H. M. BASCOM.

SYSTEM FOR COMPENSATING FOR DIFFERENCES OF POTENTIALS.

APPLICATION FILED MAY 17, 1917.

1,287,831.

Patented Dec. 17, 1918.

4 SHEETS—SHEET 1.

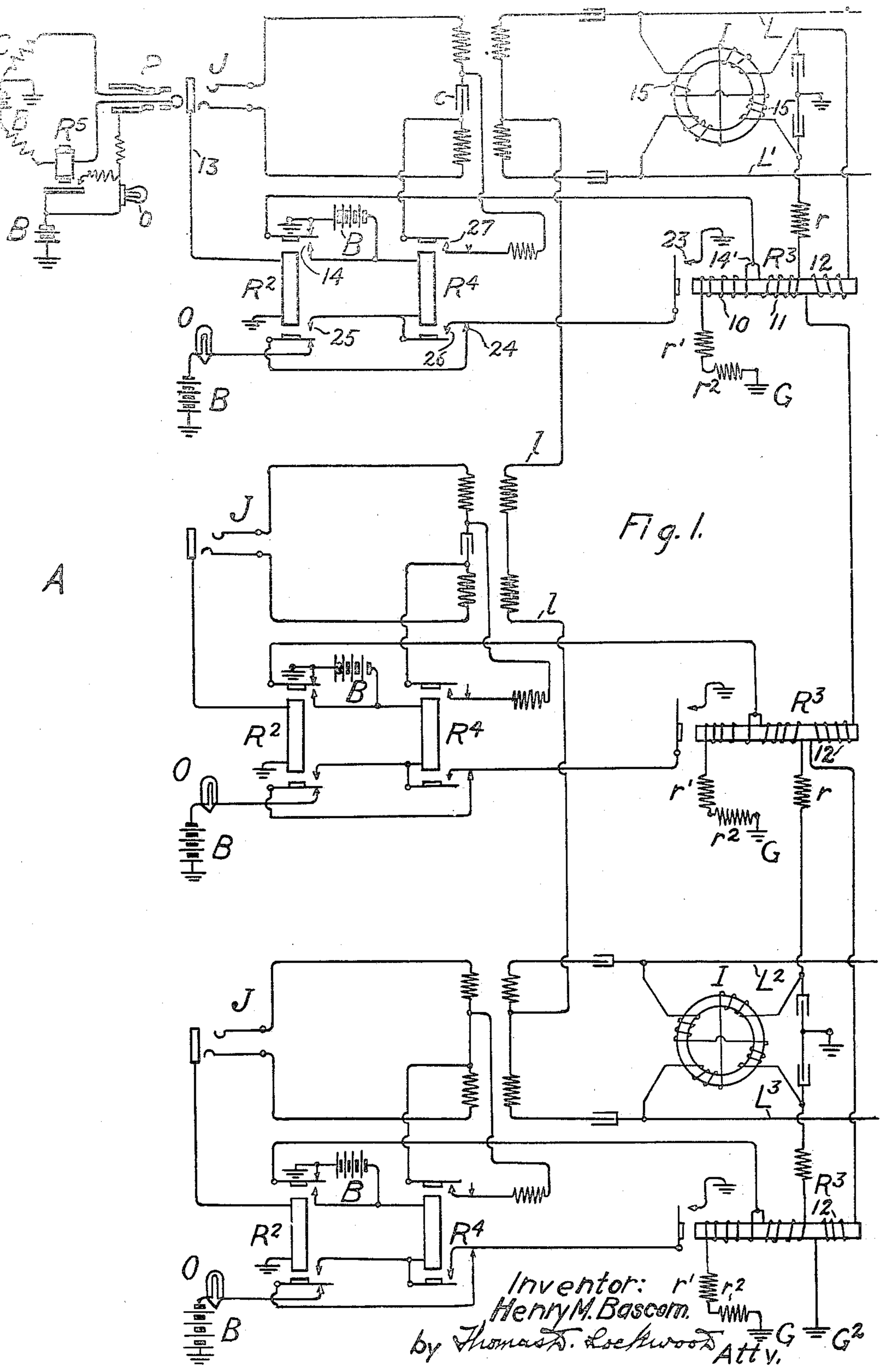

Fig. 1.

