S. H. BROWNE.

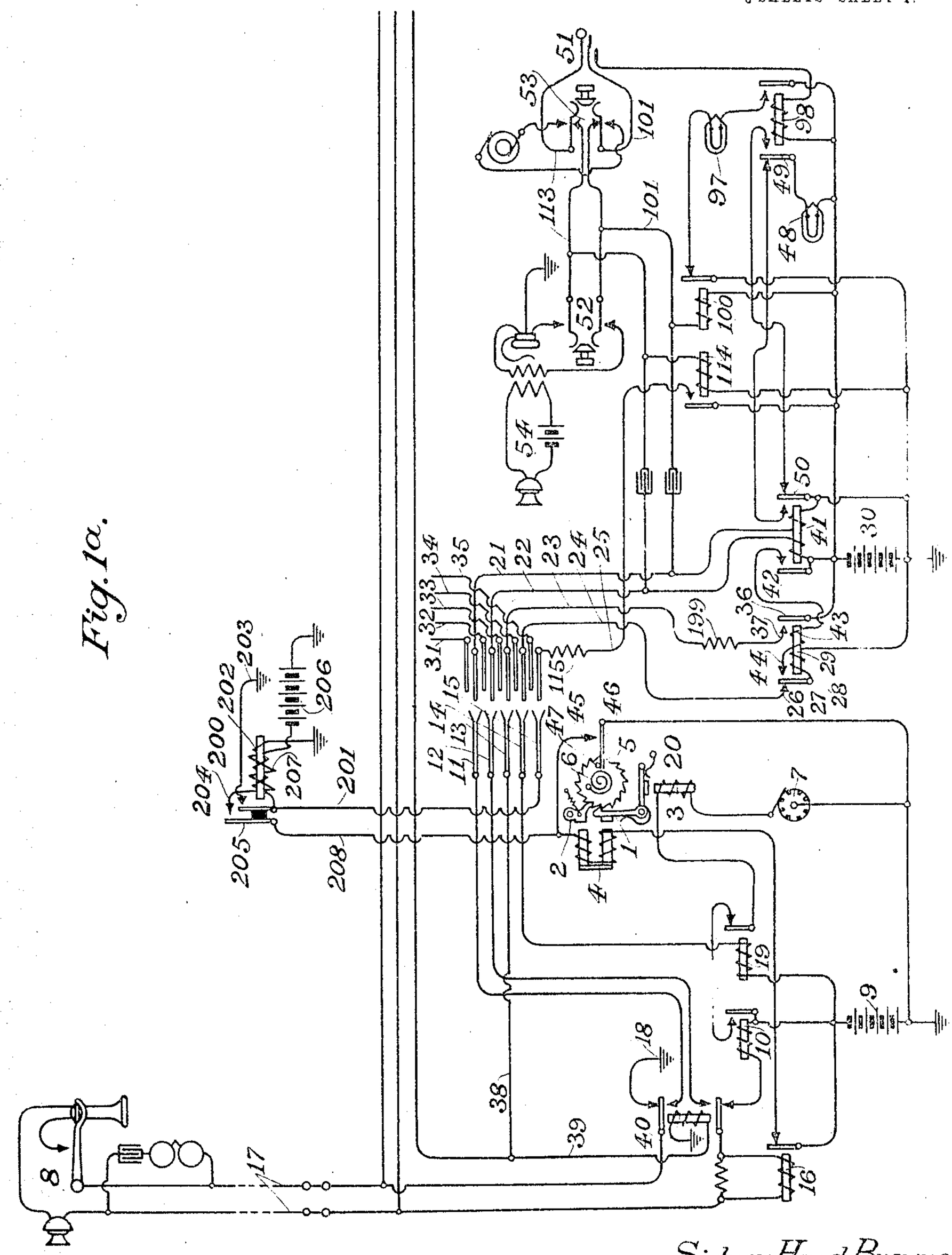
SYSTEM FOR TELEPHONE TRUNKING.

APPLICATION FILED APR. 3, 1905.

920,258.

Patented May 4, 1909.

5 SHEETS--SHEET 1.



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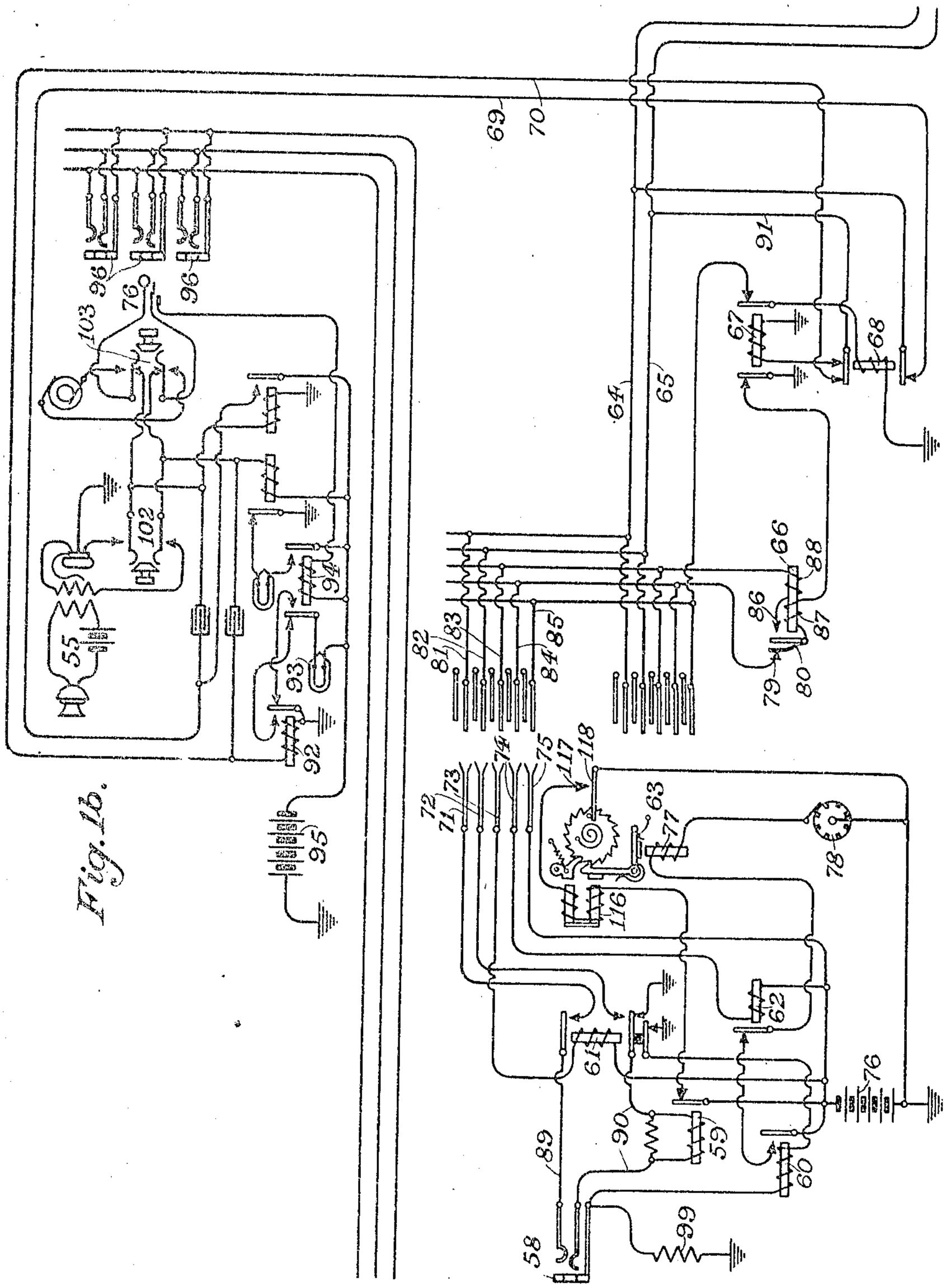

Fig. 1b.

