No. 640,618. Patented Jan. 2, 1900.

T. F. AHERN.

TELEPHONE EXCHANGE SYSTEM.

(Application filed June 26, 1899.)

(No Model.) 8 Sheets—Sheet 1.

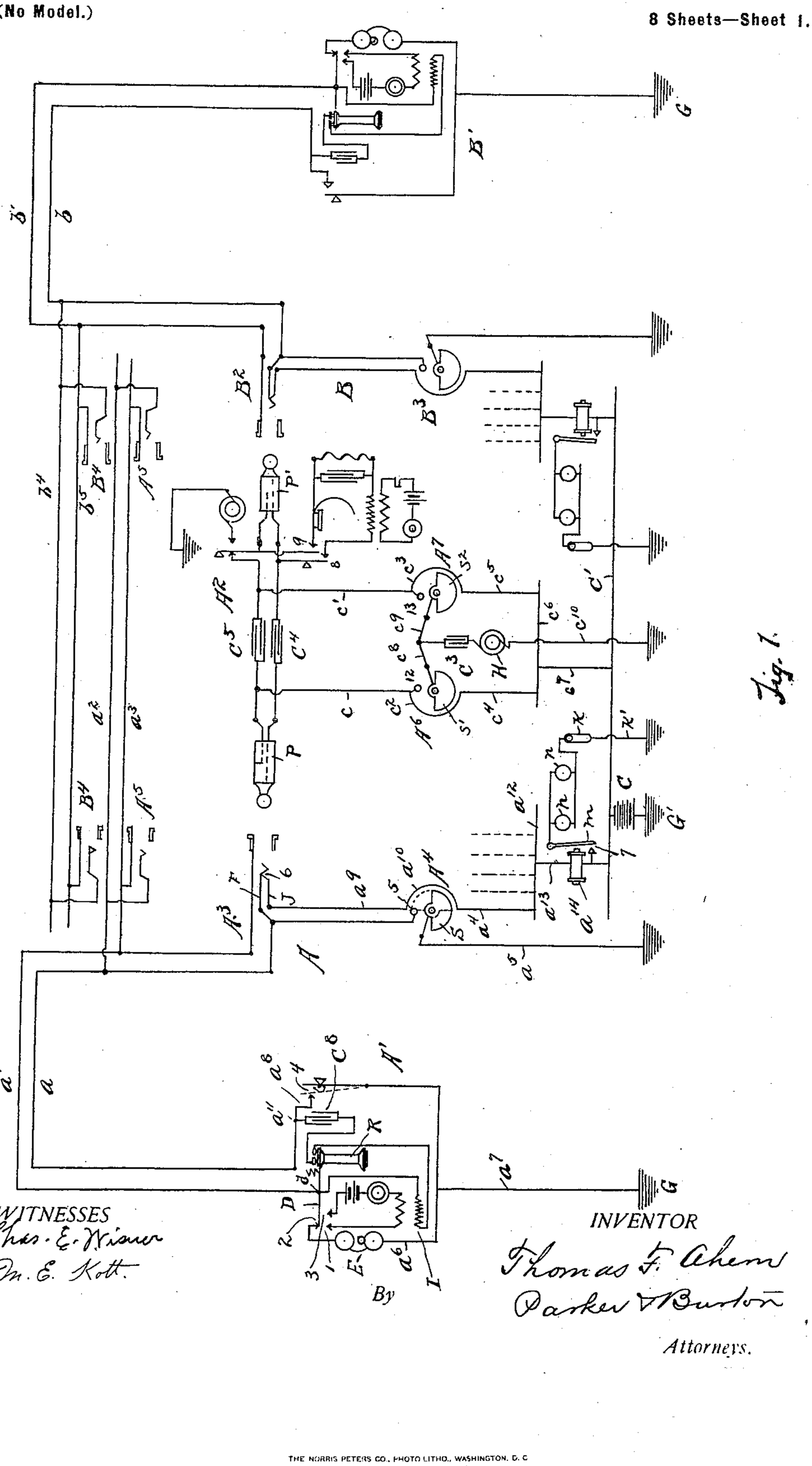

Fig. 1.

WITNESSES
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(No Model.) 8 Sheets—Sheet 2.

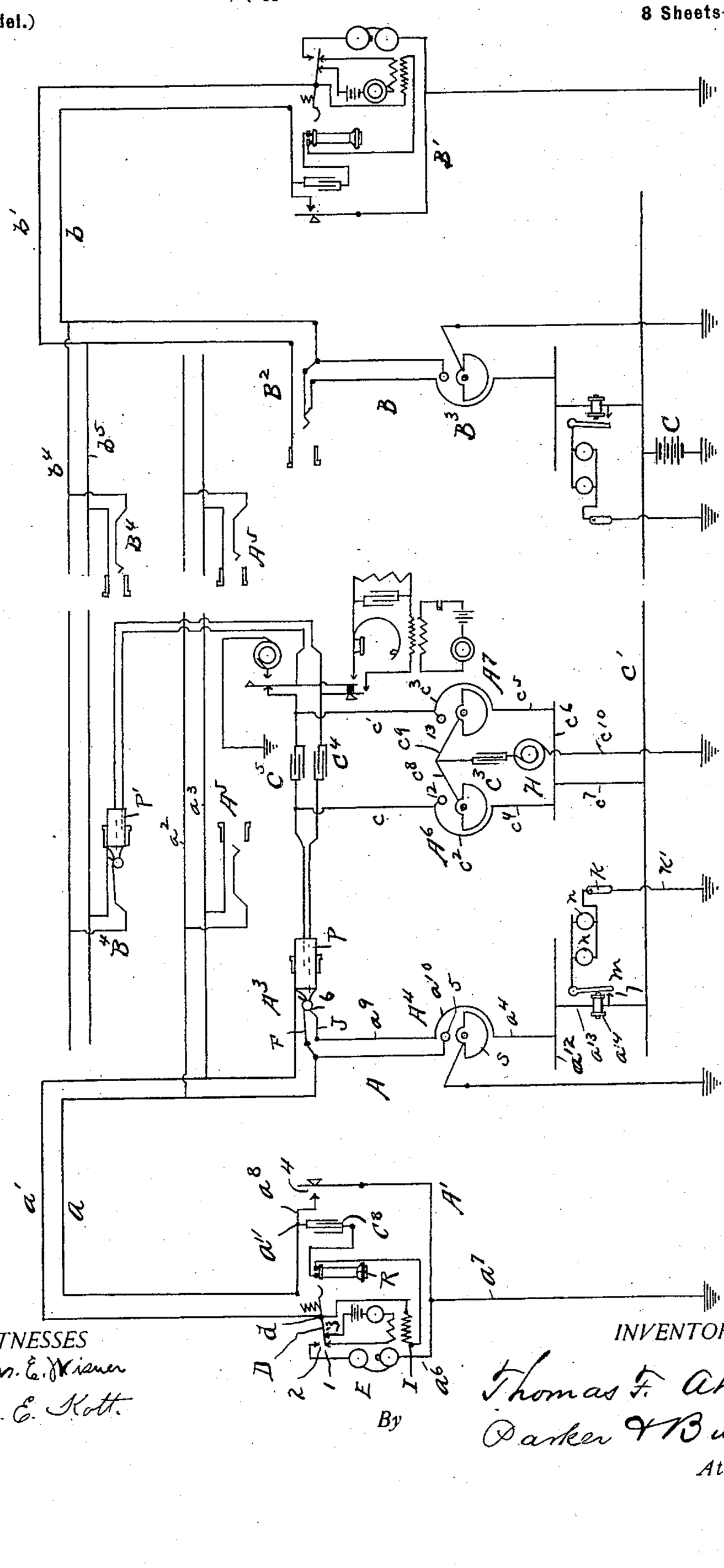

Fig. 2.