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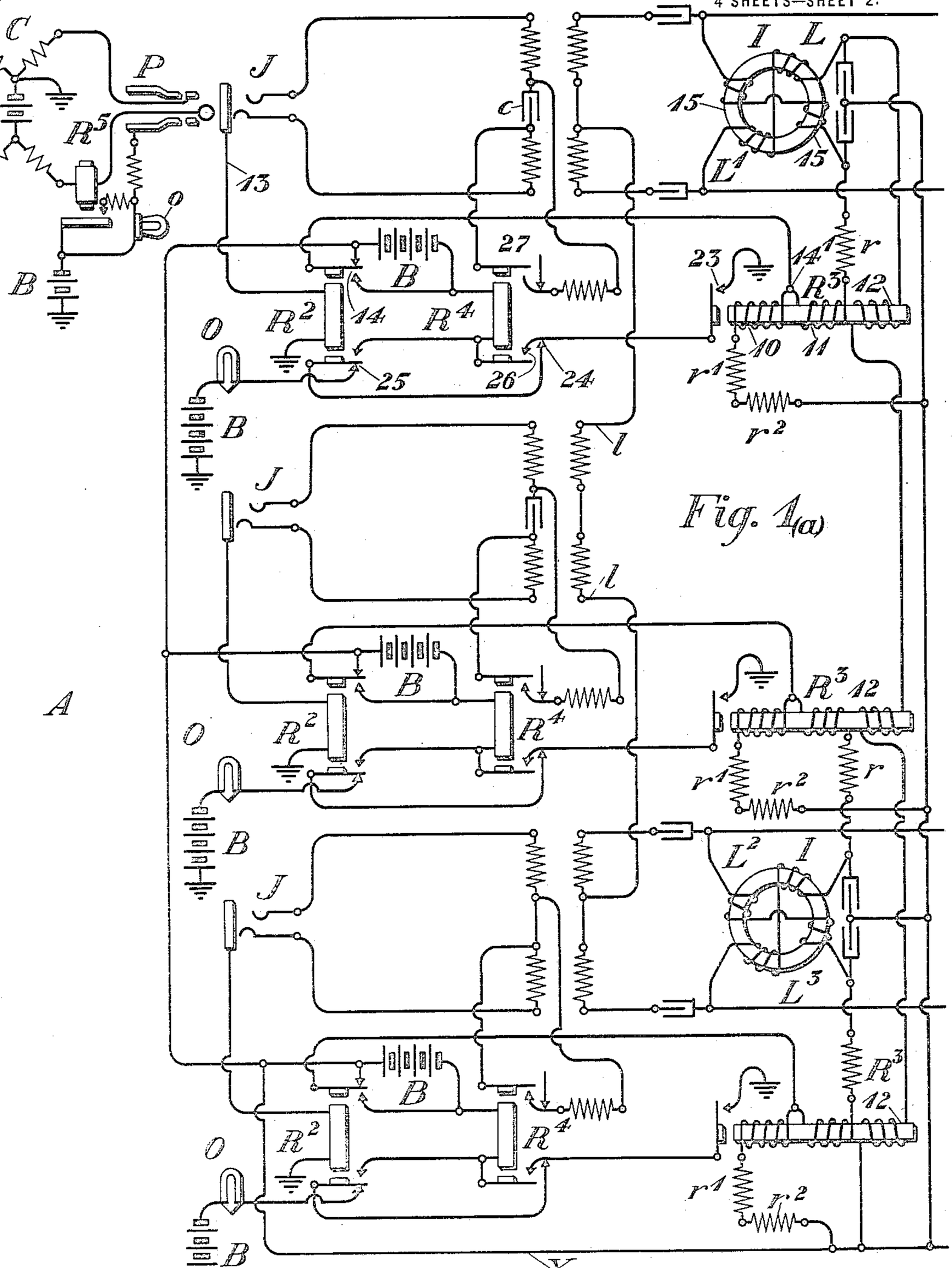

INVENTOR.

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BY

Munn, Cameron, Lewis & Washington

ATTORNEYS.

