No. 620,733. Patented Mar. 7, 1899.

C. L. BOYCE.

TELEPHONE SYSTEM.

(Application filed Apr. 29, 1898.)

(No Model.) 2 Sheets—Sheet 1.

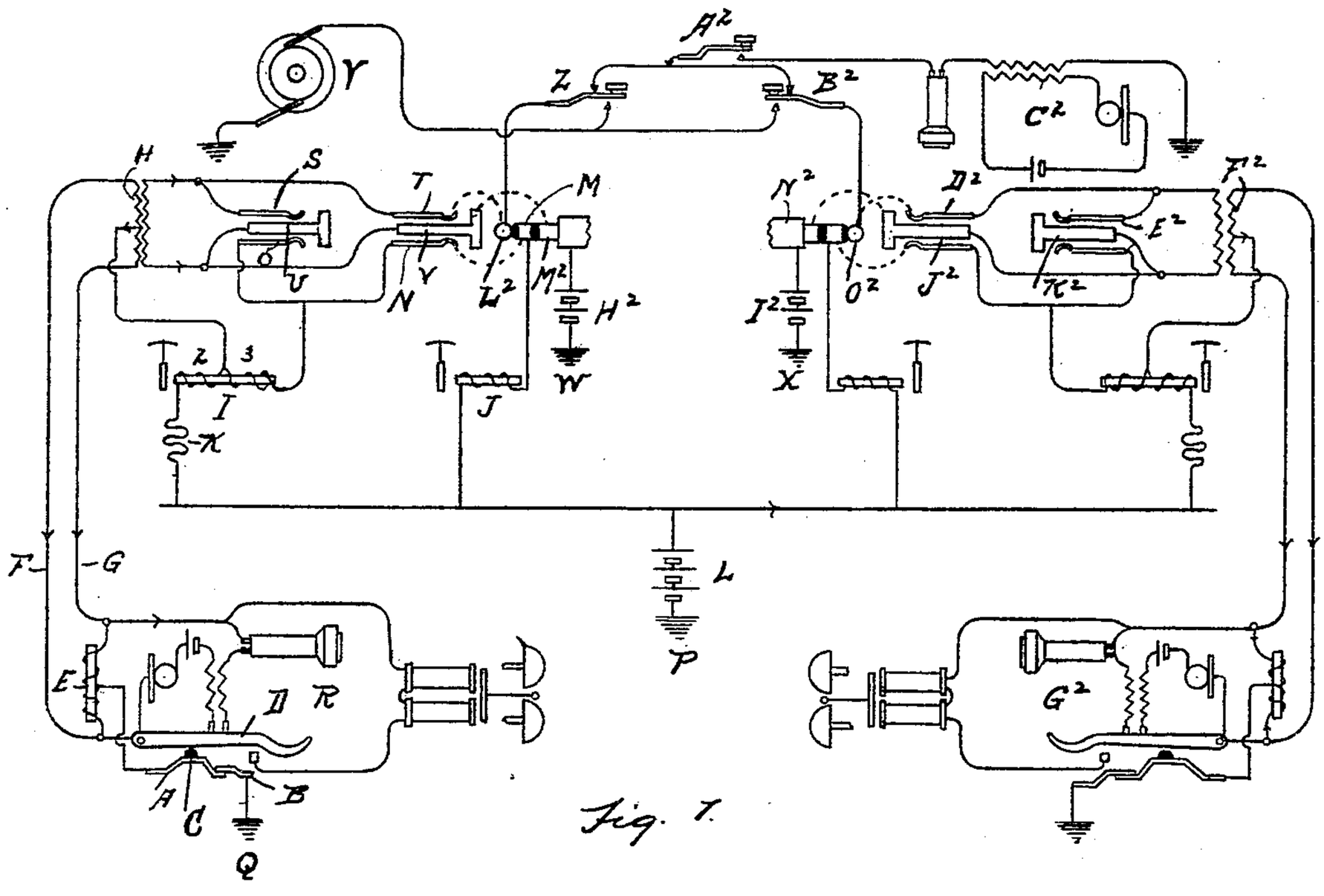

Fig. 1.