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(No Model.) 8 Sheets—Sheet 3.

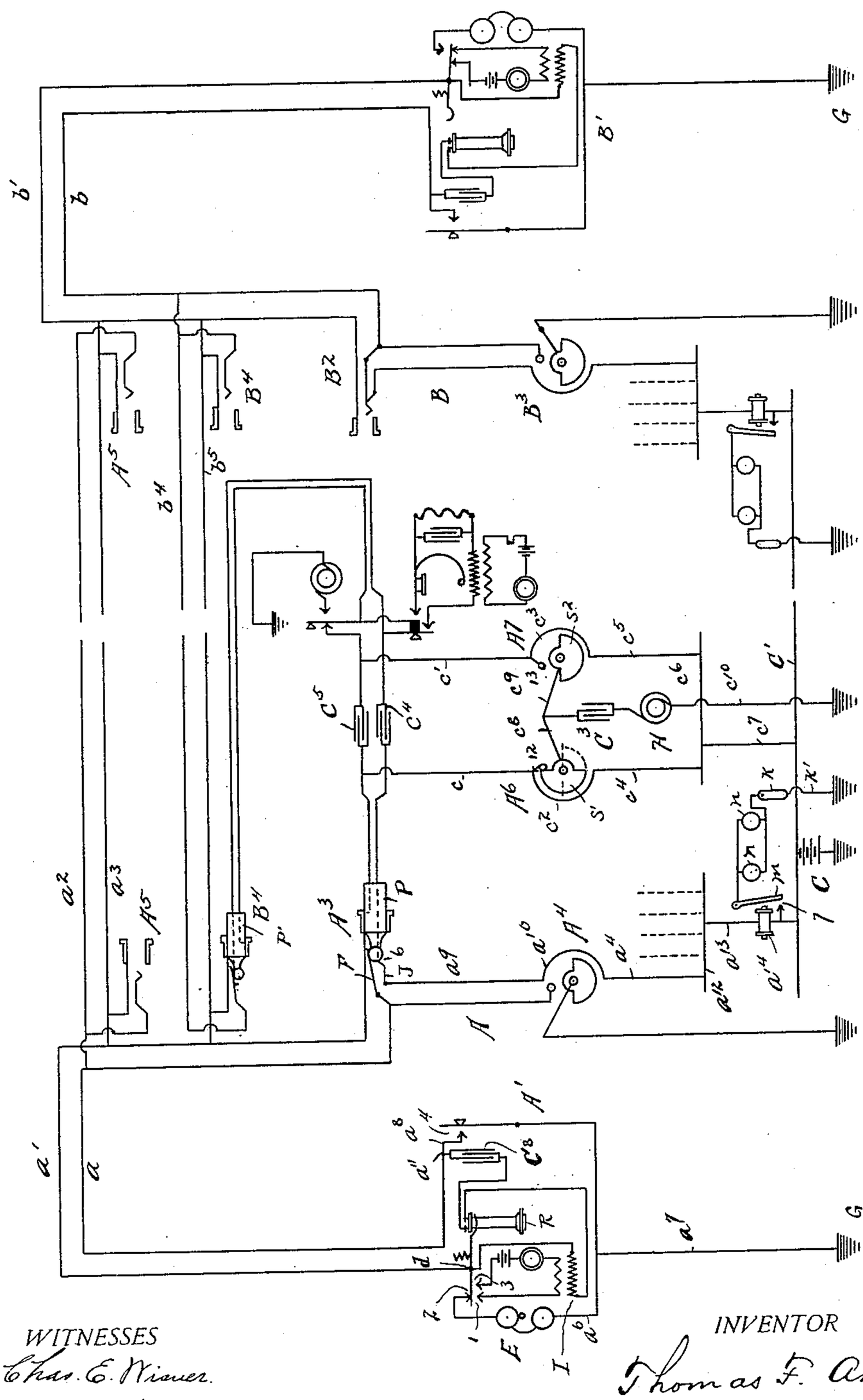

Fig. 3.

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(No Model.) 8 Sheets—Sheet 4.

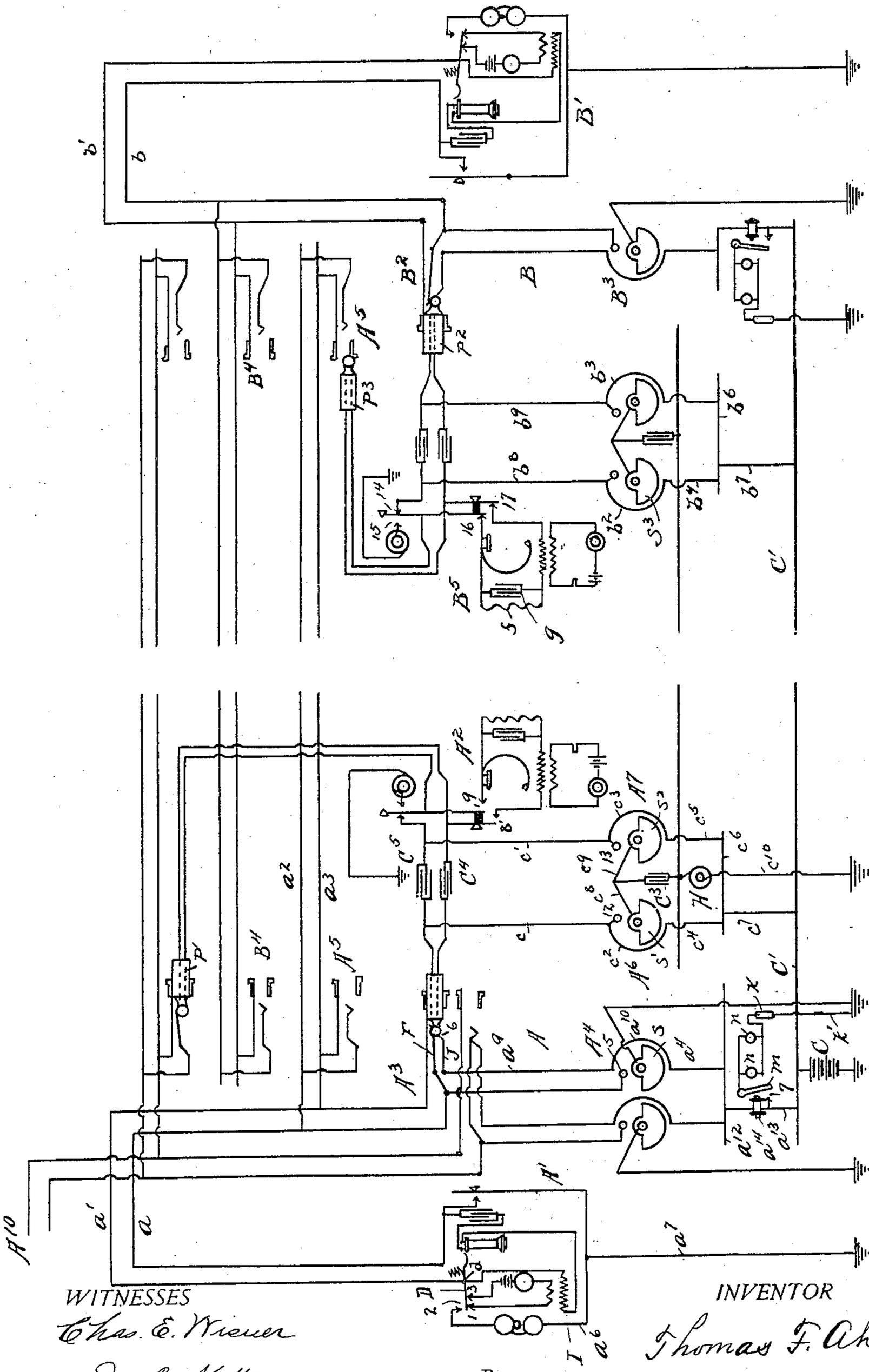

Fig. 4.

