(No Model.) 4 Sheets—Sheet 1.

F. A. PICKERNELL.

TWO STATION TELEPHONE CIRCUIT.

No. 511,276. Patented Dec. 19, 1893.

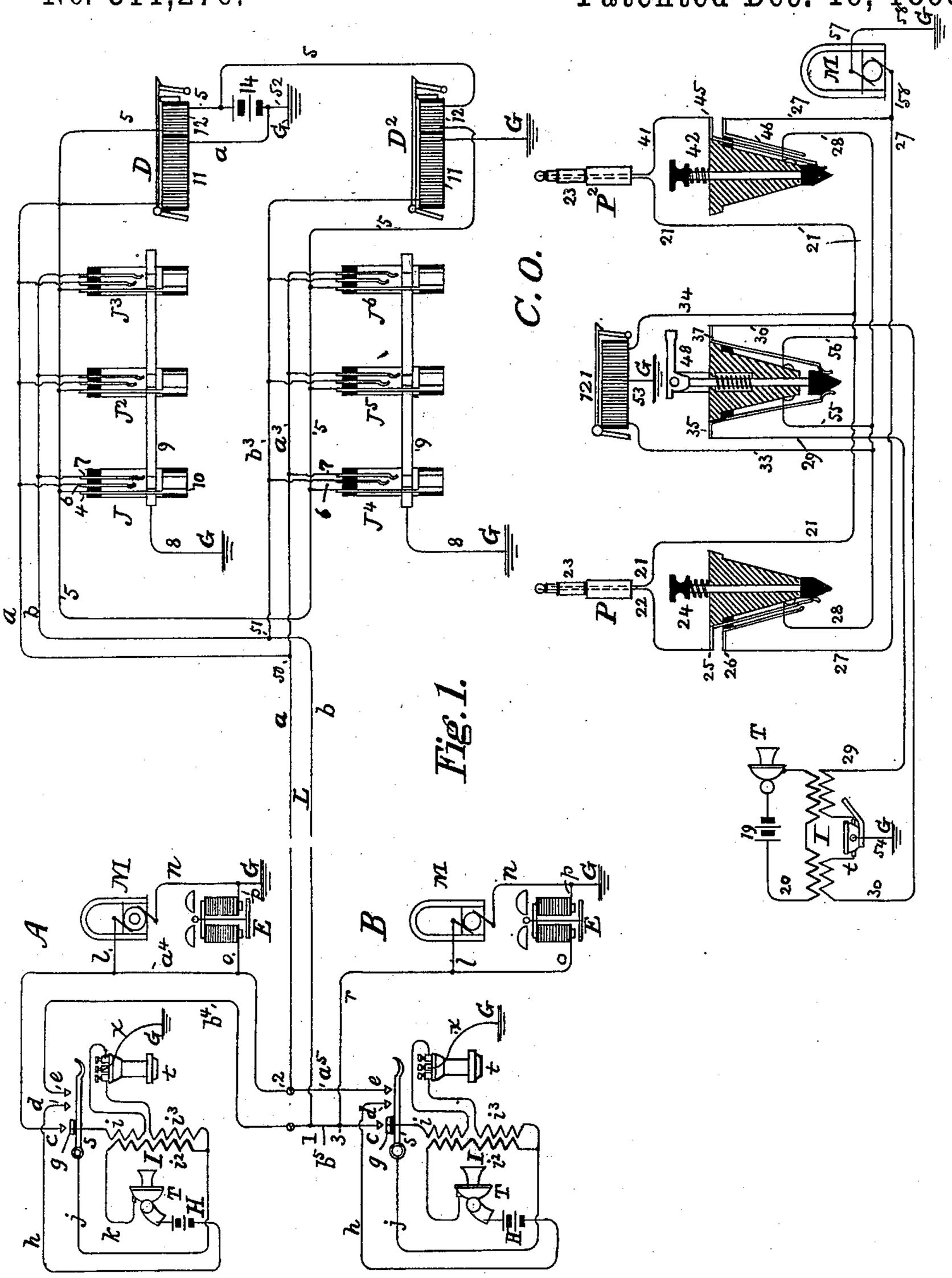

Fig. 1.

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(No Model.) 4 Sheets—Sheet 2.

F. A. PICKERNELL.

TWO STATION TELEPHONE CIRCUIT.

No. 511,276. Patented Dec. 19, 1893.