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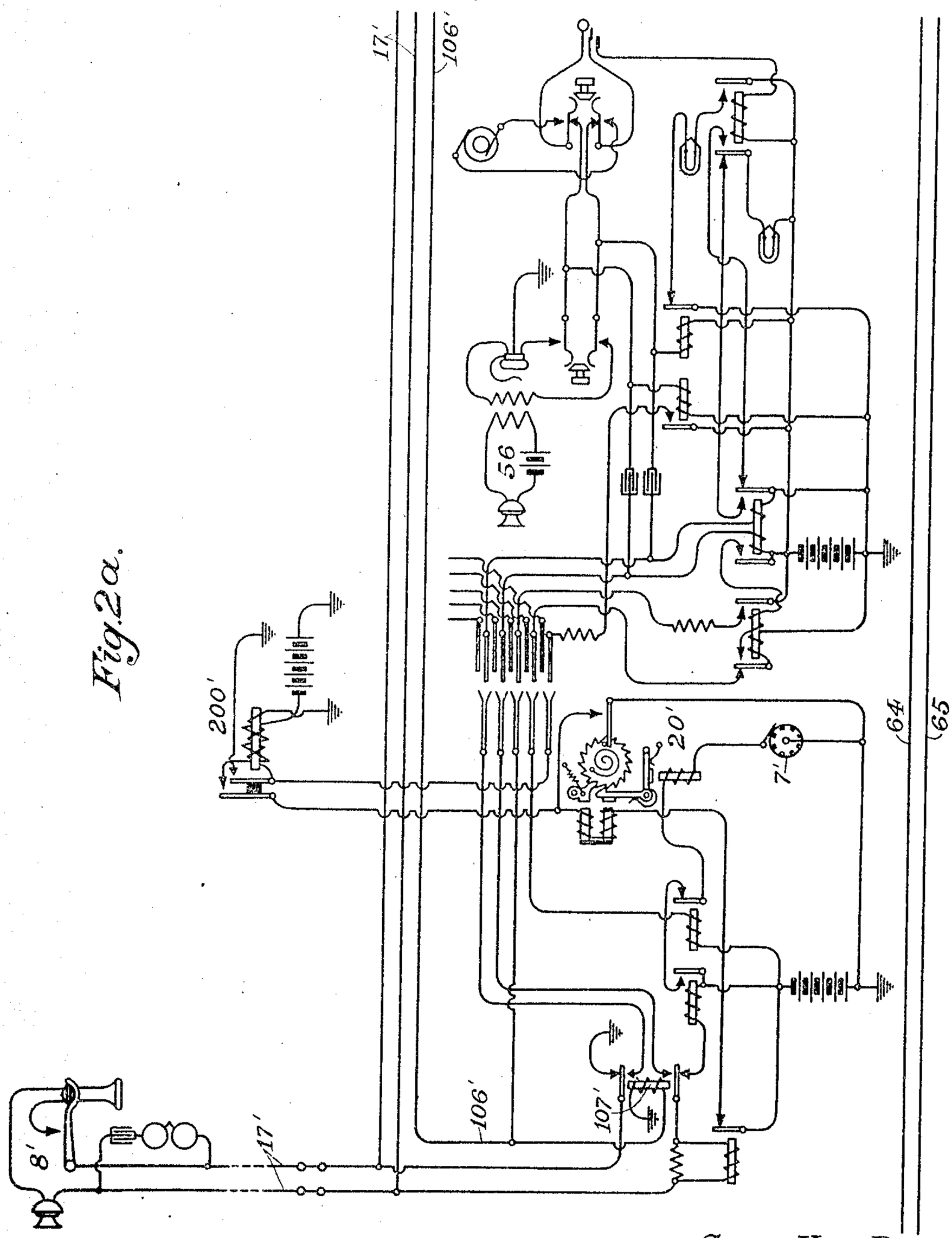
5 SHEETS—SHEET 3.

Fig. 2a.



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5 SHEETS—SHEET 4.

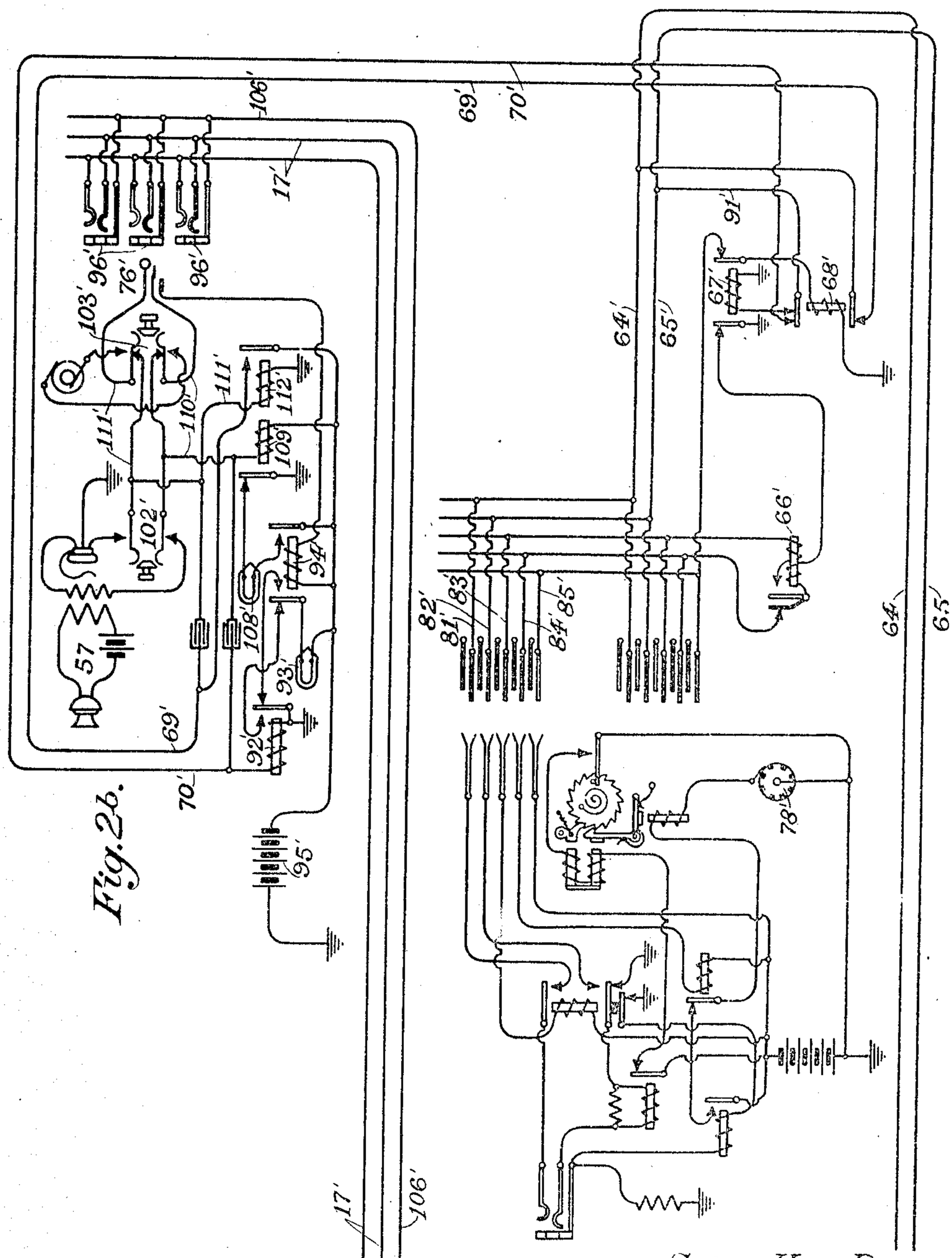

Fig. 2b.