WITNESSES

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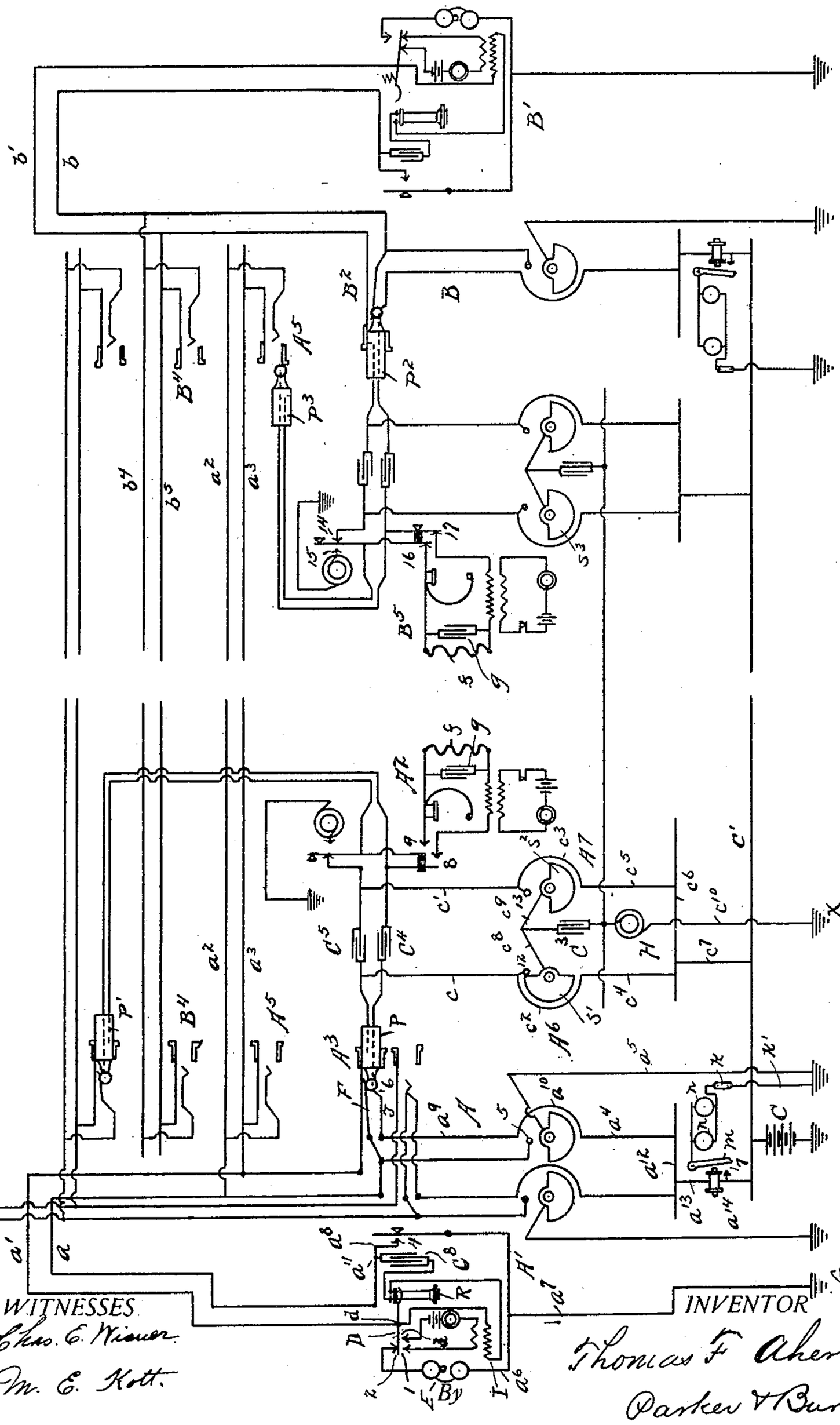

Fig. 5.

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(No Model.) 8 Sheets—Sheet 6.

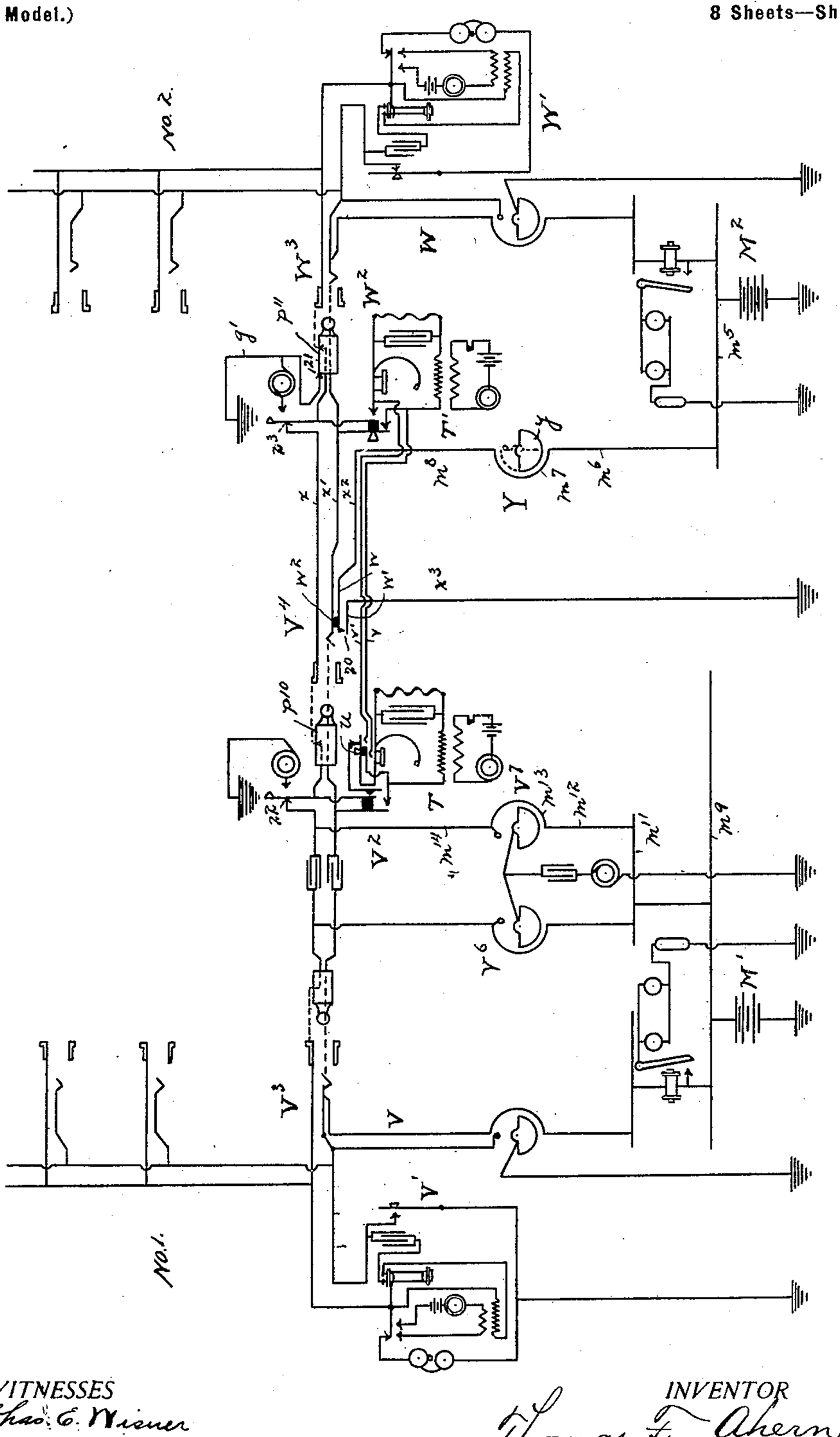

Fig. 6.