Fig. 1a

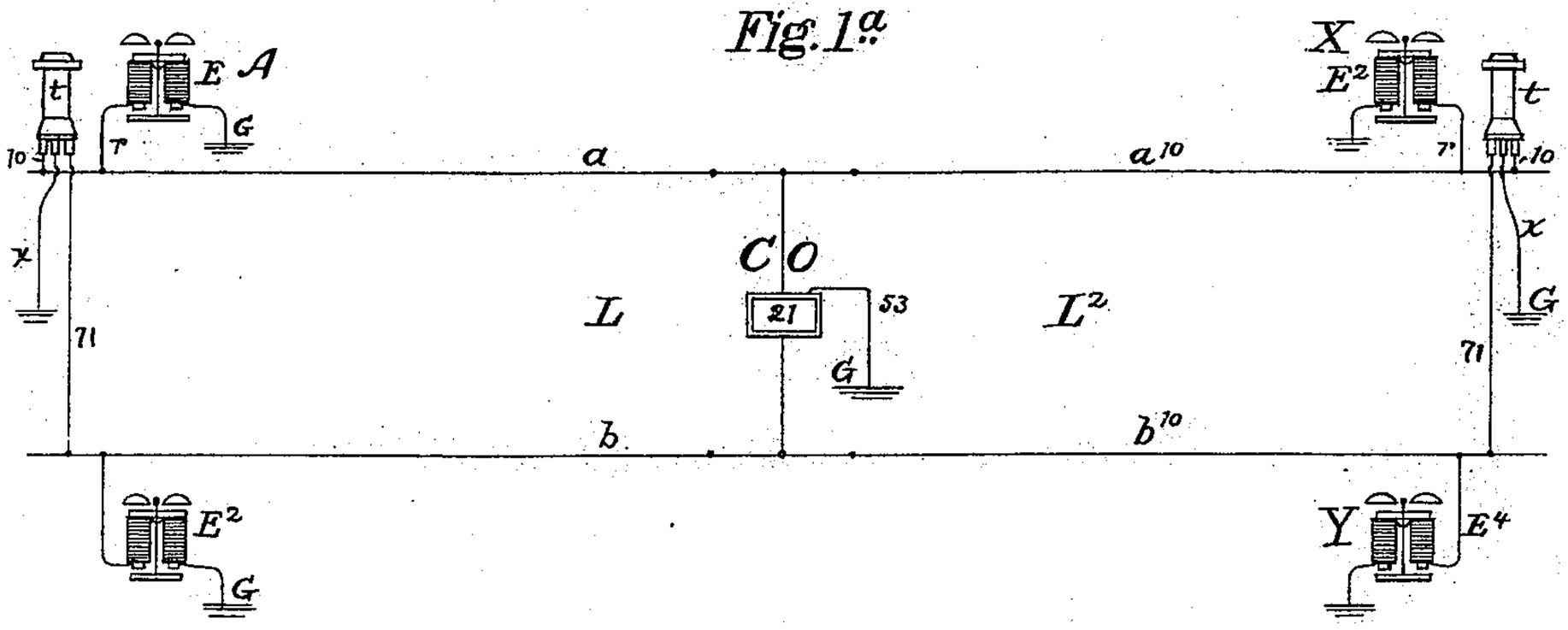


Fig. 6.

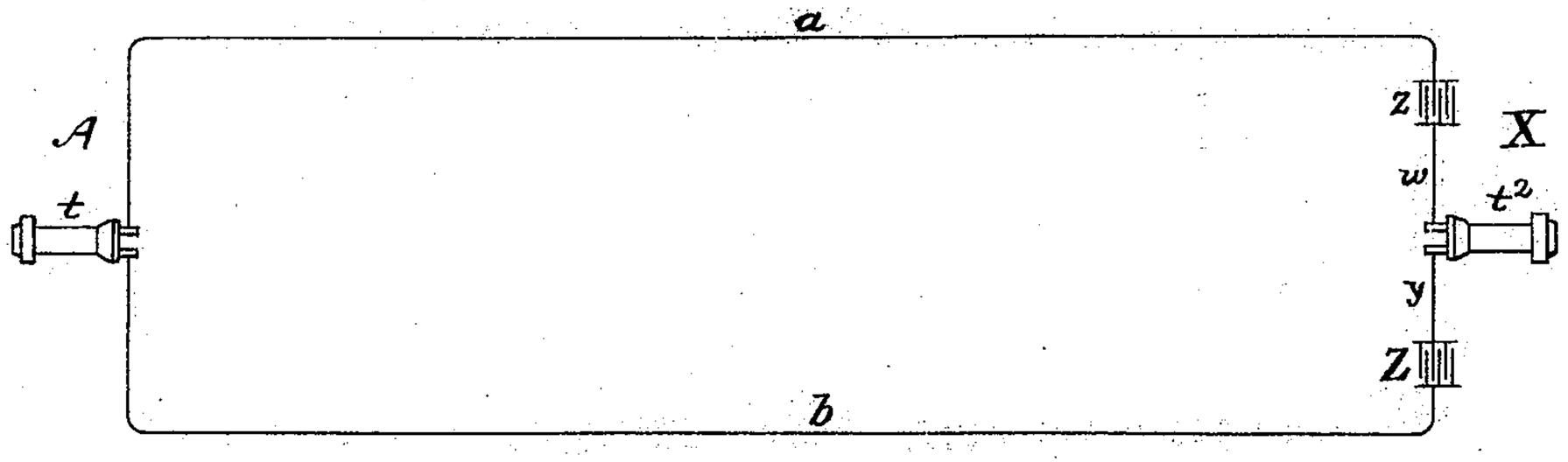
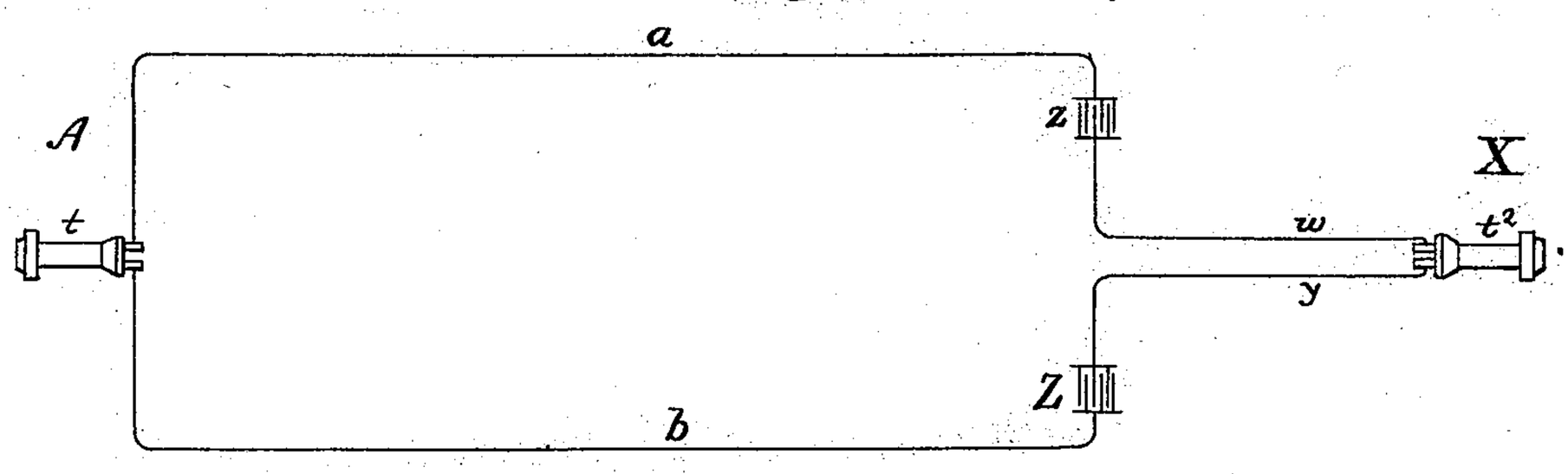


Fig. 7.