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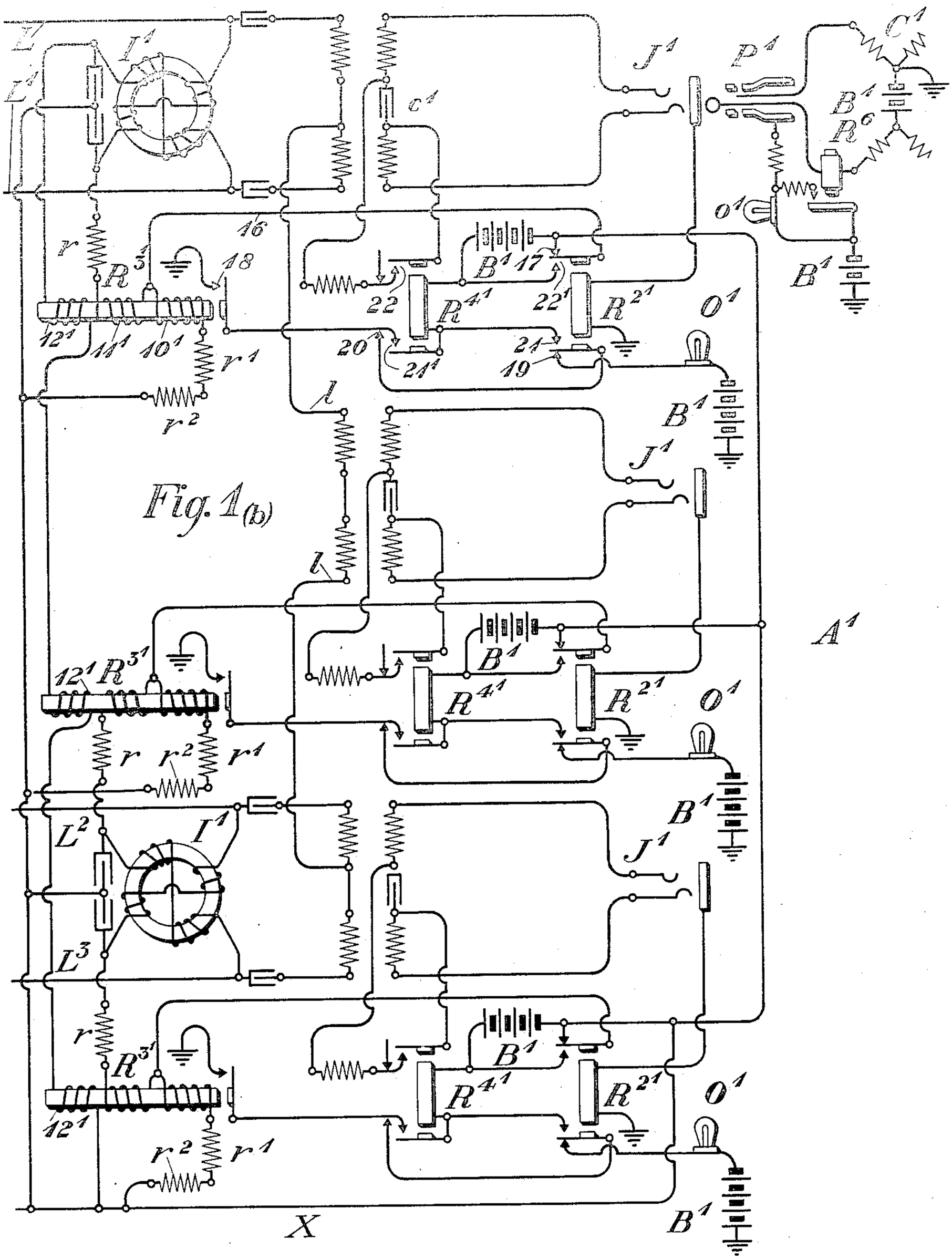

Fig. 1(b)