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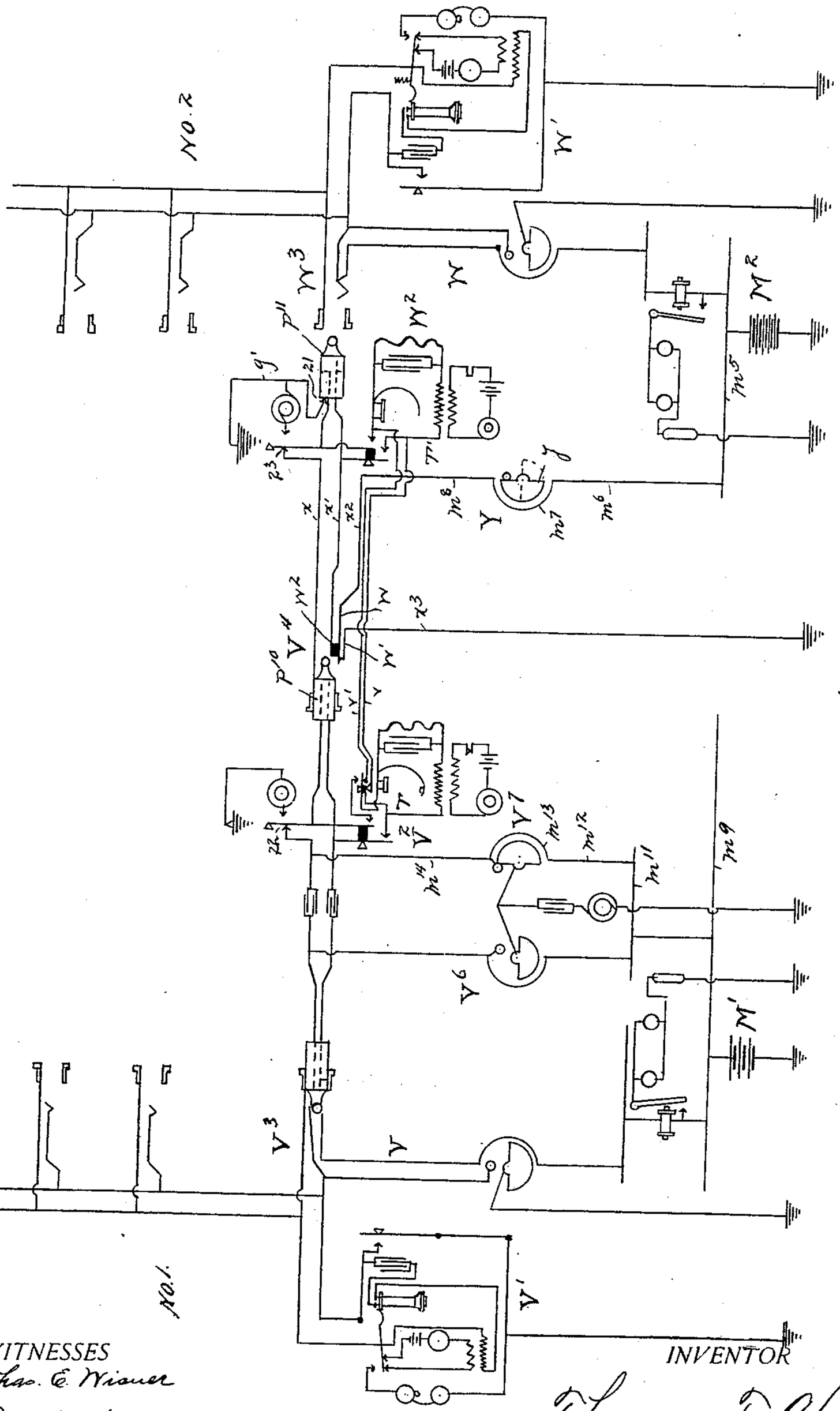

Fig. 7.

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(No Model.) 8 Sheets—Sheet 8.

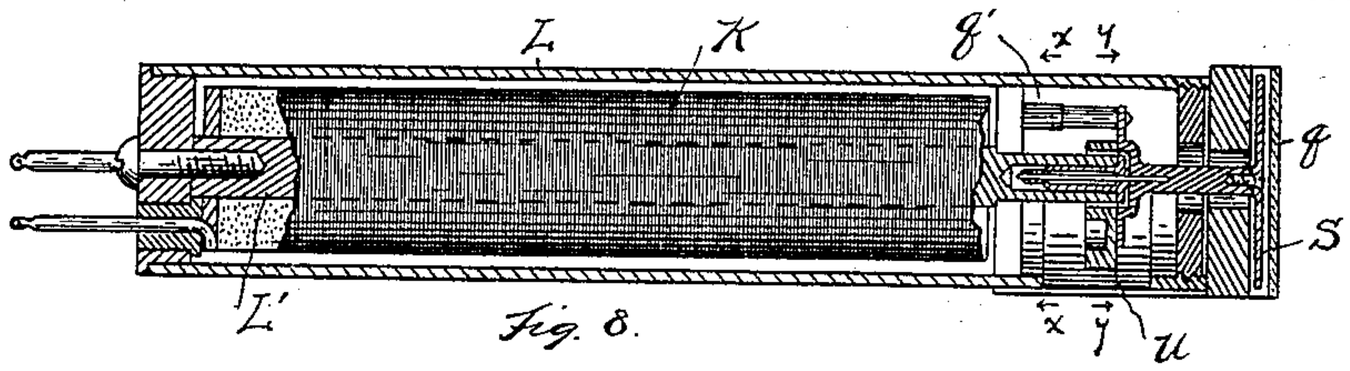

Fig. 8.

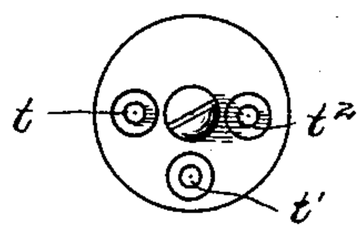

Fig. 9.

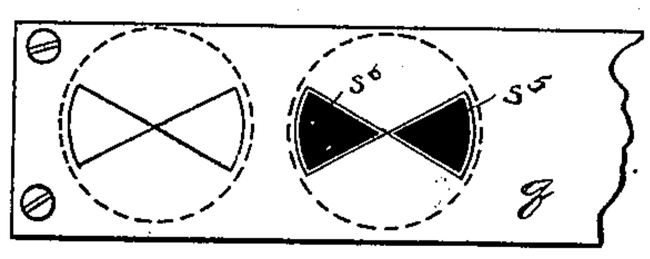

Fig. 10.

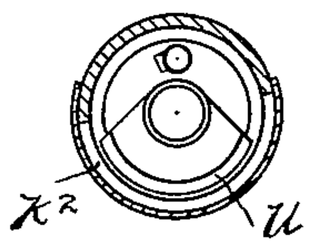

Fig. 12.