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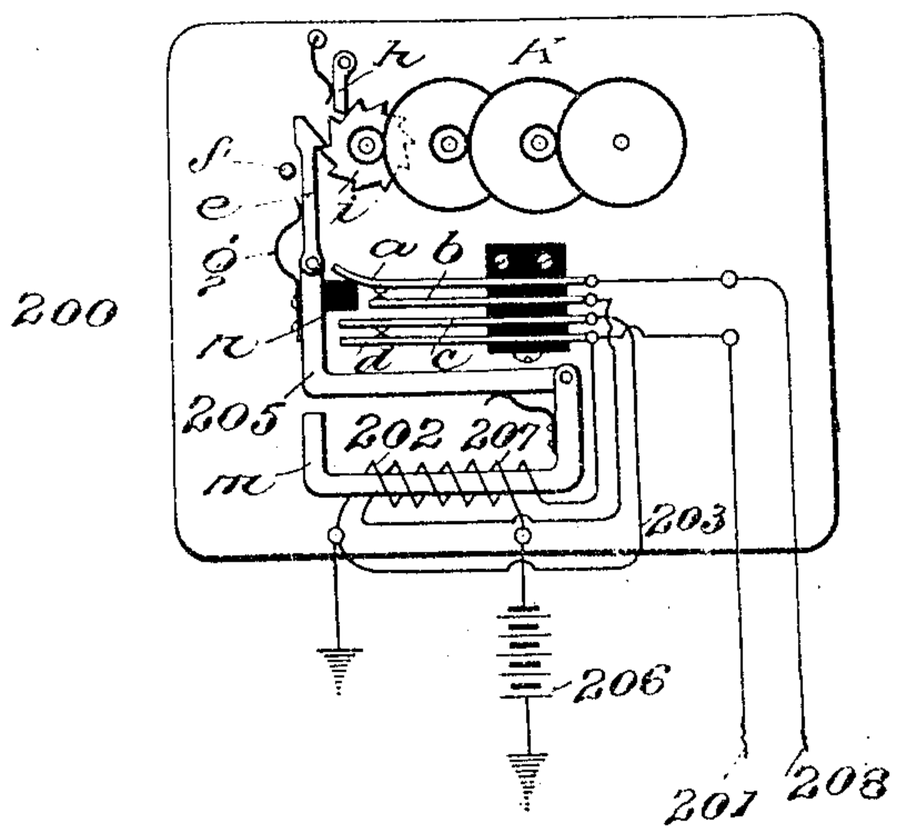
5 SHEETS—SHEET 5.

Fig. 3.



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SYSTEM FOR TELEPHONE-TRUNKING.

No. 920,258. Specification of Letters Patent. Patented May 4, 1909.

Application filed April 3, 1905. Serial No. 253,544.

To all whom it may concern:

Be it known that I, SIDNEY HAND BROWNE a citizen of the United States of America, and resident of Pittsburg, county of Allegheny, and State of Pennsylvania, have invented a new and useful Improvement in Systems for Telephone-Trunking, of which the following is a specification.

My invention pertains to telephone exchanges involving the completion of telephonic connections between substation telephones whose lines terminate in separate central offices, the central offices being connected by trunk circuits over which the connections are completed.

My object is to provide equipment by which the required acts on the part of the operator first receiving a call are reduced to a minimum in number and simplicity, and also by which the likelihood of error is much reduced as compared with present common practice.

In present common practice, when a call is received from a patron in the execution of whose order it is necessary to connect with a line terminating in a central office distant from that in which the call is received, one of two general plans is followed: First, the operator taking the order may communicate with a distant operator, in the distant central office, giving the number of the line with which connection is required, and the operator in the distant office will then select a trunk and connect it with the line required, giving to the first operator as reply to her order the designating number of the trunk used, that the first operator may connect the calling patron with that trunk; this involves the selection of a trunk by the operator in the distant central office. Second, the operator answering the call and taking the patron's order may test trunks reaching the distant central office and when an idle trunk is found may connect the calling patron with it and ring the distant exchange; the operator in the distant central office then in response to that ring will answer the calling patron and will connect him with the desired telephone line; this involves the selection of a trunk by the operator first receiving the call.

My invention in its system and in the apparatus herein described, provides for the proper and expeditious prosecution of the subscriber's order without any selection of trunks on the part of any operator, such trunk selection being taken out of the required manual operations and being made wholly automatic.

My invention provides that the operator first answering a call, learning that the call is for a substation telephone served by a line terminating in a distant central office, may connect the calling line with an idle trunk of that group without any preliminary manual method of testing, and thereby will transfer the call immediately to the central office in which the line desired by the calling patron terminates. In my description, I shall show equipment which provides that calls received at an exchange are received directly upon plugs instead of being received upon jacks requiring the insertion of a plug before the operator can place herself in communication with the calling patron; which provides that the operator first answering a call, learning that the call is for a distant office, may take any vacant jack reaching that office and thereby transfer the call immediately to that office; and which provides further that the call thus switched forward will terminate upon a plug before an operator within reach of the desired line. I accomplish these results and reduce the equipment involved to a minimum by the use of automatic switches and of trunks automatically selected.

In the drawings: Figures 1[a] and 1[b] show one central office in an exchange equipped according to my invention, Figs. 2[a] and 2[b] show another central office in the same exchange also equipped according to my invention. In each office is shown equipment for receiving a call from the distant office, as well as for receiving a call from a patron and for forwarding it to the distant office; and Fig. 3 is a diagrammatic view, illustrating more in detail a suitable connection-registering meter.

In Fig. 1[a] there is illustrated equipment by which a call originating at a substation telephone, as 8, may be terminated upon a connecting plug, as 51, in the hand of an operator advised of the requirements of the patron at the substation telephone and provided with connecting jacks, as 58 in Fig. 1[b], adapted to receive the connecting plug 51 to complete or to forward the call originated by the patron at substation telephone 8. A telephone line is shown at 17, connecting at one end with a substation telephone, 8, and at the other end with the central office line

equipment shown below at the left of Fig. 1[a], and in part in Fig. 1[b]. The central office line equipment consists of a call receiving equipment, comprising a group of multiple jacks, as 96, accessible to connecting plugs, as 76, Fig. 1[b], for the completion of calls originating on other lines and requiring connecting with the line shown, and a call forwarding equipment, for forwarding to a central office operator a call originating at the connected substation telephone, 8. The call forwarding equipment consists of an automatic switch designated as a whole 20, and associated relays 10, 16, 19, 40, the interrupter 7 and battery 9, said interrupter and battery being common to many lines. An electromagnetically operated call register, or service meter, is indicated at 200, its magnet core and associated electric circuits being shown. In this register, the attraction of the armature shall add one to the number previously registered by the dials of the device, the return of the armature being accomplished without mechanical effect upon the counting train, as is common in simple electric counting devices.

