated with said automatic switching mechanism responsive to said impulses for sending repeated impulses to the other station over a second portion of said transmission circuit for the control of said automatic switching mechanism.

20. In a switching system, a plurality of transmission circuits extending between two stations, a signaling path common to and in-

dependent of said transmission circuits extending between said stations, an automatic switch, means associated with each of said transmission circuits at one of said stations for originating impulses, an intermittently operating distributor for transmitting impulses originating with any of said transmission circuits over said signaling path to associate said automatic switch with the selected trunk, means for sending impulses over a portion of said selected trunk and means associated with said automatic switch responsive to said impulses for sending repeated impulses over a second portion of said trunk for controlling the automatic switch.

21. In a telephone system, an originating office, a distant office, a plurality of trunk lines extending between said offices, a signaling path common thereto and independent thereof extending between said offices, automatic switching mechanism at said distant office, means at the originating office for transmitting over the signaling path code impulses individual to the different trunk lines for controlling said automatic switching mechanism, means at said originating office for sending impulses over a portion of one of said trunk lines and means associated with said automatic switching mechanism responsive to said impulses for sending repeated impulses to the distant office over a second portion of one of said trunk lines for further control of said automatic switching mechanism.

22. In a telephone system, an originating office, a distant office, a pair of trunk lines extending between said offices, a signaling path common thereto and independent thereof extending between said offices, automatic switching mechanism at said distant office, an intermittently operating device at the originating office for transmitting over the signaling path code impulses individual to the different trunk lines for controlling said automatic switching mechanism, means at said originating office for sending impulses over a portion of said trunk lines and means associated with said automatic switching mechanism responsive to said impulses for sending repeated impulses over a second portion of said trunk lines for further control of said automatic switching mechanism.

23. A plurality of transmission lines, a path common thereto, an automatic switch, a source of direct current impulses, means to transmit impulses from said source over said path for associating said automatic switch with one of said transmission lines, a source of alternating current impulses, means to transmit impulses from the latter mentioned source over a portion of said transmission line and means associated with said automatic switch responsive to said alternating current impulses for sending direct current impulses over a second portion of said transmission line to control said automatic switch.

24. In a switching system, two circuits, a switching device, a source of direct current, means for transmitting impulses from said source over one of said circuits to associate said switching device with the other of said circuits, a source of alternating current, means for transmitting impulses from said alternating current source over a portion of said latter mentioned circuit and means associated with said switching device responsive to said alternating current impulses for sending direct current impulses over a second portion of said last mentioned circuit to control said switching device.

25. In a switching system, two circuits, a switching device, a source of direct current, means for transmitting impulses from said source over one of said circuits to associate said switching device with the other of said circuits, a source of alternating current, means for transmitting impulses of current from said alternating current source over said latter mentioned circuit, means for translating said impulses of alternating currents into impulses of direct current to control said switching device and an automatic switching device for associating said last mentioned means with the last mentioned circuit controlled by said direct current impulse transmitting means.

26. In a switching system, a circuit, a source of impulses therefor, a switching device for said circuit normally unresponsive to impulses from said source, a second circuit, means controlled over said second circuit to render said switching device responsive to impulses from said source and means for associating said controlled means with said switching device.

27. In a switching system, two circuits, a source of impulses for each of said circuits, a switching device normally unresponsive to impulses from one of said sources over the associated circuit, means responsive to impulses from the other of said sources transmitted over the other of said circuits to render said switching device responsive to impulses from the first mentioned of said sources and means for associating said impulse controlled means with said switching device.

28. The method which consists of transmitting a code of direct current impulses over a circuit to associate a device with another circuit, transmitting impulses of alternating current over said latter mentioned circuit, and translating the alternating current impulses into a movement of the device.

29. The method which consists of transmitting a code of direct current impulses over a circuit to associate a switching device with another circuit, transmitting impulses of alternating current over the latter mentioned circuit, translating said impulses of alternating current into impulses of direct current, transmitting said translated impulses of direct current to said switching device, and translating said translated impulses of direct current into movements of said switching device.

In testimony whereof, I have signed my name to this specfication this 7th day of August 1920.

JOHN DAVIDSON, JR.