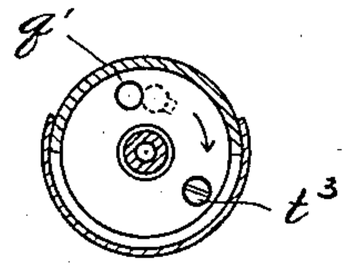

Fig. 11.

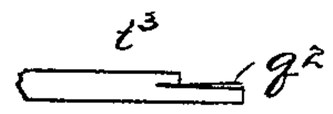

Fig. 13.

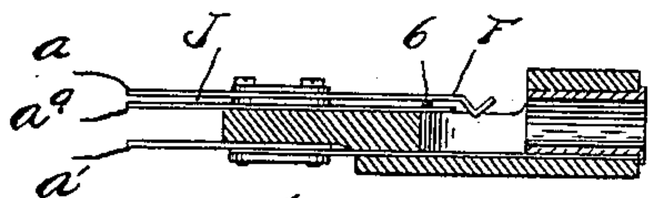

Fig. 14.

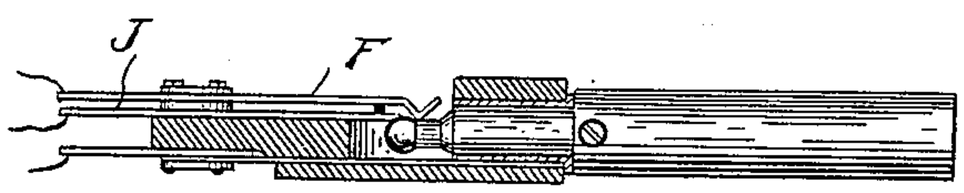

Fig. 15.

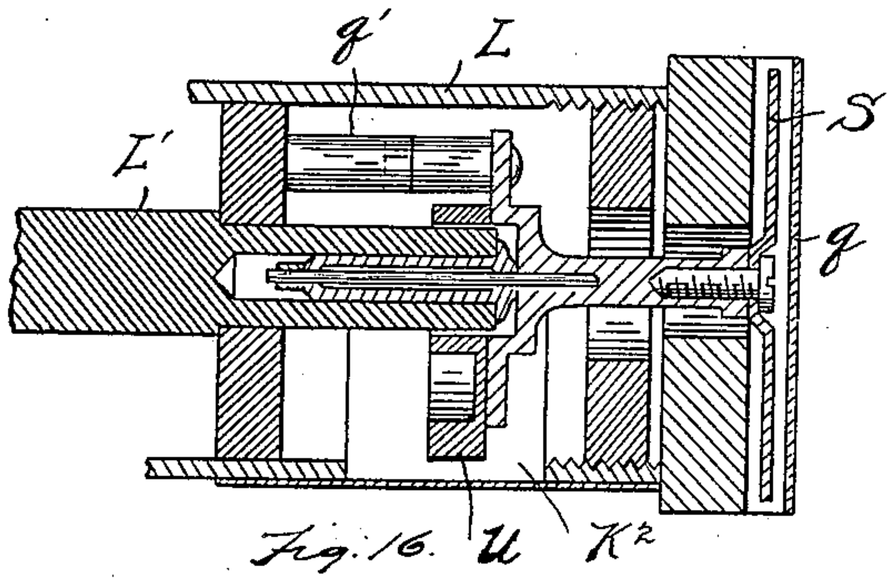

Fig. 16.

WITNESSES

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UNITED STATES PATENT OFFICE.

THOMAS F. AHERN, OF DETROIT, MICHIGAN, ASSIGNOR TO THE DETROIT SWITCHBOARD AND TELEPHONE CONSTRUCTION COMPANY, OF SAME PLACE.

TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 640,618, dated January 2, 1900.

Application filed June 26, 1899. Serial No. 721,912. (No model.)

To all whom it may concern:

Be it known that I, THOMAS F. AHERN, a citizen of the United States, residing at Detroit, county of Wayne, State of Michigan, have invented a certain new and useful Improvement in Telephone-Exchange Systems; and I declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same, reference being had to the accompanying drawings, which form a part of this specification.

My invention relates to switchboards for telephonic purposes; and it consists in the various arrangements and combinations hereinafter described and claimed.

My switchboard may be of the so-called "multiple" type, having indicators grouped upon the several sections, the indicators in each section corresponding to the substations whose lines enter that section, also having corresponding answering-jacks for the substations represented by the indicators in each section, and, further, having as many line-jacks upon each section as there are lines from substations belonging to the system, or it may be of the trunking type, as hereinafter described. In addition to the indicators upon such section representing the substation-lines entering therein each pair of plugs and cords belonging to the operator's set is also provided with two similar indicators which are temporarily associated with the two substations that may be connected by that pair of plugs and cords.

In the drawings, Figure 1 is a diagrammatic representation of a switchboard and the subscribers' sets for two substations and circuits showing the whole apparatus in its normal condition, it being understood that the delineation of the apparatus and circuits for two substations and the connections in the switchboard, together with an operator's set, is sufficient to illustrate the construction and combinations for any number of substations. Fig. 2 is a similar diagrammatic representation, but showing the circuits and connections made in the switchboard on the same section between two substations. Fig. 3 is a similar diagrammatic representation of the circuits and the connection made in the switchboard between two subscribers, but with one of the receivers on the hook which operates the corresponding signal in the operator's set. Fig. 4 is a diagrammatic representation of the circuits and the connections made between two subscribers on the same section, together with the test on another section, to ascertain if the called line is busy. Fig. 5 diagrammatically illustrates the test made when one of the connected subscribers has hung up the receiver. Fig. 6 is a diagrammatic illustration of this invention as adapted to a multiple trunking system and is shown in its normal condition. The dotted lines show how the connection is made between two subscribers, one of the subscribers' lines entering board No. 1 and the other board No. 2. Fig. 7 diagrammatically illustrates the condition of the board shown in Fig. 6 after the operator on board No. 2 has tested, found the line wanted is busy, and has dropped the trunk-plug into its seat. Figs. 8, 9, 10, 11, 12, 13, 14, 15, and 16 are illustrations of certain mechanical details which will hereinafter be more fully described.

In Fig. 1 two sections A and B are illustrated in their normal condition, in which section A includes an operator's set A^2. Two substations A′ and B′ are shown, the substation A′ being connected directly to an answering-jack A^3 in section A by lines $a\ a'$ (constituting a metallic circuit) and through line a to an indicator A^4. The lines $a\ a'$ are also branched and are continued through the board in lines $a^2\ a^3$. These are connected to line-jacks $A^5\ A^5$ in each section of the board. The substation B′ is connected in the board in a similar manner at another section by lines $b\ b'$ to answering-jack B^2 and indicator B^3 and are branched and continued through the board in lines $b^4\ b^5$. As usual, the substations are connected with the ground at G G. The circuits being metallic circuits, the lines are doubled, so that there is not only a metallic return with each substation, but, as will be hereinafter seen, a ground-line connection as well, which I utilize in the manner hereinafter stated.