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(No Model.)

4 Sheets—Sheet 3.

F. A. PICKERNELL.

TWO STATION TELEPHONE CIRCUIT.

No. 511,276. Patented Dec. 19, 1893.

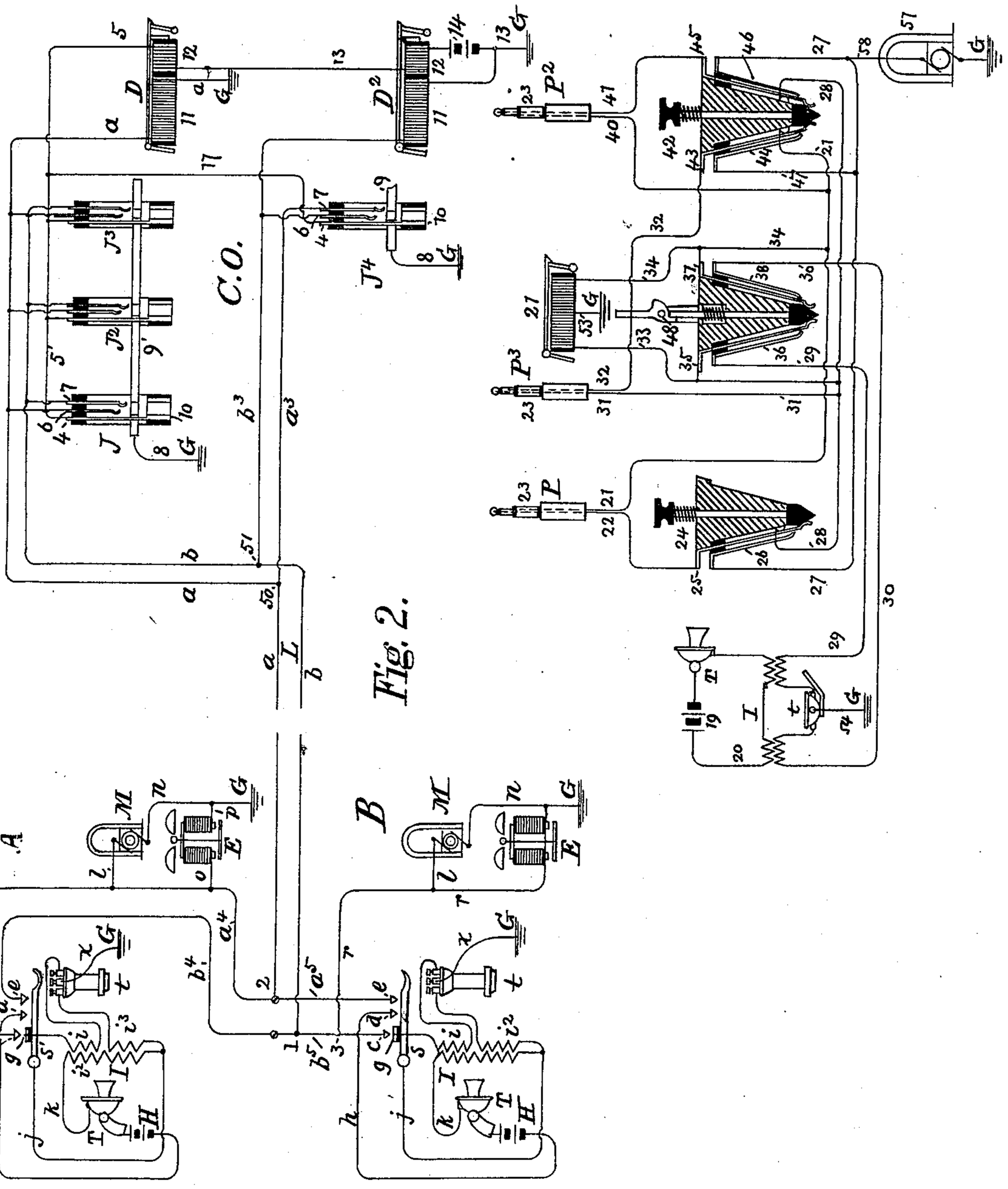

Fig. 2.

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F. A. PICKERNELL.

TWO STATION TELEPHONE CIRCUIT.

No. 511,276. Patented Dec. 19, 1893.

Fig. 4.