The automatic switch 20 may be of any desired or preferred type of electromagnetically controlled circuit selector. It is well known in the art of telephony, to construct a switch having a plurality of contacts arranged to project inwardly from a cylindrical surface, said surface being either a complete section of a cylinder, or merely a segment of a cylinder, and to arrange, supported by an axis at the center of the cylindrical surface, movable electrical terminals adapted to make contact successively with the fixed points when the supporting axis is rotated; a familiar example is the Strowger automatic switch. In such a switch the essential elements consist of a cylindrical surface, electrical contact points fixed in said cylindrical surface, a rotatable shaft occupying the position of the axis of the cylinder, terminals attached to said shaft occupying the position of radii of the cylinder and adapted to connect with the fixed contacts in the cylindrical surface, a ratchet wheel attached to said shaft, a retractile spring attached to said shaft or ratchet wheel, holding the part against a stop or in its position of rest, a holding pawl engaging the teeth of said ratchet wheel, means for withdrawing said holding pawl from the teeth of said ratchet wheel, a driving pawl adapted to engage the teeth of said ratchet wheel when actuated, actuating means associated with said driving pawl adapted to cause said driving pawl to drive said ratchet wheel and its attached shaft and radial electrical terminals at each actuation through an angular distance equivalent to the angular distance between contact points in said cylindrical surface. In such switches the usual practice provides for a plurality of radial contacts and provides for fixed contacts arranged in groups or sets, so arranged and located that the radial contacts make connection respectively with the individual fixed contacts of a given group when the shaft is at a given position, and as the shaft moves, the radial terminals move from set to set of the fixed contacts and effect electrical connection with the respective contacts of each set as progress is made from set to set.

In Fig. 1[a], I have shown two sets of fixed contact points connected with conductors 21, 22, 23, 24, 25, and conductors 31, 32, 33, 34, 35; a set of radial terminals is shown at 11, 12, 13, 14, 15; the ratchet wheel is shown at 5; the retractile spring is shown at 6; the holding pawl 2 is shown as the armature to the upper core of magnet 4; means for withdrawing said holding pawl is shown in magnet 4; the driving pawl 1 is shown pivotally attached to the armature of magnet 3, and means for actuating said driving pawl is shown in magnet 3 and its associated circuit and battery 9. It is common also in such switches to include an operating part holding an electric circuit open by the separation of a pair of electrical contacts during the period of time when the rotatable shaft remains in its position of rest, and to permit such contact pair to make connection when the shaft makes its first step away from its position of rest. Such an electrical contact pair is called an off-normal switch and is shown at 45—46 in Fig. 1[a].

The mechanism involved in the switch designated as a whole 20 in Fig. 1[a] (or switch 63 in Fig. 1[b], which is similar to switch 20) therefore is one of a general type well known in the art and one which readily may be constructed and used without further description here. The circuits by which the actuating means for the driving pawl 1 is controlled and by which the releasing means is controlled are disclosed in the paragraphs of this specification following. The circuits shown in Fig. 1[a] are in accordance with the invention of my application, Serial No. 222,645, filed August 29th, 1904.

In Figs. 1[b] and 2[b] is shown a double-track trunk for forwarding telephone calls from one central office (such as shown in Figs. 1[a], 1[b]) to another central office (such as shown in Figs. 2[a], 2[b]), the trunk being connected by circuit conductors 64, 65 across the bottom of Fig. 2[a]. The complete double-track trunk consists of the connecting circuit conductors 64, 65 provided at each end with a call receiving equipment consisting at one end (see Fig. 1[b]) of a plurality of sets of waiting contacts, as 81, 82, 83, 84, 85 and the relay 66, a switching and signaling equipment, as the plug 76, and associated elements shown adjacent to that plug, and an interference equipment comprising the relays 67 and 68.

The object of the interference equipments is to operate, when the trunk is taken at one of its call receiving equipments, to isolate the trunk from the switching and signaling equipment in the office in which the trunk is taken for use and to isolate the trunk from the call receiving equipment in the distant office, leaving the switching and signaling equipment operative in the said distant central office. The similar call-receiving equipment at the other end of the trunk consists (see Fig. 2[b]) of sets of waiting contacts, as 81′, 82′, 83′, 84′, 85′, relay 66′, plug 76′, and associated elements adjacent to the plug, and interference equipment comprising relays 67′ and 68′.

To enable the operator in charge of the connecting plug 51, Fig. 1[a], to connect with the trunk 64, 65, her switchboard position is provided with a plurality of trunk jacks, as 58, each of which has an automatic switch, as 63, containing the above mentioned plurality of sets of waiting contact points, as 81, 82, 83, 84, 85, pertaining to a plurality of trunks, and a set of movable terminals, 71, 72, 73, 74, 75 and controlling parts or relays 59, 60, 61, 62, and resistance 99. Thus equipment is provided to enable the operator to insert the connecting plug 51 into any vacant jack 58, thereby causing the automatic action of the switch 63 to select a trunk, connect the jack 58 with it, and to actuate the interference mechanisms 67, 68, and 67′, 68′ to isolate from the trunk the plug 76 at the one end and the fixed waiting contact points 81′, 82′, 83′, 84′, 85′ at the other end.

Equipment is provided in central office, 2[a], 2[b] similar in all respects to that provided for central office 1[a], 1[b], so that all of the operations herein described as originating in central office 1[a], 1[b] may be equally well accomplished when originating in central office 2[a], 2[b], the connection over the trunk being made in reverse order. To the parts and elements shown at the central office of Figs. 2[a] and 2[b], I have applied the same reference numerals, with the addition of prime marks, as are applied to corresponding parts shown at the central office at Figs. 1[a] and 1[b].

The progress of a call throughout the system shown in the four sheets of drawings is as follows: When the receiver at substation telephone 8 is taken from the hook, the automatic switch 20 immediately selects the first idle trunk leading to a telephone operator, and thus lights a signal lamp, as 48, associated with a plug, as 51, before such operator; said operator then takes the subscriber's order, and learning that the line required terminates in a distant central office, as that shown in Figs. 2[a] 2[b], immediately connects the said plug, without any process of test, with any vacant jack designated as belonging to that central office, as the jack 58, whereupon the automatic switch 63 immediately connects said jack, and therefore the calling subscriber, with the first idle trunk, as 64, 65, leading to the selected distant central office, and in so doing renders said selected trunk impossible of use by any other automatic switch at either of its ends and also lights a signal lamp, as 93′ before a telephone operator in the distant central office; the telephone operator thus secondarily selected then takes the order of the calling patron directly from substation telephone 8 by means of her key 102 and telephone set 55′, and connects the trunk plug 76′ with the line of the telephone, as 8′, called for, one of whose multiple jacks, as 96′, necessarily is located within reach of the said trunk operator by reason of the primary selection exercised by the operator who first answered the call; the called station is rung by the second operator, by operation of her ringing key 103′, and upon the answering of the called station, the service meter as 200, connected with the calling line, is operated to record the successful connection. In disconnection, the calling line controls a signal before the first operator, and the first operator controls a signal before the second operator, before whom is also a signal controlled by the called line.