In the answering-jack A^3 line a connects with line a^2 through a contact F and contact

6, the line a^9 being continued through coil a^{10} and line a^4 to line a^{12}, which is common to a number of indicators. From line a^{12} the illustrated circuit is continued as line a^{13} to a battery C, the other side of which is connected at G' to ground. A relay a^{14} is interposed in line a^{13}. The object of this relay will be hereinafter described. Thus line a connects to ground and line a' ends in the collar of the answering-jack. From the answering-jack A^3 line a is also continued to contact 5 of the indicator A^4, and when the metallic shutter S of the indicator is partially rotated, as hereinafter described, makes a contact at 5 and continues line a to ground through the shutter s and line a^5. The rotation of the metallic circuit S by making a contact at 5 thus short-circuits the previously-established circuit through the substation and maintains the signal operated by the shutter in the position initiated by the original establishment of the circuit through the substations, it being maintained in this indicating position until the circuit is broken, as hereinafter described. There is a similar indicator and its connections for each answering-jack in each section of the board. The operator's set A^2 for each section is also connected to the battery C (which thus become common to all of the operators' sets) and under certain conditions hereinafter described to ground. The operator's set in each section consists of a given number of pairs of plugs and double-stranded cords, uniting the plugs pairwise, and each pair of plugs and cords is also provided with two indicators A^6 and A^7, similar in construction and mode of operation to that of A^4, each of which is also connected to one terminal of the common battery C by lines c^4 c^5 c^6 c^7. Thus the collars of the plugs P P' are connected to common battery by lines c c', coils c^2 c^3, and lines c^4 c^5 to the common line c^6. When the shutters of the indicators A^6 A^7 are thrown, making contacts 12 and 13, the collars of the plugs are connected to ground through lines c c', contacts 12 13, shutters s' s^7, lines c^8 c^9, and line c^{10}, in which are interposed a generator H and condenser C^8.

When the system is in its normal condition, as shown in Fig. 1, with the telephone on its hook, the line a' on entering the substation A' makes permanent contact with the hook at d, passes through the coil I, the receiver R, the condenser C^8, and thence passing outward as line a. Thus the lines a a' form a metallic circuit closed by the condenser C^8. This closure is permanent. In the normal condition, as stated, the receiver-hook D forms a branch circuit which is grounded through contact 2, the bell E, and the lines a^6 a^7. As the receiver-hook D is pivoted at d and is spring-controlled, as usual, the lifting of the receiver therefrom breaks contact 2, cuts out the ground-circuit through the bell, and closes contacts 1 and 3.

From the point a^{11} a branch a^8 is taken from the line a and continued to an open switch, which has an ordinary push-button at 4, which is adapted to continue line a to earth through line a^7. In the normal condition contact 2 being made connects line a' to earth through bells E, line a^6, and line a^7, the arm D making a connection between 2 and line a'.

It is well known that a condenser prevents the passage of battery-currents, while permitting the passage of voice-currents. It follows, therefore, that each substation is connected with a permanent metallic circuit which is always closed to voice-currents, while the lines forming such metallic circuit, as illustrated by a a', are always open at the substation to battery-currents and are never closed, the battery-currents always forming a circuit through the ground either by way of contact 2 on line a^6 to a^7 or through the push-button, closing the contact 4 on the other side of the condenser through line a^7 to ground.

I have found by the employment of a condenser in the subscriber's set as described that it neutralizes the self-induction in the lines of a metallic circuit, and consequently results in a clearer and better tone in the receiver.

In operation the circuits are as follows, the lines, as will be observed, being represented by letters and the contacts by figures: Let it be supposed that A' wishes the central station. By pressing the push-button at 4 and thus making contact 4 the operator's signal A^4 is actuated by circuit, which may be traced as follows: starting from ground G of the substation A', thence through line a^7 to contact 4, to line a^8, to line a, to contact-spring F in answering-jack A^3, through contact 6 to spring J, thence to line a^9, to a coil a^{10}, which throws shutter of signal, as shown in dotted lines, from coil a^{10} to line a^4, to common line a^{12}, to line a^{13}, to common line C', and through battery C to ground, thus completing the circuit. In passing through line a^{13} the current also passes through relay a^{14}, magnetizing the core and attracting the armature m, which makes contact 7, thus throwing part of the current in parallel through the interposed pilot-lamps n n, switch k, and line k' to ground. The pilot-lamps are not an essential feature of this invention, as it will work equally well without them; but, as shown, they call the attention of the operator to that particular bank of signals in which a signal has been made. In this relation it does not matter what the signal A^4 is, provided it be a signal which shall attract the attention of the operator. In this switchboard, however, there are certain features in the signal which I have shown and shall hereinafter describe, which make it an important element and of great utility. The operator on seeing A''s signal "on" picks up one of the answering-plugs P and places it in A''s answering-jack A^3, which corresponds to the signal A^4. On placing the plug in the answer-

ing-jack it first makes contact with spring F and lifts it from spring J, breaking the contact at 6 and cutting off the current from coil a^{10}, which thus automatically restores the signal to its normal condition. The tip of the plug coming in contact with spring J bridges J and F and again restores the connection between spring F and spring J through the tip preparatory to its being thrown again, as hereinafter stated. Having received from A′ the number desired, (which is assumed in this case to be B′,) the operator makes a test, which will be hereinafter described, to ascertain the condition of B″s line. On finding B″s line "not busy," the operator inserts companion plug P′ in line-jack B^4 on the same section, which corresponds to substation B′, thus completing the connection between substations A′ and B′, as shown in Fig. 2. Should A wish another connection after having completed his conversation with B′, he again pushes the button while talking with B′, which again throws signal A^4 by circuit completed through the tip of plug P, thus notifying the operator that another connection will be wanted. The operator therefore only disconnects from B′ when she receives the signal that the conversation is ended and depresses the listening-key to receive the new number that A′ may desire.

Should either subscriber—for instance, A′—leave the telephone during the conversation for any reason (perhaps to call another person to the telephone) and hang the receiver on the hook, it throws the clearing-out signal A^6 to the "on" position, as shown in Fig. 3, as stated. The operator, however, does not disconnect until both clearing-out signals A^6 and A^7 are thrown, which signifies that both subscribers having completed the conversation have hung up their receivers. The current which throws signal A^6 makes the following circuit: Starting from ground it passes through battery C to line c^7, thence to common line c^6 to line c^4, through coil c^2, throwing the signal to line c, thence to the sleeve side of the plug, which connects with line a' through the collar of the answering-jack A^3, thence through contact 2 to line a^6 in the substation, and thence to line a^7 and to ground, thus completing the circuit.

In Fig. 4 I have shown the lines from three substations entering the board and a second operator upon the second section making a test.

In section A two subscribers A′ and A^{10} are shown connected through operator's set A^2. Let it be supposed that subscriber B′ wants A′ and has called the operator on that section of the board in which his line enters. The operator B^5 on that section having received the number wanted takes the calling-plug P^3, which is opposite the answering-plug P^2, and touches the tip of the plug to the collar of A″s line-jack A^5. Silence being the result, she calls back to B′ "Line busy." Had A″s receiver been on a hook and contact 2 closed the operator would have received a click in her ear, this signifying that line A′ was not busy. The current producing the result makes the following circuit: Starting with the main battery C, the current passes to line b^7, to line b^6 through coil b^2 of the clearing-out signal, thence through line b^8 to cord conductor, (sleeve side,) thence through contact 14 of ringing-key, thence through contacts 16 and 17 of listening-key, connecting the head-telephone with the tip of the plug P^3, thence to the collar of the line-jack and out through the board to line a', thence through switch-hook D and contact 2, through the bell E, line a^6, and line a^7 to earth, and from earth to the other side of the battery, thus completing the circuit and signifying to the operator that substation A′ is not busy. Therefore silence signifies "line busy" and a click signifies "line not busy."

In passing through the head-telephone circuit the test-current passes through the high resistance f, which is shown as a shunt across the terminals of the condenser g. Thus the test-current is light and although plainly audible to the operator is not harsh.