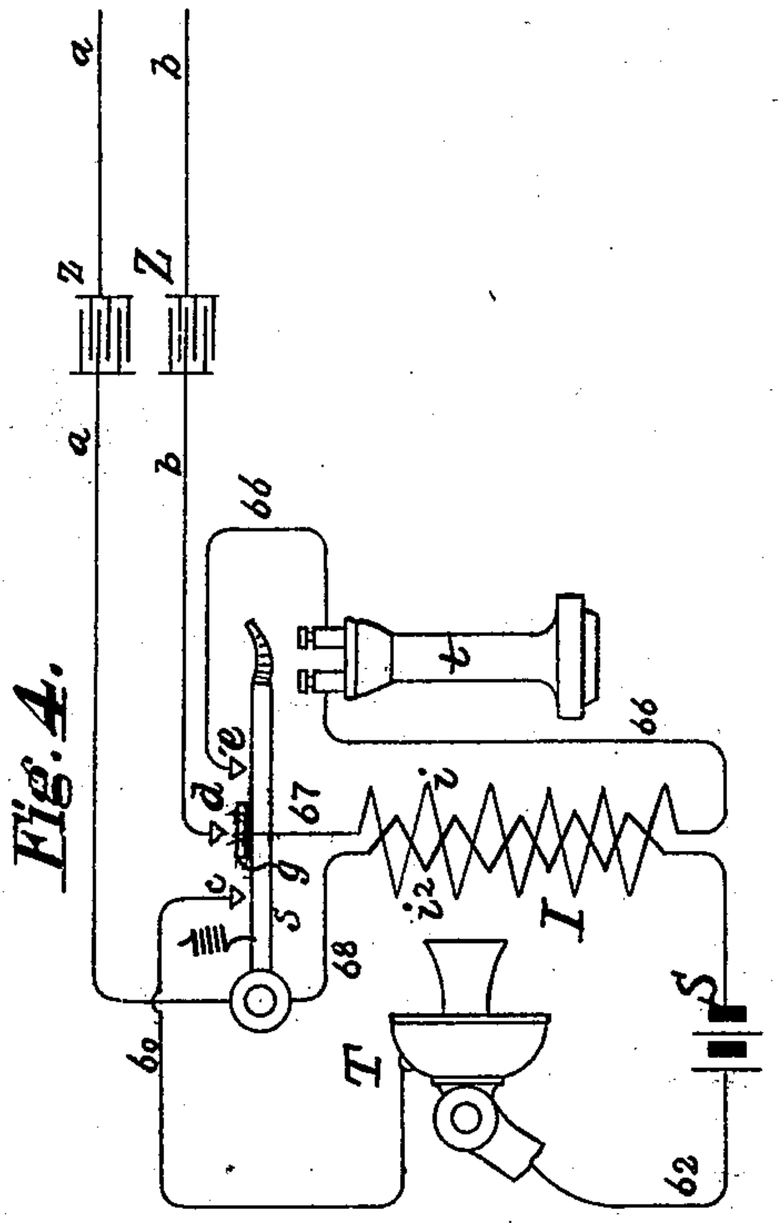


Fig. 5.

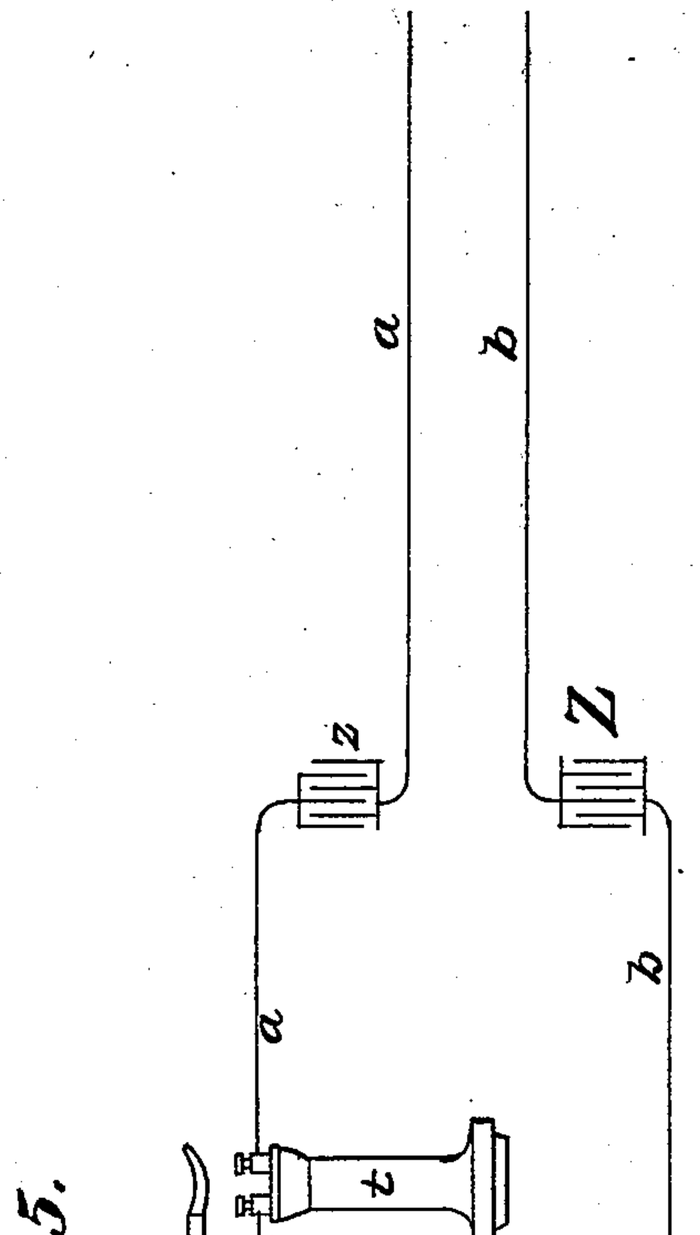
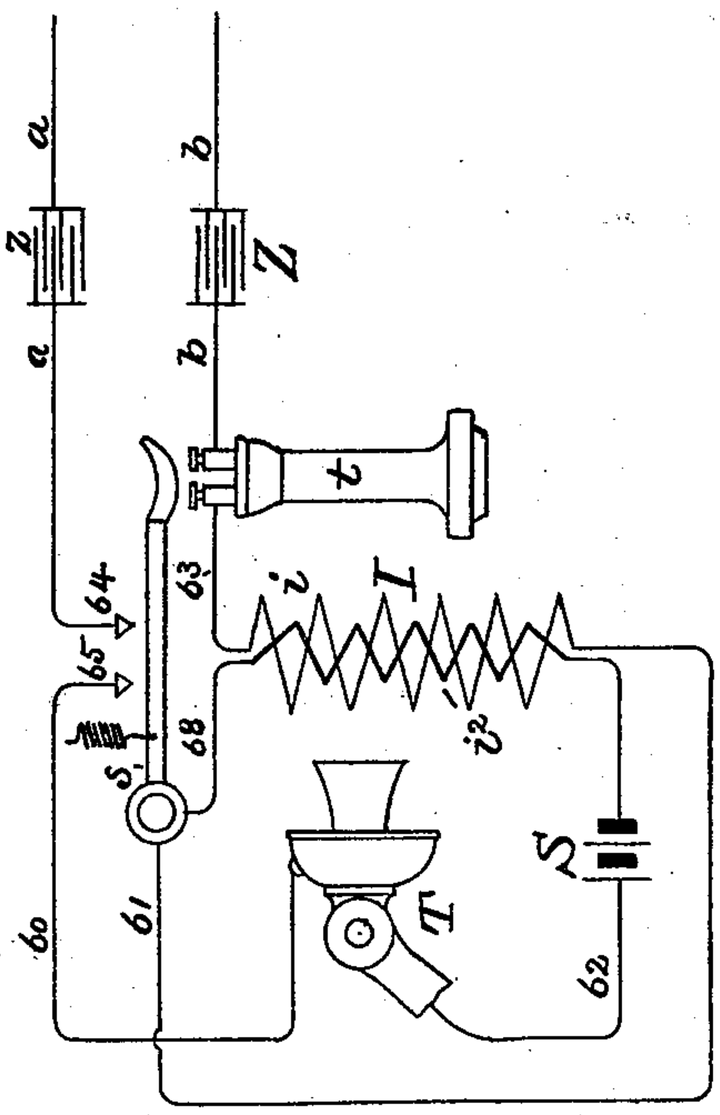


Fig. 3.