In the application of my invention as shown in the accompanying drawings, I have used automatic switches each adapted to select automatically the first idle trunk circuit, of a series of such circuits connected with the switch, whenever the one controlling telephone line or trunk circuit, which the switch serves, becomes active. One of these automatic switches appears in each of the four sheets of drawings, and the parts and functions common to all of these switches (designated as a whole, 20 in Fig. 1[a], 63 in Fig. 1[b], 20′ in Fig. 2[a], and 63′ in Fig. 2[b]) in the several drawings are as follows, referring to Fig. 1[a]: The switch consists of a fixed frame bearing magnets, pawls, springs, etc., and also sustaining a rotary part adapted to be controlled by a driving pawl 1, and a holding pawl 2, said driving pawl being controlled by magnet 3 and both of said pawls being controlled by magnet 4 to release the rotary part of the switch. The rotary part of the switch consists of a shaft 220 to which is attached the ratchet wheel 5, one end of the volute spring 6, and the five wipers 11, 12, 13, 14, 15; these wipers are moving electrical contacts permanently connected to the conductors pertaining to the one line or trunk which that automatic switch serves, and adapted to make temporary electrical connection with circuit terminals pertaining to trunks with which it is desired to connect the line or trunk served. The fixed portion of the switch supports a plurality of sets of waiting contacts, of which one set is shown connected to conductors 21, 22, 23, 24, 25.

and another set is shown connected to conductors 31, 32, 33, 34, 35. The driving pawl 1 under influence of magnet 3, is adapted to move the rotary part of the switch, one step at a time; normally, the wipers are not in connection with any of the sets of waiting contacts, but upon the first energization of magnet 3, the rotary part of the switch moves one step and the wipers are brought into connection with the first set of waiting contacts, viz., those connected to conductors 21, 22, 23, 24, 25; at the next energization of magnet 3, the second step of the rotary part of the switch brings the wipers into contact with the second set of waiting contacts, viz., those connected with conductors 31, 32, 33, 34, 35, which are provided with a complete trunk equipment identical with that shown associated with conductors 21, 22, 23, 24, 25, and so on for the entire complement of sets of waiting contacts, which in practice probably would be twenty-five to fifty sets, representing as many trunks. The progress of the rotary part, step by step, is secured by the interrupter 7 in the circuit of magnet 3, such interrupter being a continuously operating device, separate from the automatic switches. The starting and stopping of the rotary part is accomplished by relays and circuits associated with the trunks and lines.

The operation of the circuits and electrical mechanism shown in Fig. 1ª, in response to a call initiated by subscriber at telephone 8, is as follows:—The removal of the receiver from the hook at substation telephone 8 permits current to flow from battery 9 through relays 10 and 16, and line 17 to ground at 18, thus energizing relay 16 to open its contact and energizing relay 10 to close its contact, thus permitting current from battery 9 to flow through contact of relay 10, contact of relay 19, winding of magnet 3 and interrupter 7 back to battery; the energization of magnet 3 now advances the rotary part of the switch designated as a whole 20, making electrical contact between wipers 11, 12, 13, 14, 15 and waiting contacts 21, 22, 23, 24, 25 respectively; current from battery 9 flows through relay 19, wiper 14, waiting contact and conductor 24, armature contact 26, armature 27, winding 28 of relay 29 and to ground at battery 30 thereby energizing both relays 19 and 29. The energization of relay 19 attracts its armature, thereby interrupting the previously traced circuit through magnet 3 and stopping the switch with its wipers in engagement with contacts 21, 22, 23, 24, 25. Said energization of relay 29 permits current to flow from battery 30 through armature 36, armature contact 37, resistance coil 199, conductor and waiting contact 23, wiper 13, conductors 38 and 39 through winding of relay 40 to ground, energizing relay 40 and causing it by the actuation of its armature to open the circuit of the winding of relay 10 and to transfer the conductors of the line 17 to wipers 11 and 12, thus providing path for current from battery 30 through relay 41, elements 22, 12, 17, 8, 17, 11, 21 and relay 41 back to battery 30, energizing relay 41 and giving path for current from one pole of battery 30 through armature 42, winding 43 of relay 29, armature contact 44, armature 27, winding 28 and to other pole of battery 30, completing the energization of relay 29 and breaking the connection between armature and contact 27—26. If the first trunk encountered by the wipers had been already in use, the relay 29 of that trunk would have been energized, and the armature contact 27—26 would have been open, thus giving no path for current through relay 19, so that the path for current from battery 9 through magnet 3, continued through the armature of relay 19, would have been interrupted at the interrupter 7, releasing armature of magnet 3, again closed at interrupter 7, energizing magnet 3 the second time, stepping the wipers forward into connection with the second set of waiting contacts, where if relay 29 had been already energized the process would have been repeated, and so on until a set of contacts was found in which the relay 29 was not energized, thus giving path for current through relay 19 and so effecting the connection of the line 17 with that trunk and the stopping of the automatic switch in that position until conditions were proper for disconnection. Electrical contact 45 and electrical contact spring 46 have a tendency to close together when not restrained, but a projection 47 on ratchet 5 holds 46 away from 45 so long as the ratchet 5 is in its position of rest; however, at the first step of the ratchet 5, the projection 47 is moved to permit the contact pair 45—46 to close; upon the hanging up of the receiver at the substation telephone 8, the circuit is broken and current ceases to flow through relay 16, thus permitting its armature contact to close and to give path for current from battery 9 through armature contact of relay 16, magnet 4, contact pair 45—46 back to battery 9, thus energizing magnet 4 until by return of the rotary part of the switch to normal the contact between 45 and 46 is opened, thus releasing magnet 4. Thus it is seen that as soon as the receiver is removed from the hook at substation telephone 8, automatic switch 20 becomes active, selects the first idle trunk, connects the calling line with that trunk, and by the energization of relay 41 gives current from one pole of battery 30 through lamp 48, armatures 49 and 50 to the other pole of said battery, causing lamp 48, in the switchboard near plug 51, to glow as a signal to the attendant telephone operator that a calling line has been connected to plug 51.

The operator whose equipment is shown

at 54 in Fig. 1[a] may be termed a subscriber's operator, because she serves calls originating for her office upon subscriber's lines, while the operator whose equipment is shown at 55 in Fig. 1[b] may be called a trunk operator because she serves calls originating for her office upon trunks incoming from the exchange office shown in Figs. 2[a]—2[b]. In similar terminology, the operator at 54′ in Fig. 2[a] is a subscriber's operator and the operator at 55′ in Fig. 2[b] is a trunk operator. Each subscriber's operator has before her a plurality of jacks as 58, Fig. 1[b], each of which is equipped independently with associated relays as 59, 60, 61, 62 and with an automatic switch as 63, having a set of wipers 71, 72, 73, 74, 75, and a plurality of sets of waiting contacts, as 81, 82, 83, 84, 85.