In addition to the double test when the operator's telephone indicating line is not busy there is also a visual test by the actuation of the shutter s^3, inasmuch as a circuit is established from the battery C through line b^4, line b^3, contact 14, through the shunt f, around the condenser g, contact 17, through the cord of the plug to the tip of plug P^3 to collar of the jack A^5, to line a^3, thence to line a', thence to switch D, then to contact 2, and thence through bells E to line a^7 to ground, thus completing the circuit.

A "buzz" may also indicate a busy line, and what I call a "buzz test" is shown in Fig. 5.

As hereinbefore stated, should one of the subscribers hang the receiver on the hook for any purpose before completing the conversation it is necessary to place the line in such a condition that other operators may know the line is busy and not be led into the error of making a false test and calling on a line to which a connection is already made. This is accomplished by means of a generator, one terminal of which is connected to earth and the other connected through a condenser of low capacity to the armature of the clearing-out signals.

As shown in Fig. 5, A′ has hung the receiver on the hook, thus actuating the clearing-out signal A^6 and closing contact 12. Operator at B^5 is testing A″s line, which ends in line-jack A^5 in that section of the board, and by touching the tip of the plug to the collar of the jack, thus closing the circuit, the testing-operator receives a buzz in her head-telephone, which is produced by generator H, the current from which traverses the following circuit, as shown in Fig. 5:

Starting from earth at x, pass through the generator H, (which is a generator that is being constantly driven,) through the condenser C^3 to the axis of the shutter S′ of the signal, thence to contact 12, thence to line c, thence to line a', thence to line a^3, to the collar of jack A^5 on section B, to the tip of the plug P^3, to the strand connected with the tip, to contact 17, through the operator's head-telephone in the operator's set B^5 to contact 16, to contact 14, thence through the coil of signal S^3 to the line C′, and thence through battery C to ground. It is obvious that by attaching the collars to any jack A^5 on any section belonging to this line a similar circuit would be established leading to the common conductor C′, and therefore the buzz test would be heard by any operator testing the line. Thus the generator H in its continued movement would be heard in any testing-operator's telephone as a buzz.

The condensers C^4 and C^5 in the cord circuit are to prevent the battery-current passing from plug to plug and jointly operating A″'s and B″'s signals when one or the other pushes the button when a connection is on or the joint action of the two clearing-out signals A^6 A^7 when either A′ or B′ hangs the receiver on the hook. The condensers are, however, of ample capacity to admit of the clear and distinct passage of the voice-currents.

In Fig. 6 I have shown my invention as adapted to use in a trunking system, it being understood that in a trunking system all the lines do not enter each section of the board, as in the multiple system with a single board, part of the lines entering board No. 1 and the balance entering board No. 2. In the drawings I have shown one section V of board No. 1 with the operator's set V^2, substation V′, &c., and also one section of board No. 2 at W. The system is shown in its normal condition, and the dotted lines show how a connection is made between subscribers. The conditions of a talking-line through a trunk are exactly similar to those of a talking-line made on a single board. The trunk-signal is like all the other signals. Let it be assumed that subscriber V′, whose line ends in section V of board No. 1, wishes to talk to subscriber W′, whose line ends in section W of board No. 2, and also let it be assumed that operator V^2 has learned the number desired on board No. 2, which operation is exactly the same as on a single multiple board. Upon learning the number desired, the operator on V section immediately presses the call-circuit button u, thereby directly connecting the head-telephone set T in circuit in v v' with the head-telephone set T′ of the trunk operator, who has charge of the trunk-lines leading from the operator's position on board No. 1 to board No. 2, and at the same time giving the number of the trunk she intends to use and the number of the subscriber wanted, and also inserts the call-plug P^{10} in the corresponding trunk-jack V^4, which terminates the trunk x x' on her board and restores the ringing and listening key to neutral position. This ends the first operator's part of the work of making the complete connection, and that part of the board is now in the same condition as though she had made a complete connection on her own section, and she disconnects only when both clearing-out signals appear "on."

The act of inserting the call-plug P^{10} in trunk-jack Y^4 closes a contact 20 between the two springs w w', which are insulated at w^2 from other parts of the jack. The spring w is connected to the trunk-signal Y, and spring w' is connected to earth. The trunk-signal Y serves as a disconnect-signal to the operator on board No. 2, as will be shown later. On inserting the call-plug P^{10} in the trunk-jack Y^4 the current which actuates the trunk-signal flows from the main battery M^2 on board No. 2 to line m^5, thence to line m^6 through coil m^7, throwing the shutter y, thence to line m^8 and x^2 to spring w, thence through contact 20 and spring w' to line x^3 and to earth, back to the other side of the battery. The trunk-signal remains on, as shown by dotted lines, until operator No. 1 removes the call-plug from the trunk-jack, thereby breaking contact 20.

Operator W^2 on board No. 2 upon hearing the number of the trunk to be used picks up the corresponding trunk-plug P^{11} (the trunk-lines all ending at the outgoing end in plugs and cords) and proceeds to test the line in the same way as previously described. Should the line wanted (W′) be busy, the operator simply drops the trunk-plug back into its seat, thus making contact 21 and actuating signal V^7 of operator's set V^2 of board No. 1, and thus also notifies the operator V^2 to the effect that the line is busy. This operation is shown in Fig. 7.

The current which actuates the signal V^7 flows from main battery M′ on board No. 1 to line m^9, thence to line m^{11}, thence to line m^{12} and through coil m^{13} and line m^{14} to cord-conductor, (sleeve side,) thence through contact 22 and sleeve of plug P^{10} to collar of jack V^4, thence through trunk-line x and contact 23 to sleeve side of trunk P^{11}, thence through contact 21 and line g' to earth and the other side of battery M′. If line W is not busy, the operator inserts trunk-plug P^{11} in answering-jack w^3 on a corresponding line-jack, whichever may be the nearest, thus completing the circuit between subscribers, and from this time on the operator at W^2 takes entire charge of the line, and when the conversation is ended and the clearing-out signals V^6 and V^7 have both been thrown by both the subscribers by hanging their respective receivers on the hooks, as hereinbefore described, operator V^2 disconnects the plugs from the jacks, which not only restores the clearing-out signals, but

also restores the trunk-signal Y to its normal condition, thus notifying operator at W^2 to disconnect.

The signal used in this system preferably consists of a disk or plate of any definite color having orifices or transparent segments therein so arranged in relation to a shutter that in its normal condition the plate or disk appears of one color; but on the shutter being rotated a quarter of a revolution, as hereinafter shown, the orifices appear of a different color, thus signaling the operator that a connection is desired.

In Fig. 8 I have shown a sectional view of one of the signals, which is composed of an outer shell L, of low-carbon steel, and a soft-iron core L′, wound with coil K. The shell L is cut away upon one side opposite the armature U, as indicated in Figs. 11, 12, and 16, and when assembled in the switchboard the cut-away portion is underneath, so that the armature U is held in a non-indicating position by gravity, with its mass opposite the cut-away portion of the shell. Cutting away a portion of the outer steel shell results in making the shell "magnetically unbalanced," so to speak, when currents are passed through the coil which it incloses—that is to say, the magnetic center of the shell does not coincide with the center of rotation of the armature or the core-piece, as would be the case if the shell were complete and of uniform dimensions. Therefore on the passing of the current the armature seeks to bridge the eccentric magnetic center and the iron core or is attracted to that side of the shell developing the greatest amount of magnetic force. It therefore makes a quarter-revolution against the force of gravity, and thus actuates the signal. It is apparent that on the stoppage of the current and the destruction of the magnetism the signal by force of gravity will return to its original position.