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UNITED STATES PATENT OFFICE.

FRANK A. PICKERNELL, OF NEWARK, NEW JERSEY.

TWO-STATION TELEPHONE-CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 511,276, dated December 19, 1893.

Application filed August 7, 1893. Serial No. 482,570. (No model.)

To all whom it may concern:

Be it known that I, FRANK A. PICKERNELL, residing at Newark, in the county of Essex and State of New Jersey, have invented certain Improvements in Two-Station Telephone-Circuits, of which the following is a specification.

This invention relates to telephonic switchboard interconnecting systems and circuits by means of which the subscribers at the several associated substations may call the central station and be placed by an operator there in electrical connection with any one of the said associated substations; and by means of which any one of the central station operators may receive calls, make tests, signal the substations, and perform all the acts necessary to effect the connection and disconnection of the substations with and from each other. It has been found desirable to connect the substations with the central station by means of metallic circuits or circuits consisting of two conductors, instead of by grounded circuits or circuits in which the ground acts as one side of the circuit, and preferably to place but one substation in the circuit. A multiple switchboard arranged and wired throughout all its sections, to effect connections and disconnections for the metallic circuit substation circuits associated therewith, is very much more costly in its construction and maintenance than one to which grounded substation lines are connected, and to reduce the expense per substation, and at the same time increase the facilities for extending the system are the objects of my invention. It has been found that there is a wide difference in the use of the telephone by the different subscribers to an exchange; in the business part of a town or city, the use is more frequent than in the residential part, and in each part there are substations who use their telephones much more frequently than do others.

My invention applies chiefly to the circuits which are in less frequent use and with such circuits I associate more than one substation; heretofore it has been customary to connect more than one substation upon telephone circuits but only to a limited extent has this been done in the case of metallic circuits. Lines of such character have been designated as party lines or circuits.

The particular circuit arrangements which I have devised to effect the purpose desired, are applicable to the form of switchboard known as the branch terminal multiple board. My invention comprises the association of two substations with each metallic circuit and an arrangement of circuits and apparatus whereby either of the substations may call the operator at the central station, without disturbing the other station and may give direction to be connected with one of two substations upon a similar or other metallic circuit; and whereby the operator may call the desired station without disturbing its associated station, and put the two stations in circuit with one another. And at the same time by the operation of so connecting the said two stations, the two idle stations on the circuits which are not connected, are prevented from using the line, and are compelled to wait until the connected stations are disconnected before they can attract the attention of the central station operator and themselves effect a conversational connection. The metallic circuit thus branched to the two substations extends to the central station where it may in the first instance divide or branch and pass through the several sections of the open branched terminal switchboard as two separate metallic circuits each being provided with spring jacks and with a locking calling annunciator and an answering jack; or in the second instance extend through the several sections of the switchboard as a single metallic circuit provided with spring-jacks and with separate locking calling annunciators and answering jacks. In association with the several terminal and answering spring jacks there is a common metallic strip, having a permanent ground connection; and the test rings of all of the said spring jacks are connected in a normally open circuit which includes the locking coils of the calling annunciators and a battery. The connecting plugs are provided with insulated metal shanks and when inserted in either of the jacks short circuit the metal strip with the battery circuits, locking the line annunciators of the several circuits, so that a call cannot be

received from any other associated station while a call is being attended to by the operator or while two substations are connected together for conversation; at the same time the test rings of the connected and associated substation jacks are thus arranged to test busy. Where two substations are thus connected to a metallic circuit, in connecting the said circuit with the two switch board circuits, one side of the pair of conductors is connected to the inner spring of the spring jack of one subscriber's circuit and to the outer spring of the spring jack of the other subscriber's circuit. One side of the office generator is grounded, and the plug is so connected to the ringing key, that the tip of the plug is always connected to the insulated side of the generator, while the sleeve of the plug is always connected to the grounded side of the generator by means of a grounded connection from the center of the clearing out annunciator. And as far as signaling the associated substations from the central station is concerned, they are operated selectively and as though they were grounded circuit stations and had separate circuits through the switchboards. In either of first or second instances mentioned the arrangement of apparatus and circuits at the substations is the same, both limbs of the circuit being normally open, when the receiving telephone is hung upon its hook lever. The relatively opposite conductors of the two branch circuits, at their respective stations, have legged thereto two grounded branches, one of which includes a high resistance signal bell, and the other of which is normally open and includes a magneto generator.

The usual telephones are provided, the receiver being placed in the center of the induction coil secondary and having a branch to ground from the center of its coil. There is an insulated metal contact upon the switch by means of which the secondary coil is connected to line. I show several modifications of substation circuits to avoid the employment of the split induction and receiver coils.

Of the drawings forming a part of this specification Figure 1 is a diagram illustrating the circuits and apparatus of a metallic circuit, having two associated substations and extending to a branch multiple switchboard where it divides, each division passing through the several sections thereof as two separate metallic circuits. Fig. 1^a is a diagram illustrating the connection of two metallic circuits upon each of which are two associated substations. Fig. 2 is a diagram illustrating the circuits and apparatus of a metallic circuit having two associated substations, and extending to a branch multiple switchboard, where it passes through the several sections thereof as a single metallic circuit. Figs. 3, 4, and 5 are modifications of substation circuits and apparatus, and Figs. 6 and 7 are diagrams illustrative of the phenomena attending the use of condensers in telephonic circuits.