Between the offices of Figs. 1[a]—1[b] and Figs. 2[a]—2[b] are provided a plurality of trunk circuits, each consisting of two conductors, as 64 and 65. The trunk conductors 64—65 have associated with them the plurality of waiting contacts 81, 82, 83, 84, 85 in multiple in a plurality of said switches as 63 before the subscribers' operators of the office; each trunk has also a relay as 66 and a pair of relays as 67, 68, whence the trunk is extended by conductors 69, 70 to a plug 76 acting as a terminal of the trunk before an operator at 55. Trunk conductors 64, 65 are equipped at their distant end, in the office shown in Figs. 2[a]—2[b], with similar apparatus.

The purpose of the relay 66 is to open the circuit between the conductor leading to contact 84 and ground in manner similar to the action of relay 29 (Fig. 1[a]) and for the same purpose, viz., to place busy test conditions upon the waiting contacts connected with that conductor. The purpose of the relay 67 is similar, viz., to place busy test conditions upon the waiting contacts in the office of Figs. 1[a]—1[b] when the trunk has been taken for use from office of Figs. 2[a]—2[b]; the purpose of relay 68 is to remove the connection of extension conductors 69—70 from the trunk when the trunk has been taken for use from the office of Figs. 1[a]—1[b]. The two relays, 67 and 68, are so related that by the operation of one the other is rendered inoperative.

The object of the pair of relays, 67, 68 is to permit intercommunication over the trunk, either from office of Figs. 1[a]—1[b] to office of Figs. 2[a]—2[b] or in the reverse direction from office of Figs. 2[a]—2[b] to office of Figs. 1[a]—1[b], thus making it a two-way trunk. Although in this description I shall describe a two-way trunk, my invention embraces also a one-way trunk having waiting contacts in one office and a plug end in the other, with the relays 67 and 68 and associated connections omitted.

The operation of the circuits and electrical devices shown in Fig. 1[b] is as follows: By the insertion of a plug, as 51, in jack 58, current, from grounded battery 30, Fig. 1[a], flows, from the body of said plug through winding of relay 60 and contact of relay 61 to ground, and current from the same source also flows from the ring of said plug 51 through winding of relay 59 and contact of relay 61 to ground; the energization of relay 60 gives path for current from battery 76 through contact of relay 60, contact of relay 62, magnet 77 and interrupter 78 back to battery, thus operating the rotary part of the automatic switch 63; by the action of the interrupter 78 the said rotary part progresses step by step until a trunk is found in which neither relay 66 nor 67 is energized, at which time current will flow from grounded battery 76, wiper 75, contact 85, contact of relay 67 and winding of relay 68 to ground, energizing relay 68 and disconnecting from the trunk the extension 69, 70; also current from battery 76 will flow through winding of relay 62, wiper 74, contact 84, contact 79, armature 80, winding 87 of relay 66 and contact of relay 67 to ground, energizing relay 62 which attracts its armature stopping the action of the automatic switch. Relay 66 is also energized by this circuit and attracting its armature 80, closes contact 80—86 and gives path for current from grounded battery 76 through winding of relay 61, wiper 73, contact 83, winding 88 of relay 66, contact 86, armature 80, winding 87 of relay 66, and contact of relay 67 to ground; this energization of relay 66 also opens armature contact 79—80. The energization of relay 61, by the circuit above traced therethrough, opens the circuit of current through winding of relay 60, releasing the armature of that relay; the opening of contact 79—80 interrupts the circuit through winding of relay 62, releasing the armature of that relay; the energization of relay 61 connects conductor 89 to wiper 71 already in electrical connection with contact 81 and consequently with trunk conductor 64, and also connects conductor 90 with wiper 72 already in electrical connection with contact 82 and therefore with trunk conductor 65, and current previously flowing through relay 59 and the contacts of relay 61 to ground, now flows through relay 59, conductor 90, armature of relay 61 and its front contact, wiper 72, waiting contact 82, and trunk conductor 65 to the distant office (see now Fig. 2[b]) and over conductor 91′ to armature of relay 68′ where the current divides, one portion passing through the winding of relay 67′ to ground and the other portion passing over extension conductor 70′ and through winding of relay 92′ to ground. The energization of relay 67′ opens the circuit between conductor 84′ and ground, thus giving busy test conditions to all automatic switches in central office of Figs. 2[a]—2[b]; the energization of relay 92′ gives path for current from battery 95′ through lamp 93′ con-

tacts of relay 94′ and contacts of relay 92′ to ground; lamp 93′ is located in the switchboard near plug 76′, and by the glowing of lamp 93′ the telephone operator using the equipment at 57 is notified that a calling line is connected with plug 76′, and she therefore completes the connection by taking the patron's order by means of her telephone set 55′ and key 102′ and selecting and connecting with the proper jack, in a manner similar to that of the operator using equipment at 54, who first received the call.

I have described the operation of portions of the apparatus in showing how a call is received from a subscriber, first in the central office of Figs. 1^a—2^b, and then from a trunk, in the central office of Figs. 2^a—2^b. I shall describe now the progress of a complete connection, originating at substation telephone 8 on a line terminating in central office of Figs. 1^a—1^b, progressing over trunk 64—65 and terminating in substation telephone 8′ on a line terminating in central office of Figs. 2^a—2^b, together with the consequent actuation of the service meter connected with the line of the originating substation telephone. In this part of the description, those parts which have been described in detail previously will be passed briefly here, while those parts will be given in detail which have not been so given before.

A patron at substation telephone 8 desires to call substation telephone 8′ and takes his receiver from the hook; immediately automatic switch 20 selects its first idle trunk, establishes busy test conditions upon the multiple jacks of the calling line, and lights a signal lamp associated with a trunk plug before a subscriber's operator, as signal lamp 48 associated with trunk plug 51 before operator using equipment 54; operator at 54 by means of key 52 communicates with the patron, takes his order for connection with substation 8′, recognizes from the directory number that substation 8′ is to be reached by office of Figs. 2^a—2^b, and inserts the trunk plug 51 into any jack connecting with that central office, as jack 58; ringing key 53 is not used in such a connection, nor is signal lamp 97 used, those elements being provided for use in such calls as would require connection with a called line also terminating in office of Figs. 1^a—1^b, there being no necessity in such calls to use a trunk to another office of the exchange. By the insertion of plug 51 into jack 58, path is given for current from grounded battery 30 through relay 98 to body conductor of jack 58 whence it flows to ground through resistance 99 and also through relay 60 and contacts of relay 61 to ground. Path is given also for current from grounded battery 30 through relay 100, conductors 101 and 90, the latter containing the winding of relay 59, and through the contacts of relay 61 to ground. An armature of relay 98 closes circuit for lamp 97, but the armature of relay 100 simultaneously opens said lamp circuit, thus preventing the lamp from glowing; also armature 49 of relay 98 opens the circuit of signal lamp 48, extinguishing that lamp and leaving no signal before operator at 54, indicating that her work is temporarily completed.

The insertion of plug 51 into jack 58 causes automatic switch 63 to select its first idle trunk as 64, 65 to the central office of Figs. 2^a—2^b, establishes for said trunk busy test conditions at all accessible points, and by the energization of relay 92′ causes the glowing of a signal lamp associated with a trunk plug located before a telephone operator in the distant office, as signal lamp 93′ associated with trunk plug 76′ before operator using equipment 55′. The operator at 55′ by means of key 102′ communicates directly with the calling patron, takes his order for connection with substation 8′, tests a multiple jack as 96′ of the line serving substation 8′ and finding that the line is not busy inserts plug 76′ in jack 96′ and actuates the signal bell of substation telephone 8′ by means of the ringing key 103′.