As shown in Fig. 9, there are three terminals t t' t^2, from which lead the lines a a^4 a^9, which are practically continuous from line a of substation A′. The terminal t connects with the wire leading to stop-plug t^3. The terminals t' t^2 connect with the coil K. In operation when the circuit is closed the coil magnetizes the soft-iron core L′ and the shell which revolves the armature U upon its axis and closes the circuit at contact 5 between line a^5 and line a, which ends in the contact-pin t^3 in the signal.

It will be noted in Fig. 12 that the rotating armature u is normally nearer the shell L on one side than the other, and as the core and shell are magnetized the tendency of the rotating armature is to cross the narrow gap in that side and arrange its mass in the shortest distance between the core and magnetic center of the shell. This causes the rotation specified, which is so adjusted that it amounts to a quarter-revolution, as described.

Integral with the armature is a circular shutter S, which has two triangular colored segments s^5 s^6 on its face, as shown in Fig. 10. When in a normal condition, these colored segments are behind the opaque part of the plate q, and when the current is on which revolves the armature the shutter S also makes a partial revolution, bringing the colored segments opposite the orifices or transparent part of the plate q. This plate is composed of any transparent substance and is made opaque, except the two segments in front of each signal.

In Fig. 11 is shown a cross-sectional view on line x x of Fig. 8, showing the stop-pin q', which prevents rotation of the armature beyond a certain point when acted on by gravity. The armature-pin is shown in this view as dotted, and when the current is thrown on it comes forward in the direction of the arrow, making contact at 5, and the wire from this contact leads back across the top of the coil to one of the terminals, as line t, as shown in Fig. 9.

Fig. 12 is a view on line y y of Fig. 8, showing the armature and contact-plate. It will be seen that the armature usually hangs in the open part K^2 of the shell.

Fig. 13 is a detail of the contact-pin t^3, showing a swell-spring q^2 inserted in the end, so that when the armature is in contact at that point and the current is cut off the spring q^2 gives it an impetus to return to its normal position.

Figs. 14 and 15 are details of the answering-jack, normal size, showing the spring-contact at 6, which has heretofore been described, and in Fig. 15 also showing how the tip of the plug bridges springs F and J.

Fig. 16 is an enlarged sectional view of the forward part of the signal, showing the armature-shutter, which has already been described.

It will be seen by this system that, whether applied to the so-called "multiple" system of switchboards or to a trunking system with two operators, I have a metallic-return system between the two connected subscribers when conversing; also, that the calling-subscriber calls and rings off by a current passing over one of these wires only and returning to complete the circuit through the ground, and that the called subscriber is called over the opposite line from that which is used by him in calling or ringing off, the return of this circuit also being through the ground. Combined with this system is a system of office-signals which are flexible, as well as simple, so that all of the wishes of the subscribers are instantly shown to the operator having charge of the connections. It will be further seen that I entirely dispense with a test-wire, substituting therefor one of the lines over which the talking-circuit is made, combined with a local ground return. Hence the action of testing does not interfere with the talking-circuit. It will also be seen that the calling-

signal is operated by a circuit actuated by a local battery in the exchange and not, as is usually the case, by a local generator at the subscriber's station and that the operation of calling is performed by pressing a button when the receiver is lifted from its spring-hook.

What I claim is—

1. In a telephone-exchange, the combination of an answering-jack; two wires leading therefrom to a substation, one of the wires thereof connecting with the front thimble of said jack and the other to a spring therein; a contact-piece in said jack from which said spring is adapted to be lifted; a source of electricity one pole of which is grounded, the opposite pole leading through a relay to a contact-piece in the jack; the relay and contact-piece, means for continuing the circuit, a switch at the substation adapted to close the grounded circuit of said battery through the metallic line leading to the substation which is connected with the aforesaid spring of the said jack, the armature of said annunciator being so constructed and so operating as to close the secondary contact in the path of said circuit, whereby, when the circuit is closed at the substation, a closed path exists through the spring-jack and the relay, and the actuation of the armature closes contact and changes the circuit of the battery through the separate line leading from said spring-jack in such manner as to preserve the integrity of the signal on the opening of the contact at the substation, substantially as described.

2. In a telephone-exchange, the combination of an answering-jack; two wires leading therefrom to a substation, one of the wires thereof connecting with the front thimble of said jack and the other to a spring therein; a contact-piece in said jack from which said spring is adapted to be lifted; a source of electricity in a grounded circuit, the opposite pole leading through a relay to a contact-piece in the jack, a relay and contact-piece; a switch at the substation adapted to close the grounded circuit of said battery through the metallic line leading to the substation which is connected with the aforesaid spring of the said jack, the armature of said annunciator being so constructed and operating to close the secondary contact in the path of said circuit, whereby when the circuit is closed at the substation a closed path exists through the spring-jack and the relay, and the actuation of the armature closes contact and changes the circuit of the battery through a separate line leading from said spring-jack in such manner as to preserve the integrity of the signal on the opening of the contact at the substation; a plug connecting with the operator's set having an enlarged tip adapted to lift the spring in the jack from the contact-piece hereinbefore described, thus breaking the short circuit, whereupon the rotating armature immediately resumes its normal position, said plug through said tip restoring the circuit with the contact-piece in the jack, whereby a signal may be sent through such restored contact from the substation, thus actuating the armature-signal; substantially as described.

3. The combination of an operator's set for a central station of a telephone system, consisting of a multiplicity of double-pointed plugs connected pairwise by double-stranded cords, one strand connecting the tips of said plugs and the other strand connecting the insulated sleeve of said plugs; condensers located as described in each of said strands; a double signal apparatus located on lines connecting the sleeves, one portion of said signal apparatus being connected between the condenser thereon and the sleeve, the other said signal apparatus being connected on the line between the condenser and the opposite sleeve; a grounded battery in which one pole is connected through the pair of annunciators to the strand connecting the sleeves as above stated; a source of electricity connected in a grounded circuit with that one of the wires which leads from a substation and connects with the thimble of the answering-jack, and adapted to be connected thereby with the sleeve of the answering-plug, thus through the annunciator in advance of the condenser to ground; a corresponding source of electricity in a grounded circuit, and the corresponding branch of a metallic circuit connecting with the thimble of its connecting-jack and thence to the sleeve of the connecting-plug and adapted to close the circuit through the annunciator with the strand connecting said sleeve in advance of the condenser located therein; and a receiver-controlled switching apparatus at the said substation, whereby the hanging up of the receiver at each substation is indicated by the respective annunciator-shutters connected with the sleeved strand of the pair of plugs in the operator's set; substantially as described.

4. In a switchboard for telephones, the combination of a continuously mechanically operated generator, a signal connected therewith and adapted to close the circuit when operated, a circuit-closer in an operator's set, a condenser located on the strand connecting the tips of the plugs between the generator connection and the answering-plug, a receiver-controlled switch at the substation adapted to operate the signal to close or open the generator-circuit, substantially as described.

5. The combination of a magnetic core, a coil surrounding the same, means for exciting the coil, an unbalanced magnetic shell inclosing the coil, a weighted rotating armature rotatably attached to the magnetic core, and an indicating-disk carried by said armature and adapted to operate as a signal, substantially as described.

6. The combination of a rotating armature

adapted by gravity to remain in a certain position, a magnetic core, an unbalanced magnetic shell, a coil interposed between said core and said shell, and a stop-piece electrically connected to a leading-in line, said leading-in line, another leading-in line electrically connected to the axis of said rotating armature, whereby the rotation of said armature against the stop closes a circuit, and a visual signal operated by said armature and corresponding in its visibility with the closure of said circuit, substantially as described.

In testimony whereof I sign this specification in the presence of two witnesses.

THOMAS F. AHERN.

Witnesses:
MARION A. REEVE,
JEAN BARMATYNE.