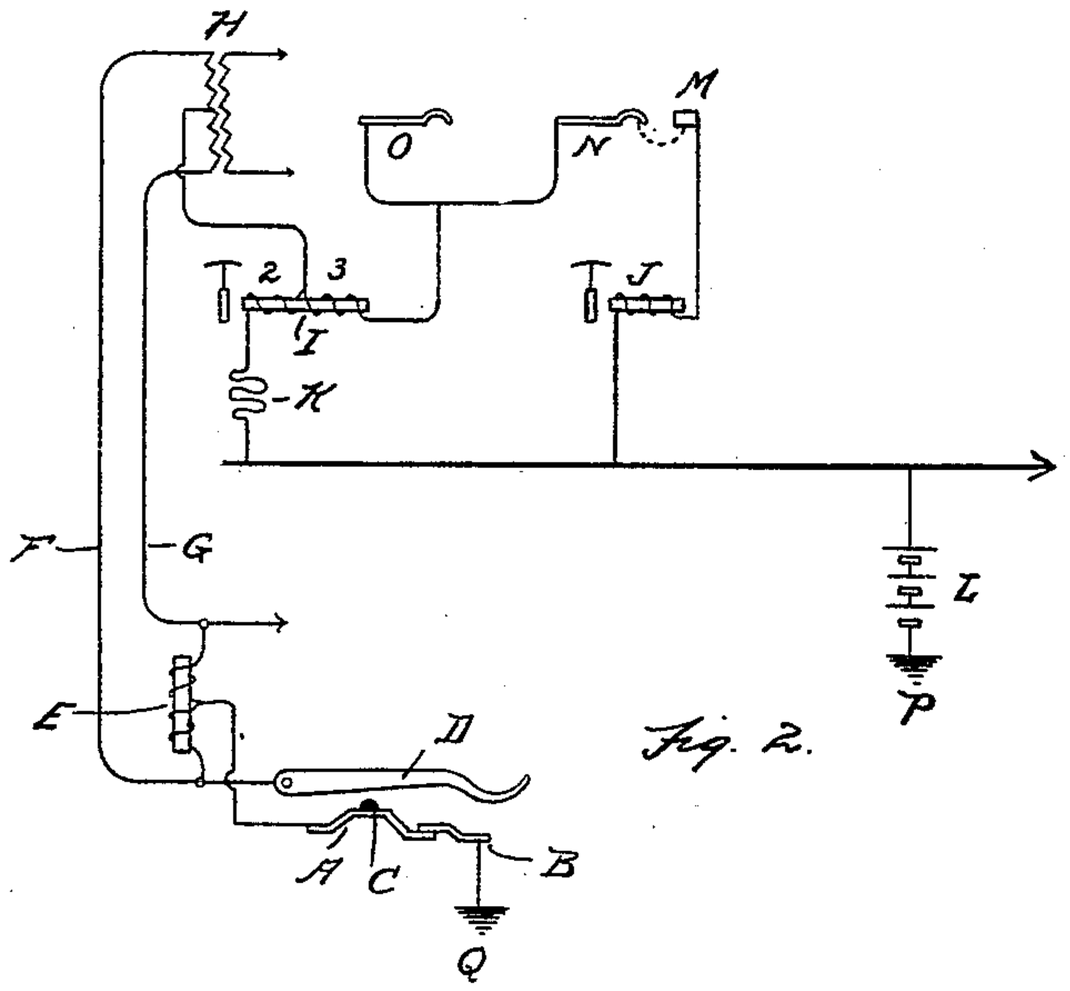

Fig. 2.

WITNESSES
Chas. Wiener
E. L. Jennings

INVENTOR
Charles L. Boyce
By Parker & Burton
Attorneys.