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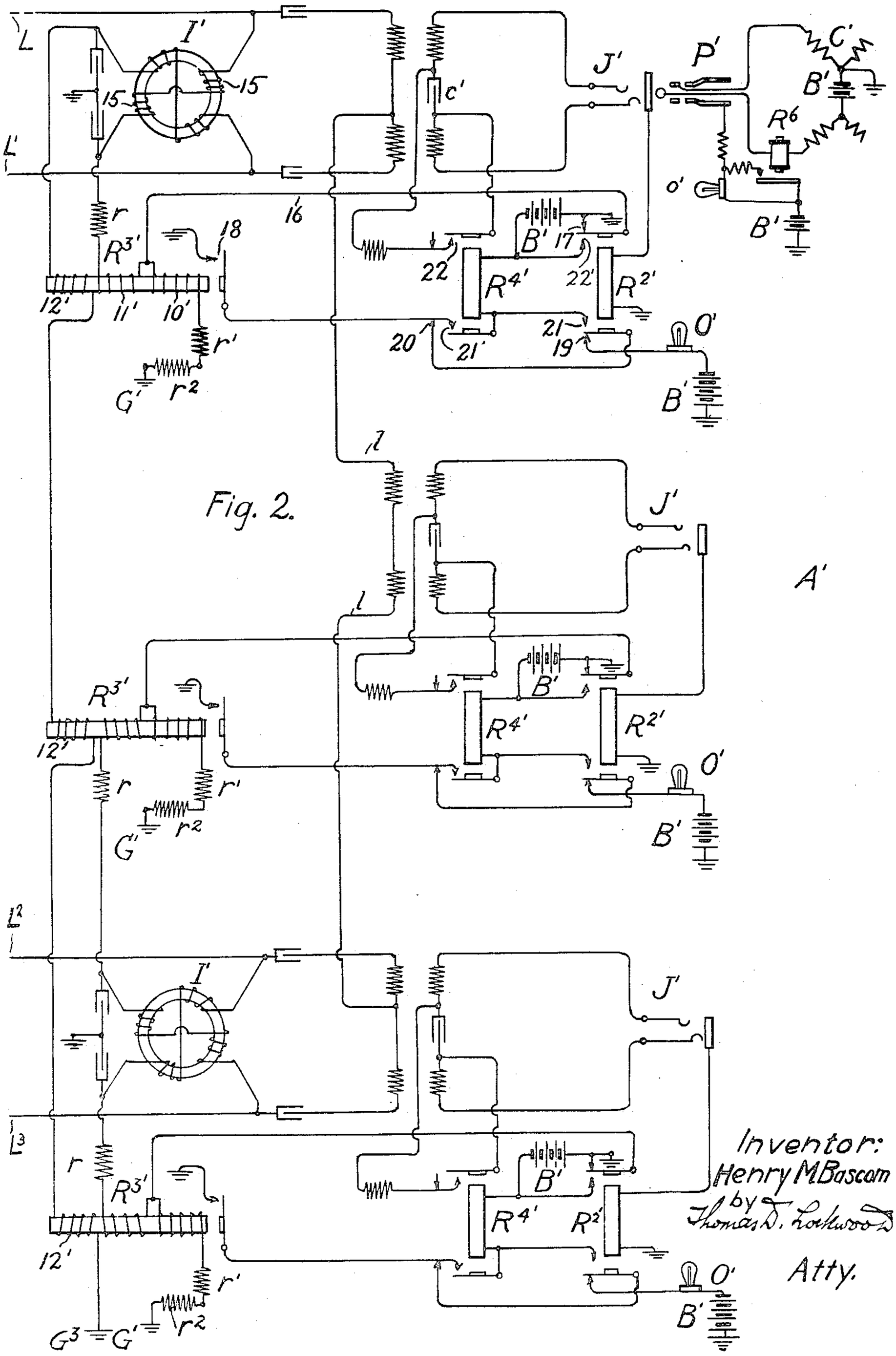

Fig. 2.

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UNITED STATES PATENT OFFICE.

HENRY M. BASCOM, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SYSTEM FOR COMPENSATING FOR DIFFERENCES OF POTENTIALS.

1,287,831. Specification of Letters Patent. Patented Dec. 17, 1918.

Application filed May 17, 1917. Serial No. 169,223.

To all whom it may concern:

Be it known that I, HENRY M. BASCOM, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Systems for Compensating for Differences of Potentials, of which the following is a specification.

In a number of types of signaling circuits, as those employed for duplex telegraphy or for the common battery operation of signals over phantomed telephone circuits, the action of the relays or other signal controlling devices depends upon a balance of electrical or magnetic forces, one of the balanced forces being supplied over a common return, which may consist of a ground or a metallic conductor, the separated terminals of which are subjected to differences of potential, while the other force is produced locally and is therefore not affected by the previously mentioned potential differences. In absence of means for preventing this, the flow of current through one of the two circuits may so unbalance the devices that they fail to operate properly. To provide such a compensating means is the object of my invention.