The insertion of plug 76′ into jack 96′ gives path for current from battery 95′ through relay 94′ to the body conductor of jack 96 and thence over conductor 106′ and through the winding of relay 107′ to ground, energizing relays 94′ and 107′, the latter of which isolates line 17′ from the equipment associated with automatic switch 20′. Relay 94′, thus energized, opens the circuit of lamp 93′ and extinguishes that signal, but also closes by contacts of another armature a circuit by which current flows from grounded battery 95′ through the contacts of relay 94′, lamp 108′ and contact of relay 109′ to ground, thus illuminating lamp 108′ as a signal to the operator at 55′ that the receiver at substation telephone 8′ has not been taken from the hook. By means of key 103′ the patron at substation telephone 8′ is called, and as stated above, when he answers the call and removes his telephone from the hook he closes the circuit through his hook switch and gives path for current from battery 95′ through relay 109′, conductor 110′, plug 76′, jack 96′, line 17′, substation telephone 8′, line 17′, jack 96′, plug 76′, conductor 111′ and relay 112′ to ground, thus energizing relays 109′ and 112′. By energization of relay 109′, circuit through lamp 108′ is interrupted and that lamp is extinguished, leaving all signals before the operator at 57 dark, and indicating to her that the party rung has answered the call, and that she has no further immediate duties in connection with the call.

By the energization of relay 112′, path is given for current from battery 95′ through contacts of relay 112′ to conductor 69′, through contacts of relay 68′ to conductor

64 contact 81, wiper 71, contact of relay 61, conductor 89, jack 58, plug 51, conductor 113 and relay 114 to ground at battery 30. By energization of relay 114 path is furnished for current from battery 30 through contacts of relay 114, conductor 25, resistance 115, wiper 15, conductor 201 and winding 202 to ground, energizing the core of service meter 200 and actuating its armatures and the counting train connected therewith but not shown in Fig. 1. By the actuation of the armatures of service meter 200, ground at 203 is connected directly to wiper 15 and resistance 115, so that these parts now have no potential tending to produce current flowing to earth in any meters of any lines which may be brought into electrical connection with any accessible multiple contacts by reason of other automatic switches testing the trunk and passing it as busy. In the progress of the motion of the armatures of service meter 200, and prior to the making of the contact with ground at 203, contact is made between parts 204 and 205, giving path for current from grounded battery 206 through meter winding 207, contact 204, armature 205, conductor 208, contact point 45, contact spring 46 and to ground at battery 9, thus continuing the energization of the core of meter 200 after current has ceased to flow through winding 202 because of the shunt placed upon that winding by the connection of ground 203.

Explained in connection with Fig. 3, the operation of the meter is as follows:—The current to the meter by conductor 201 passes through winding 202 to ground, as above explained. This energizes core *m* and the latter attracts its armature 205, actuating pawl *e*, ratchet *i*, and counting train K, the pawl *e* being always maintained in proper operative position by a spring *g* and stop pin *f*. Retaining pawl *h* holds the ratchet *i* and counting train K in their advanced positions. In the movement of the armature 205, a projection *n* thereon of insulating material is first drawn away from a spring contact *a* permitting the latter to move into engagement with a spring contact *b*, thereby closing the circuit from grounded battery 206, through meter winding 207, contacts *b* and *a*, conductor 208, etc., heretofore explained in connection with Fig. 1[a]. In the further movement of the armature 205, the projection *n* presses spring contact *c* into engagement with spring contact *d*, thereby connecting conductor 201 to ground through contacts *d* and *c* and conductor 203.

For the purpose of supervision and disconnection, the lamp 108′ glows when the receiver at substation 8′ is hung upon the hook; this, however, cannot be taken as a disconnect signal by the operator at 55′ since to disconnect upon this signal would at times lead her to disconnect a trunk upon which the called substation had not responded to the ring; therefore the operator at 55′ must disconnect only upon signal of lamp 93′.

When the patron at substation telephone 8 hangs his telephone upon the hook and opens the circuit through that substation telephone, he interrupts the current flowing through relays 41 and 16. The interruption of current flowing through relay 16 releases its armature, closing its armature contact and giving path for current from battery 9, through armature contact of relay 16, winding of magnet 4, contacts 45 and 46 back to battery 9, thus by the energization of magnet 4 releasing the rotary part of the automatic switch 20 and permitting its return to normal; upon the return to normal of the rotary part of automatic switch 20, the projection 47 engages the contact spring 46 and presses it away from contact 45, opening the circuit just described and releasing magnet 4; also by the opening of the contact between parts 45 and 46, the circuit from grounded battery 206 through 207, 204, 205, 208, has been opened, and the meter 200 therefore is released also. The disengagement of wiper 13 from its waiting contact releases relay 40, and all parts associated with the line 17 return to their normal position of rest.

By the interruption of current therethrough, as above stated, relay 41 releases its armatures; release of armature 42 interrupts current through relay 29, which releases its armatures; release of armature 50 gives path for current from battery 30, through signal lamp 48, armature 49 of energized relay 98 and armature 50 of released relay 41 back to battery 30; the glowing of this lamp acts as a positive signal for disconnection for operator at 54, who then removes the plug 51 from the jack 58, releasing all relays associated with that plug. In connection with jack 58, by the removal of plug 51, current ceases to flow through relay 59 and this relay releases its armature and so closes its armature contacts. Thus a path is given for current from battery 76 through armature contacts of relay 59, winding of release magnet 116, contact pair 117—118 back to battery 76, thus releasing the rotary part of the automatic switch 63; by the return of switch 63 to normal, with the incident opening of contact pair 117—118 and disconnection of the wipers 71, 72, 73, 74, 75 all relays and magnets in connection with automatic switch 63 are released and the source of current is disconnected from relays 66. 68, 67′ and 92′. By the release of relays 66, 68, 67′, busy test conditions are removed from the trunk, and by the release of relay 92′ path is given for current from grounded battery 95′, through signal lamp 93′, contacts of energized relay 94′, contacts of released relay 92′ and to ground, causing lamp 93′ to glow as a

disconnect signal to the operator at 57, who then removes the plug 76′ from jack 96′, which releases all relays, including the relay 107′ of the line 17′.

A condition encountered in the testing action of the automatic switches requires mention, as it effects the limitations of design of the apparatus required. Assume in Fig. 1ª that the trunk connected with waiting contacts of conductors 21, 22, 23, 24, 25, is busy, and that the automatic switch 20 attempts to connect with that trunk. The waiting contact of conductor 23 is connected to the conductor 38, and relay 40 of the line holding the trunk busy, and thence to ground; when the automatic switch 20 steps its wipers into connection with the waiting contacts of this trunk, conductor 23, through its waiting contact in switch 20 is connected also to conductor 38, and through relay 40 of the testing line, and to ground. Thus a circuit exists from battery 30, through armature 36, contact point 37, resistance 199, and conductor 23, thence dividing, one part passing over conductor 38 and winding of relay 40 of the line holding the trunk busy, and the other part passing over conductor 38 and winding of relay 40 of the line testing the trunk. With this condition existing the relay 40 of the line holding the trunk busy, which relay was energized and attracted its armatures at the time the trunk was taken by the line, and has held its armatures continuously since then, must not now release its armatures; relay 40 of the line testing the trunk for busy must not attract its armatures. By making resistance 199 comparatively high with respect to the resistance of the relay 40, all relays 40 being of equal resistance, the desired result is attained.