Referring to Fig. 1: L is a metallic circuit extending between the substations A B and the central office C. O. The two conductors *a b* of the circuit L extend to normally open contact points *c d e* in each substation. The substations are treated "selectively" from the central station, and to this end conductor *a* may be called the incoming wire for station A, and conductor *b* the incoming wire for station B; and to conductor a^4 of station A, which is a continuation of main conductor *a*, are legged two grounded branches *o. p.* and *l. n*, in the former of which is placed a high resistance call bell, E, and in the latter is located a normally open calling generator, M; and at station B the call bell and generator are similarly connected in the relatively opposite conductor, b^5, which is a continuation of the main conductor *b*. The bell and generator branches at station B are connected in conductor b^5 through a conductor *r*, which joins b^5, at the point 3. At both substations the transmitting telephone T is connected in the primary of induction coil I, one side of which extends from contact *d*, by wire *h*, to battery H, and the other side of which is connected by wire *j* to the switch hook lever *s*. One side of the secondary of the induction coil is connected to the insulated plate, *g*, on the lever, *s*, while its other side is connected with wire, *j*, a receiving telephone, *t*, being looped to the center of the said secondary coil, the coil of which is grounded at its center.

The metallic circuit L enters the central station C. O. and divides at points 50 and 51, the circuits *a*, *b* and a^3, b^3, continuing through the open branch terminal springjacks J, J^2, J^3 and J^4, J^5, J^6 respectively, as separate branches or circuits. The conductor, *a*, of one circuit extends through the switchboard and branches to the tip springs, 6, of each spring jack, J, and the main coil, 11, of line annunciator D to ground; its other side or conductor, *b*, branches to each of the sleeve springs of the jacks, J; while the conductor a^3 of the other circuit extends through the switchboard and branches to the sleeve springs 7 of the spring jacks J and its other side or conductor, a^3, branches to the tip springs, 6, of the said jacks and through the main coil 11 of the line annunciator, D^2, to ground. A local test wire, 5, connects the test rings 10 of each spring jack J in a metallic circuit and includes the locking coils 12, 12, of each line annunciator D and D^2 and is provided with a grounded branch 52 including a battery, 14. A grounded metal strip, 9, extends through the spring jacks, J, of each circuit inside of the test rings 10.

The operator's outfit includes the plugs P and P^2, the sleeves of which are connected by wire 21, the tips being normally connected from plug P, by wire 22, spring 25, wire 28, spring 45, and wire 41; spring 26 of key 24 is

connected to spring 46 of key 42, by wire 27, which has a grounded branch 58 including a calling magneto generator 57. The clearing out annunciator, 121, is bridged in between the wires, 21, and 28, and has a ground branch, 53, from the center of its coil. The listening key, 48, is bridged to the looping wire, 21, and 28 by wires 55 and 56, its springs 35 and 37 being connected to the secondary of the induction coil I by the wires 29 and 30 respectively. The said secondary includes a receiving telephone, *t*, grounded at the center of its coil. T, is the operator's transmitter in the primary circuit of induction coil I, with battery 19. The plugs P and P^2 are provided with an insulated sleeve 23, for a purpose to be hereinafter described.

The operation of the circuits just described is as follows: For example suppose substation A of circuit L wishes to converse with any station X of a similar metallic circuit. By operating the magneto generator M a circuit is established from ground G, wire, *n*, *l*, wire, a^4, conductor, *a*, through coil, 11, of line annunciator D to ground G at central station. As the branch a^5 from the conductor, *a*, which enters the associated substation B is open, normally, there is no disturbance there when the generator of station *a* is operated, as described. The operator at the central station noticing the fall of the annunciator shutter, takes either one of the plugs, say plug P, and inserts it in the answering jack J, and operating the lever 48 connects the telephone T and *t* into circuit with subscriber at substation A, who meanwhile has taken the telephone *t* from its hook lever *s*, which act causes the lever to rise and bring the contact *c* in connection with insulated metal plate *g*, and the contacts *d* and *e* with the metal substance of lever *s*. A circuit is now established between the central and substations which may be traced as follows: Starting from one side of the operator's telephone by wire, 29, spring, 35, wires, 55, and, 28, spring 25, wire 22, tip of plug P, spring, 6, of jack J, conductors, *a* a^4, metal plate *g*, secondary *i* and i^3 of induction coil I, wire *j*, contact *e*, conductors b^4 and *b*, spring 7 of jack J, sleeve of plug P, wires 21 and 56, spring 37 and wire 30 to the other side of operator's telephone *t*. At the substation, the local circuit was completed from one side of the battery H, transmitter T, primary of induction coil I, wire *j*, lever *s*, and wire *h* to other side of battery H. The insertion of the plug P in the jack J caused the multiple jacks J of both substations A and B to test busy and also locked both line drops; this was caused by the insulated sleeve 23 of the plug making a connection between the test ring 10, frame 4, and the common metal strip 9, and forming a circuit from ground, wire 8, metal strip 9, frame 4; metallic circuit 5 which includes the locking coils 12, of both line annunciators D and D^2 and through battery 14 to ground G. The battery 14 is thus grounded and a current circulates therefrom in the circuit thus formed. The associated substation B is thus prevented from calling the central station, and the other sections of the switchboard are notified that the line is in use, when a test is made. After finding the number of the line wanted, the operator lifts the other plug of the pair P^2 and after touching the test ring 10 of the line terminal jack of the circuit to see if the line is busy or not, and finding it not engaged, inserts the plug into the jack, and rings by depressing the ringing key 42. A circuit would thus be formed from ground G, wire 58, generator 57, wire 27, springs 46 and 45, wire 41, tip of plug P^2, spring 6 of jack J, and (see Fig. 1^a) by conductor, a^{10}, of circuit L^2, through the one thousand ohm bell E^2 to ground G. It will be noticed that in connecting the incoming metallic circuits L and L^2 with the two switchboard circuits, one side of each pair is connected to the inner spring of the spring jack of one substation circuit and to the outer spring of the spring jack of the other substation circuit. One side of the generator at the central station is grounded and the plug so connected to the ringing key that the tip of the plug is always connected to the insulated conducting side of the generator while the sleeve is always connected to the grounded side of the generator. I thus insure ringing the bell whose line is connected with the inner spring of that spring jack. It will be seen that the two substations are signaled as though they were grounded circuit stations and had separate circuits through the switchboard.