To illustrate the invention, I have chosen from the several systems in which it may be incorporated, one for controlling from a central station battery signaling lamps associated with phantomed telephone circuits, a system of this character being shown diagrammatically in the accompanying drawings, Figure 1 representing one central station and the corresponding portion of the circuits, and Fig. 2 another central station with its portion of the circuits.

Fig. 1^a and Fig. 1^b illustrate a slightly different embodiment of the same invention.

Between the central stations A and A′ extend two physical trunk circuits, including respectively the conductors L, L′ and L^2, L^3, terminating at jacks J and J′ for the coöperation with the plugs P and P′ of the usual cord circuits C and C′. The terminal conductors of the phantom circuit appear at *l*, these also terminating at jacks J and J′. In accordance with the customary practice each trunk at the central station has the respective lamp signals O, O′, by which is indicated the connection with the associated jack of the plug of the distant operator's cord circuit. Each of these lamps is governed by a group of relays R^2, R^3, R^4, or $R^{2\prime}$, $R^{3\prime}$, $R^{4\prime}$, which also share in the control of the supervisory relays R^5 and R^6 and supervisory lamps *o* and *o′* in the cord circuits C and C′, respectively. According to the usual practice, the relays R^3, $R^{3\prime}$ possess two windings 10, 11, and 10′, 11′, which are differential and at times have equal operating currents passing through them oppositely to neutralize one another's action. All these windings 10 and 10′ are supplied with current locally at the stations A and A′ from common batteries B and B′, respectively, while windings 11 and 11′ receive their current over the trunk conductors, the ends of these conductors being grounded at G and G′ to complete the circuits. The difference of ground potential between two stations frequently becomes sufficiently great to cause a resultant flow of current through the line, which disturbs the balance of the differential windings, and the lamps controlled by the relays are incorrectly lighted or extinguished. To prevent this, I provide each of the relays R^3, $R^{3\prime}$ with a third winding 12 or 12′ equal and opposite in effect to the windings 11, 11′, and through which are permitted to flow any earth currents created by the same potentials as are applied to said windings 11, 11′. For the operation of the signaling relays, three conductors of the two physical circuits are employed, as L, L^2 and L^3, thus permitting independent control of the signals for each of the three telephone circuits. The conductor, L′, remaining I utilize as a compensating conductor and to it join the windings 12, 12′ of the relays R^3 and $R^{3\prime}$ of both physical circuits and the phantom circuit, this being in the present instance in series. The terminals of this compensating conductor are grounded at G^2 at station A and G^3 at station A′, these grounding points being so located with respect to the grounds G and G′ of the signaling circuits that they are at the same potentials. It will be noted that at each station there is included in the compensating circuit three of the windings 12 or 12′, while corresponding to these in each signaling circuit there is but one winding 11 or 11′. To preserve the equality of earth currents in the two sets of windings there is included in cir-

cuit with each of the windings 11 or 11′ a resistance r twice that of the windings 12, 12′. Furthermore, to maintain the balance between windings 10 and 11 and 10′ and 11′, resistances r' equal to r are placed in the local circuits. These latter are in addition to resistances r^2, used to equalize the resistance of the local circuits through windings 10 and 10′ and the trunk circuits through windings 11 and 11′. The novel relations and functions of the elements not previously described will be brought out in the following statement of operation.