Before the trunk was tested and while it was being held busy by the first mentioned line, a circuit existed including battery 30, armature 36, point 37, resistance 199, conductor 23, its waiting contact, wiper 13 of the first line, conductor 38 of the first line, conductor 39 of the first line, and winding of relay 40 of the first line, over which circuit current was flowing. By the shunting of relay 40 of the second or testing line, around the winding of relay 40 of the first line, the total resistance of the circuit above described in detail was reduced by one-half the amount of the resistance of one of the relays 40; this caused an increase of the total current flowing in the circuit, the ratio of increase being controlled by the ratio which the resistance of the relay 40 bears to the total resistance of the circuit, or to the resistance 199. If now, the resistance of the relay 40 be small as compared with the resistance 199, the increase in current produced by the shunting of the two relays, will be small. By the shunting of the two equal relays, the relays divide equally between themselves the total current flowing through resistance 199, and as that current is but slightly increased over what it was before the second relay was shunted around the first, the current received by such relay is but little more than one-half the current which would be received by the relay 40 of the testing line, if the tested trunk were not busy, and which was received by the relay 40 of the first line before the second line tested the trunk for busy. The relays 40 may be adjusted not to respond to the energization produced by that proportion of normal current received when testing a busy line; by reason of the armature being much nearer to the core of the relay after the attraction of the armature, the armature will be retained by that degree of energization which was insufficient to attract it in the first place. With the resistance of the relay 40 equal to one-fourth of the resistance 199, and assuming the conductors external to those elements to be of negligible resistance, the current received by each relay when the two are shunted together, solves to be about 55% of the current received by one relay when the other is not shunted around it. The margin of operation of the relay 40 of the testing line therefore is liberal. With reference to the reduction of current to 55% of normal for the retention of the armatures of the relay 40 of the tested line, it is found that relays as commonly constructed in present telephone practice require a much greater reduction than this. Specially constructed relays, therefore, are not required for this circuit, the limitation being that proper relation be established between the resistance of the winding of the relay 40 and the resistance of 199 to avoid the necessity of close adjustment of relay 40.

In Fig. 1ᵇ a relation of relays of testing and tested circuits is encountered similar to the one just described as to Fig. 1ª. The relay here involved is numbered 61 and the series resistance involved is made up of the windings 87 and 88 of the relay numbered 66. In this portion of the circuit it is required that the resistance of the winding of relay 61 be not more than one-quarter of the resistance of the windings 87 and 88, or of those windings plus an external resistance in series with them; in neglect of this relation of resistance, some special adjustment of relay 61 might be required.

The equipment shown in drawings Figs. 1ª and 2ª may be replaced with other types of equipment. Many different devices and arrangements of parts might be designed to accomplish the same results: for instance, it would be possible obviously, to end the circuit leading from the calling subscriber in a jack instead of a plug, and to terminate the outgoing ends of the trunk lines in plugs rather than in jacks so that the operator would make a connection between a calling

line and a trunk by inserting the plug of the trunk into the jack of the calling line. A jack and a plug, regardless of which is associated with the trunk and which with the line, is a form of manually operated switch, and obviously other forms of manually operated switches than those consisting of jacks and plugs might be used by the operators to perform their respective functions. Therefore, while I consider that my invention is well illustrated in the drawings herewith, it is to be understood that my invention is not restricted to the specific type of apparatus shown.

What I claim as new, and desire to protect by United States Letters Patent, is:

1. In a telephone system, two central stations; a trunk extending between said central stations; multiple contacts connected with said trunk at the said central stations respectively; relays also at both central stations; extensions at said central stations connecting the respective ends of said trunk with switching and signaling devices; and circuits, by which, when connection is made with said trunk at one of its multiple contacts at one central station, said relays at such station operate to disconnect the extension thereat from said trunk, and said relays at the other station operate to establish busy test conditions at the multiple contacts of said trunk at said other station, substantially as described.

2. In a telephone system, two central stations; a trunk extending between said central stations; automatic selective switches in each of said central stations; multiple contacts in said automatic selective switches of both central stations, said contacts being connected with said trunk; relays at both central stations; extensions at said central stations connecting the respective ends of said trunk with switching and signaling devices; and circuits, by which, when connection is made with said trunk at one of its multiple contacts at one central station, said relays at each station operate to disconnect the extension thereat from said trunk, and said relays at the other station operate to establish busy test conditions at the multiple contacts of said trunk at said other station, substantially as described.

3. In a telephone system, a switching plug; a relay in connection with said switching plug; a meter; circuits by which said meter is electrically operated consequent upon the energization of said relay; a trunk jack; an automatic switch connected with said jack; a distant switchboard; trunks terminating in said automatic switch and in said distant switchboard; mechanisms and circuits by which said automatic switch may select an idle one of said trunks and connect it to said jack, the selected trunk including a conductor continuous for direct current and connecting said switch with said distant switchboard; circuits by which when said switching plug is connected with said jack and said jack is connected with said trunk said conductor will be connected with said relay; a source of electric potential at said distant switchboard not normally connected with said conductor; a telephone line terminating in said distant switchboard; a substation telephone on said telephone line; the circuit through said telephone line and substation telephone; switching devices for connecting said trunk to said telephone line; a relay associated with said distant switchboard and with said trunk; circuits by which said second relay is energized when said trunk is connected with said telephone line and said circuit through said telephone and substation telephone is closed; and circuits which by the energization of said second relay place the said source of electric potential in connection with the said conductor and said first relay is energized, substantially as described.

4. In a telephone system, a telephone line; a meter associated with said line; an automatic selective switch; a manually operated switch whereby said telephone line may be connected with said automatic switch; a distant switchboard; a trunk terminating in said automatic switch and in said distant switchboard; automatic devices by which said switch connects said line with said trunk when said line is connected manually with said switch; a conductor included in said trunk continuous for direct current and connecting said switch with said distant switchboard; circuits by which said meter is electrically operated; a source of continuous and direct electric potential at said distant switchboard not normally impressed upon said conductor; a telephone line terminating in said distant switchboard and including a substation telephone; switching devices for connecting the said trunk to said latter telephone line; a relay associated with said distant switchboard and with said trunk; circuits by which said relay is energized when said trunk is connected with said telephone line and the circuit through said telephone line and substation telephone is closed; circuits which by the energization of said relay impress said potential upon said conductor; and circuits and devices associated with said automatic switch, manually operated switch and telephone line and meter, by which said meter is actuated consequent upon impressment of said potential on said conductor, substantially as described.

5. In a telephone system, the combination of a telephone line; an electrically operated meter; an automatic selective switch; a distant switchboard; a trunk terminating in said automatic switch and in said distant switchboard; a telephone line terminating

in said distant switchboard; a substation telephone on said latter telephone line; manually operated means for connecting said first telephone line with said automatic switch; means for connecting said trunk with said second telephone line; a relay; means whereby said relay is energized consequent upon the answering of said substation telephone upon said second telephone line; and means whereby said meter is actuated consequent upon the energization of said relay, substantially as described.

Signed by me at Pittsburg, county of Allegheny, State of Pennsylvania, in the presence of two witnesses.

SIDNEY HAND BROWNE.

Witnesses:
ALICE M. GODFREY,
A. H. MORAWEEK.