Fig. 1^a illustrates the connection between the substations A and X upon the two metallic circuits L and L^2 through the central station C. O. The insertion of the plug P^2 in jack of substation X locks the line drops of both stations X and Y and causes their lines to test busy, as previously described of the insertion of plug P in jack of station A. The connection being now completed, should either substation signal they cannot call the central station, as their line drops are locked, nor can they ring either of the bells of A or X as before the current could reach the bells it would go to ground after passing through half of the telephone of station rung. Upon the termination of conversation, ringing off by either connected substation creates a circuit from the ground there to ground by way of wire 53 from the center of clearing out annunciator 21.

In order to obviate the use of split induction coils and split receivers at the substations I may use either of the circuits shown in Figs. 3, 4, and 5. In these circuits I connect both sides of the metallic circuit L through small condensers Z and Z, the capacity of which is not to exceed 0.3 of a microfarad. The use of such small condensers through which speech may be transmitted is warranted by the following facts: I have found that where a telephone is connected through a condenser to line, the condenser

need only have a capacity sufficient to transmit energy enough to operate the receiver. If however, the condenser is looped into the line at an intermediate point, the condenser has got to be large enough to transmit sufficient energy not only to operate the receiver but also to charge up the intervening line. This is shown clearly by the comparison made in connection with Figs. 6 and 7. Fig. 6 shows a line of very considerable length with a telephone at each end connected to the line through two condensers, and Fig. 7 shows a similar line with the condensers connected at the middle of the line.

In Fig. 6 if transmission is from A to X the condensers z Z can be of very small capacity as they only have to transmit energy enough to energize the receiver t^2. If the transmission is from X to A these condensers being placed at the terminals of the transmitter are charged to the maximum electro-motive force and consequently transmit energy enough to charge the whole line and also to operate the receiver at A.

In Fig. 7 if we have the transmission from A to X the condensers z Z have to be large enough to transmit not only energy to operate the receiver t^2 but also to charge up the intervening line w, y. If the transmission is from X to A there is a considerable fall in the difference of potential along the intervening line to the condensers z and Z and consequently they have to be larger than the condensers z and Z of Fig. 6 in order to transmit energy enough to charge up the intervening line and operate the receiver A. In the metallic circuit party-line circuits, which I describe herein, these condensers are always connected close to the terminals of the transmitting and receiving telephones, and consequently the condenser through which telephone transmission takes place may be small, the conditions being analogous to those shown in Fig. 6. By making these condensers of very small capacity the comparatively slow alternating ringing current from station A to station X cannot pass through.

In Fig. 3, a substation circuit is shown in which the telephones are introduced therein by the hook switch lever s closing against two contacts 64 and 65. The conductors a and b including the condensers z and Z are open when the telephone is on the hook lever.

In Fig. 4 a substation circuit is shown in which the telephones are introduced therein by the hook switch lever closing against three contacts c, d, and e, the contact g being insulated from the lever; and in Fig. 5 a substation circuit is shown in which the telephones are introduced therein by the hook switch lever closing against one contact 65, and this effects simply the closing of the primary circuit of the induction coil, the two conductors a, b of the circuit L being constantly closed through the secondary of the induction coil and including the condensers z and Z and the receiving telephone. The operation of these three modifications of substation circuits will be readily understood without further description.

Fig. 2 illustrates a modification of Fig. 1, in which the main metallic circuit extending between two associated substations and the central station passes through the switchboard as one circuit. In this case the arrangement of circuits at the substations is the same as described in Fig. 1. Upon the switchboard the main circuit conductors a b are represented upon each section by a spring jack J, and the two substations are represented by separate answering jacks J^3 and J^4 and line annunciators D and D^2 and consequently they must be known by the same number and with suitable designating letters affixed thereto; the conductor, a, extends through the jacks J and line annunciator D to ground, while the conductor, b, branches to the shank springs of each jack; a leg b^3 extends from conductor b with a branch to the tip spring 6 of answering jack J^4 through line annunciator D^2 to ground, and another leg, a^3, extends from conductor, a, to the shank spring 7 of the jack J^4. A common test wire 5 extends from the test rings 10 of the several jacks through the locking coils of the line annunciators D and D^2 and battery 14 to ground G; a leg 17 extends from wire 5 to test ring of answering jack J^4.

The keyboard or operator circuit comprises one double ringing key 42 and a single ringing key 24. An extra plug P^3 is furnished and is connected to the ringing key 42 in such a way that when it is depressed, the sleeve of said plug is connected to the insulated conducting side of the generator 57, while the plug P^2 is so connected that when the key 42 is depressed, its point is connected to the insulated conducting side of said generator. Without further description I will illustrate how connections are made with this system of circuits. Suppose station A upon metallic circuit L wishes to converse with station X one of the associated substations upon a similar metallic circuit. The current from the generator M passes over the conductor a, and causes the shutter of line annunciator D to fall, and removing the telephone t from its hook s connects in the substation apparatus in the same manner as described in Fig. 1. The operator answers by inserting the plug P, in this case the answering plug, into answering jack of the substation A, which causes the multiple circuit to test busy at all other sections of the board, and locks both line drops of the circuit. The operator having learned the number of the desired substation calls up the station either with plug P^3 or with plug P^2 depending upon whether the station called for has an "A" or a "B" affixed to its number. If "A" is affixed to its number, the operator uses plug P^2, and if "B" is affixed to the number, the operator uses plug P^3. If, however, the number called for is not located upon a party line such as herein de-

scribed, the operator would use plug P^2. But for the purpose of this specification station X is the one wanted and having "A" affixed to its number, the plug P^2 is inserted in jack of X. Depressing key 42 rings the bell of the substation connected to the inner spring 6 of the jack because the tip of the plug P^2 is connected to the insulated conducting side of the generator 57. And in a similar manner by using the plug P^3 the substation connected to the outer spring 7 of the jack will be signaled, as the sleeve of this plug is connected to the insulated conducting side of the generator when the key 42 is depressed.