It being assumed that the operator at station A trunks a call to station A′ over the line L, L′ upon the insertion of the plug P of her cord C in the jack J of this trunk, relay R^2 is energized from battery B over the sleeve strand of the cord, sleeve contacts of the plug and jack, and local conductor 13 of the trunk. At its contact 14 relay R^2 connects battery to a point 14′ between the windings 10 and 11 of relay R^3. From this point current flows to ground locally through the winding 10 and resistances r' and r^2, and also over the trunk to station A′, the latter circuit including winding 11 of relay R^3, resistance r, winding 15 of the retardation coil I, trunk conductor L, windings 15 of retardation coil I′, resistance r at station A′, winding 11′ of relay $R^{3'}$, conductor 16 and contact 17 of relay $R^{2'}$ to ground. Because of the differential character of windings 10 and 11, relay R^3 does not attract its armature if the currents flowing therethrough are equal. So far as operating currents are concerned, this is provided for by substantial equality of resistance of the circuits of windings 10 and 11. The widely separated grounding points G and G′ may, however, at the time be under the influence of substantial differences of ground potential, and whatever current from this source circulates in the windings 11 and 11′ of relays R^3 and $R^{3'}$, respectively, passes equally over the compensating conductor L′ and oppositely through the windings 12 and 12′. The effect of ground potential upon relays R^3 and $R^{3'}$ is therefore neutralized and their proper operation is not interfered with. Relay $R^{3'}$ is energized and at contact 18 completes the circuit of lamp O′ through the resting contacts 19 and 20 of relays $R^{2'}$ and $R^{4'}$, respectively. The operator at station A′ observing this signal inserts the plug P′ of her cord circuit C′ in the jack J′ of the trunk L, L′, energizing relay $R^{2'}$ through the sleeve circuit from battery B′. This extinguishes the lamp O′ by opening contact 19. At its contact 21 a path for current through relay $R^{4'}$ is formed by way of its contact 20 and contact 18 of relay $R^{3'}$. Relay $R^{4'}$ locks itself at contact 21′ and at contact 22 bridges the condenser c' in the trunk so that the answering supervisory relay R^6 in the cord circuit C′ may operate. Relay $R^{2'}$ also transfers the connection of conductor 16 from ground contact 17 to battery contact 22′. The batteries B and B′ of stations A and A′ now oppose one another and consequently the windings 11, 11′ of relays R^3 and $R^{3'}$ receive no operating current, the equalization of effect with respect to earth currents being maintained by the windings 12, 12′ of these relays. Current still flows from battery B through winding 10 of relay R^3, and winding 10′ of relay $R^{3'}$ now has current from battery B′ by way of contact 22′, conductor 16 and resistances r' and r^2. Relay $R^{3'}$ therefore remains operated and relay R^3 attracts its armature. There is now a circuit for relay R^4 by way of contact 23 of relay R^3, break contact 24 of relay R^4 and front contact 25 of relay R^2. The consequent operation of relay R^4 causes it to lock itself through contact 26 and to close at contact 27 a bridge of condenser c to energize the calling supervisory relay R^5 in the cord circuit C. This completes the signaling operations incident to originating a connection.

If when disconnection is desired the operator at A′ withdraws the plug P′ from the jack J′ the circuit of relay $R^{2'}$ is severed at the sleeve contacts of the plug and jack. Releasing, it removes battery B′ from the windings 10′ and 11′ of relay $R^{3'}$ at contact 22′ and unites ground thereto at contact 17. Though the winding 10′ no longer receives current there is a circuit from battery B at station A over the trunk for the windings 11 and 11′ of relays R^3 and $R^{3'}$. As previously pointed out, compensating earth currents flow in the windings 12 and 12′ of the relays. Relay $R^{3'}$ consequently remains energized, as does relay $R^{4'}$. The latter prevents the illumination of the lamp O′ by holding open contact 20. The current in the winding 11 of relay R^3 now balances that in winding 10, so the armature if said relay is retracted. At contact 23 the circuit of relay R^4 is broken and this at contact 27 opens the bridge of condenser c to release the supervisory relay R^5 in the cord circuit C. Upon the consequent lighting of the calling supervisory lamp o the operator at station A removes the plug P from jack J and the release of relay R^2 opens contact 14. This cuts off battery from the circuit of relays R^3 and $R^{3'}$, the breaking of contact 18 of the latter deënergizing relay R^4. The system is now restored to its normal condition.

It will be obvious that instead of the ground return above described a common metallic return conductor X might be employed as illustrated in Figs. 1^a and 1^b, which are in other respects identical with Figs. 1 and 2 above described and therefore

require no further detailed description. In this modified arrangement, the battery for signaling between stations A and A′ would be independent from that used to operate local relays and lamps. In this case the differences of potential for which it would be necessary to compensate are due to the drop in potential between the stations through the resistance of the conductor X.

I claim as my invention:

1. In a system for compensating for differences of potential, signaling stations, a plurality of signaling conductors connecting the stations, a compensating conductor connected to the signaling conductors at the stations, and a relay at each station provided with a winding in its respective signaling conductor, there being windings for all the relays included in the compensating conductor and being equal and opposite in effect to the windings in the signaling conductors.

2. The combination with separated stations, a plurality of line circuits connecting the stations, a relay at each station for each line circuit, an operating circuit for the relays of each line, said operating circuit including a conductor of a line circuit, and a compensating circuit for the relays including a line conductor different from those utilized for the signaling circuits.

3. In a system for compensating for differences of potential, signaling stations, a plurality of signaling conductors connecting the stations, a compensating conductor connected to the signaling conductors at the stations, a relay at each station provided with a winding in its respective signaling conductor, there being windings for all the relays included in the compensating conductor and being equal and opposite in effect to the windings in the signaling conductors, and a resistance included in each signaling conductor corresponding to the resistance of the other compensating windings than those associated with its relays.

4. In a system for compensating for ground potentials, a plurality of grounded signaling circuits, a grounded compensating circuit exposed to substantially the same differences of ground potential as the signaling circuits, and electromagnetic signal controlling devices each having a plurality of windings, two of which are inductively opposing one of the two being in one of said signaling circuits, there being associated with each electromagnetic device another winding included in the compensating circuit and producing an effect opposite to that in the signaling circuit.

5. The combination with a signaling circuit having separated ground connections subject to differences of ground potential, a compensating circuit grounded at points subject to said difference of ground potential, and a signal controlling relay provided with differential windings one of which is in the signaling circuit and with an oppositely acting winding in the compensating circuit.

6. The combination with signaling stations, of a signaling conductor connecting the stations, a common return therefor, a circuit local to one of the stations, a compensating conductor extending between the stations and being connected to the common return, and an electromagnetic device having windings in the signaling conductor, in the local circuit and in the compensating conductor.

7. The combination with signaling stations, of a signaling conductor connecting the stations, ground connections for the signaling conductor at each station, a circuit local to one of the stations, a compensating conductor extending between the stations and being provided with ground connections thereat, and an electromagnetic device having windings in the signaling conductor, in the local circuit and in the compensating conductor, the first two windings being differential and that of the compensating conductor being opposite in its effect to that in the signaling conductor.

8. In a telephone system, central stations, a trunk line between the stations subject to differences of potential, signals at the stations, a relay at each station acting to control the signals, an operating circuit for the relays including a conductor of the trunk, and a compensating circuit common to said relays, both of said circuits being subjected to like potentials at both stations.

9. In a telephone system, central stations, a trunk line between the stations subject to differences of potential, signals at the stations, a relay controlling the signals, an operating circuit for the relay including a conductor of the trunk, and a compensating circuit for the relay including another conductor of the trunk, both of said conductors being subjected to like potentials at both stations.

10. In a telephone system, central stations, a trunk line connecting the stations subject to differences of potential, signals situated at the stations, a relay at each station acting to control the signals, an operating circuit for the relays including a conductor of the trunk, and a compensating circuit for the relays including a trunk conductor, both of said circuits being subjected to ground potentials at both stations.

11. In a telephone system, central stations, a trunk line connecting the stations subject to differences of potential, signals at the stations, a relay at each station having a plurality of windings and acting to control the signals, a circuit through the windings of said relays including a trunk conductor, and

a compensating circuit for other equal and opposite windings of the relays, said circuit also including a trunk conductor.

12. The combination with separated stations, of a plurality of line circuits connecting the stations, a signal for each line circuit, a relay controlling each signal, an operating circuit for the relay of each line, said operating circuit including a conductor of a line circuit and a common return, and a compensating circuit for the relays including a line conductor different from that utilized for the signaling circuit and the common return.

13. The combination of two physical telephone circuits and a phantom circuit formed therefrom, of signals associated with each circuit, a relay controlling the signals of each circuit, separate circuits for independently governing the relays, said circuits being furnished by three of the four conductors of the physical circuits and ground connections therefor, and a common compensating circuit for all the relays furnished by the fourth conductor and ground connections therefor.

In testimony whereof, I have signed my name to this specification this seventh day of May, 1917.

HENRY M. BASCOM.