The substation circuits illustrated by Figs. 3, 4, and 5 can of course be employed in connection with the modification shown in Fig. 2.

Having now fully described my invention, I claim—

1. In a telephone system, the combination of a central station and two substations, with a metallic circuit extending from the central station to the substations, both of its conductors entering both substations by normally discontinuous extensions which are adapted to lead through the substation telephones; each of the said extensions leading by sub-extensions from one of its conductors through one of the substation call devices to earth, so that the call devices of the two stations are connected respectively with relatively opposite conductors of the metallic circuit as set forth.

2. In a telephone system, the combination of a central station and two substations, with a metallic circuit extending from the said central station and entering and terminating at the said substations by separate normally open or discontinuous branches, each of said branches being provided in their relatively opposite conductors at each substation with an electric generator in a normally open supplementary earth branch and an electric call bell in a normally closed supplementary earth branch; the said metallic circuit being provided at the central station with branch terminal spring jacks at each section of the switchboard, and each of said substations having separate answering jacks and line annunciators.

3. In a telephone system, the combination of a central station and two substations, with a metallic circuit extending from the said central station and entering and terminating at the said substations by separate normally discontinuous branches, each of said branches having in their relatively opposite conductors at each substation an electric generator in a normally open supplementary earth branch the said metallic circuit being divided into two separate metallic branches at the central station both of which are provided with open branched terminal spring jacks at each section of the switchboard, and with separate answering jacks, and with separate grounded line annunciators; whereby either substation may operate its individual line annunciator.

4. In a telephone system the combination of a central station and two substations with a metallic circuit extending from the said central station and entering and terminating at the said substations by separate normally open branches, each of said branches having in their relatively opposite conductors at each substation an electric call bell in a supplementary earth branch; the said metallic circuit being divided into two separate metallic branches at the central station both of which are provided with open branched terminal spring jacks at each section of the switchboard, and with separate answering jacks and line annunciators; and an operator's outfit consisting of telephones looping plugs listening and ringing keys and an electric generator in a ground branch; whereby either of the substations may be selectively signaled from the central station.

5. In a telephone system, the combination of a central station and two substations, with a metallic circuit extending from the said central station and entering and terminating at the said substations by separate normally open branches, each of said branches having in their relatively opposite conductors at each substation an electric generator in a normally open supplementary earth branch, and an electric call bell also in a supplementary earth branch; the said metallic circuit being divided into two separate metallic branches at the central station both of which are provided with open branched terminal spring jacks at each section of the switchboard; and with separate answering jacks and line annunciators; and an operator's outfit consisting of telephones and listening and ringing keys and an electric generator in a ground branch whereby either of the substations may call the central station, or whereby either of the substations may be selectively signaled from the central station, as set forth.

6. In a telephone system, the combination of a central station and two substations, with a metallic circuit extending from the said central station and entering and terminating at the said substations by separate normally open double conductor branches, each of said branches having in their relatively opposite conductors at each substation an electric call bell in a supplementary earth branch; the said metallic circuit being divided into two separate branches at the central station both of which are provided with open branched terminal spring jacks at each section of the switchboard, and with separate answering jacks and line annunciators, one side of each branch being connected to the inner or tip springs of the jacks in one circuit, and to the outer or sleeve springs of the jacks in the other circuit; and an operator's outfit consisting of telephones looping plugs, listening and ringing keys, and an electric generator in a ground branch, the said plugs being connected to the ringing keys so that their tips are always connected to the insulated conducting side of the generator, while their

sleeves are always connected to the grounded side thereof; whereby either of the substations may be selectively signaled from the central station.

7. In a telephone system, the combination of a central station and two substations, with a metallic circuit extending from the said central station and entering and terminating at the said substation as described; the said metallic circuit being divided into two separate metallic branches at the central station, both of which are provided with open branched terminal spring jacks at each section of the switchboard and with separate answering jacks and locking line annunciators, the test rings of said terminal and answering jacks of both circuits with the locking coils of the said annunciators being connected in a normally open battery circuit; and a metal strip grounded at one end extending to the spring jacks of each circuit as described; and an operator's outfit the looping plugs of which are provided with an insulated metal sleeve; whereby when either of said looping plugs is inserted in either of the said spring jacks, the two line annunciators are locked, and the said test rings will indicate that the said metallic circuit is in use.

8. In a telephone system the combination of a central station and two substations with a metallic circuit extending from the said central station and entering and terminating at the said substations by separate normally open metallic branches there being interposed in each of the conductors of each branch a condenser of small capacity; each of said branches being provided in their relatively opposite conductors with an electric generator in a normally open grounded circuit, and a high resistance call bell in a grounded circuit.

9. In a telephone system, the combination of a central station and two substations with a metallic circuit extending from said central station and entering and terminating at the said substations by separate normally open metallic branches there being interposed in each of the conductors of each branch a condenser of small capacity; each of said branches being provided in their relatively opposite conductors with an electric generator in a normally open grounded circuit, and a high resistance call bell in a grounded circuit; the said metallic circuit being provided at the central station with branched terminal spring jacks at each section of the switchboard, and each of said substations having separate answering jacks and line annunciators.

10. The combination of a double conductor telephone circuit extending between two substations and a central station and branching at its outer end to the said two substations and at its inner end to two switchboards; with telephones and signaling appliances at each substation, the signaling appliances being in normally closed branches of the two main circuit conductors respectively, and the telephones at each station being in a normally open branch of that main circuit conductor which branches to the signaling appliance of the other; a series of spring jacks or plug-sockets on each central switchboard containing branch connections to both of the said main circuit conductors; and an annunciator for each of the said circuit conductors located at the two switchboards respectively; whereby signals may reciprocally be transmitted between either substation and its own central station switchboard independently, and whereby the said two conductors form a double conductor talking circuit from either substation to either switchboard, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 27th day of July, 1893.

FRANK A. PICKERNELL.

Witnesses:
F. S. PERRIN,
A. N. MANSFIELD.