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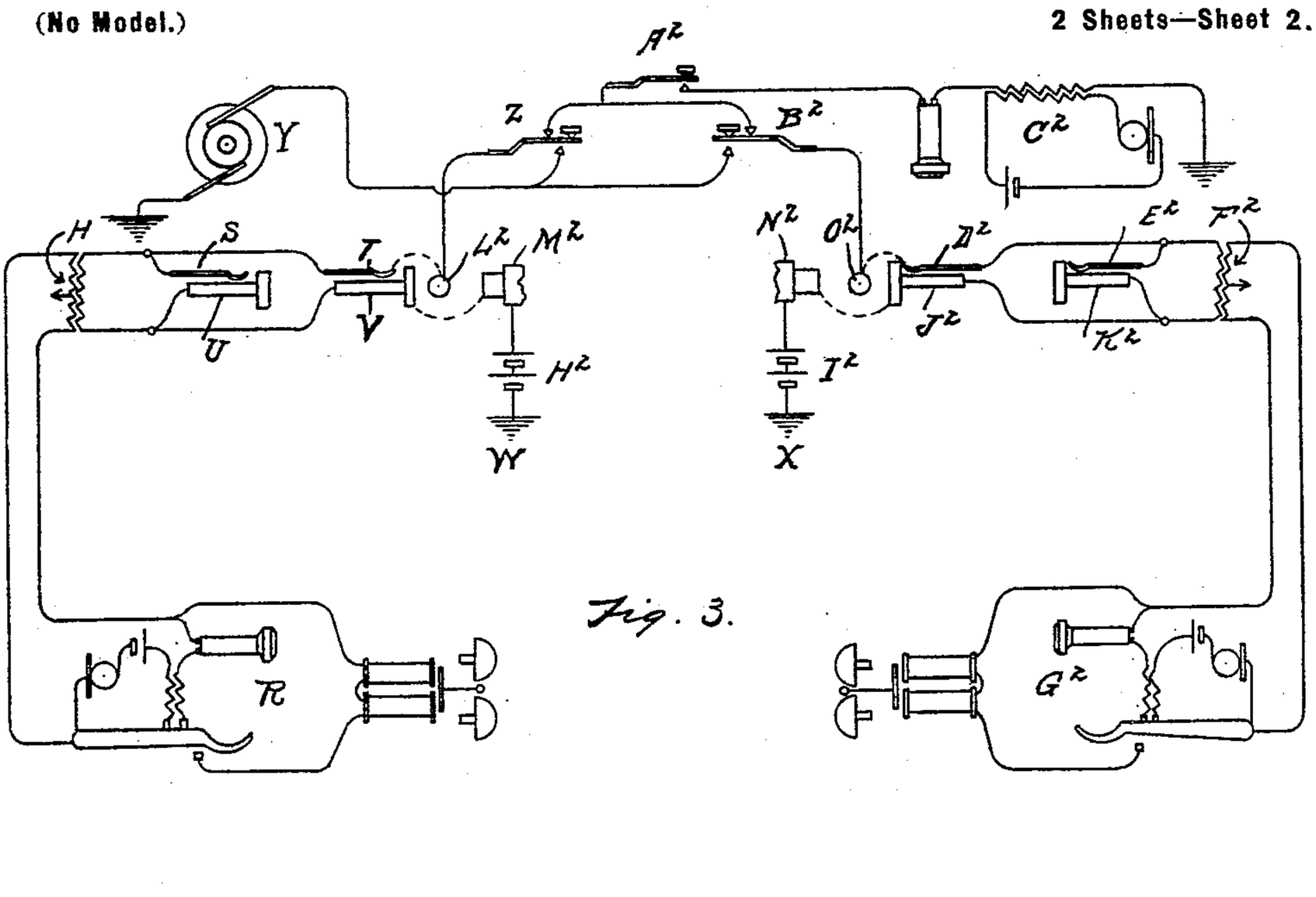

Fig. 3.

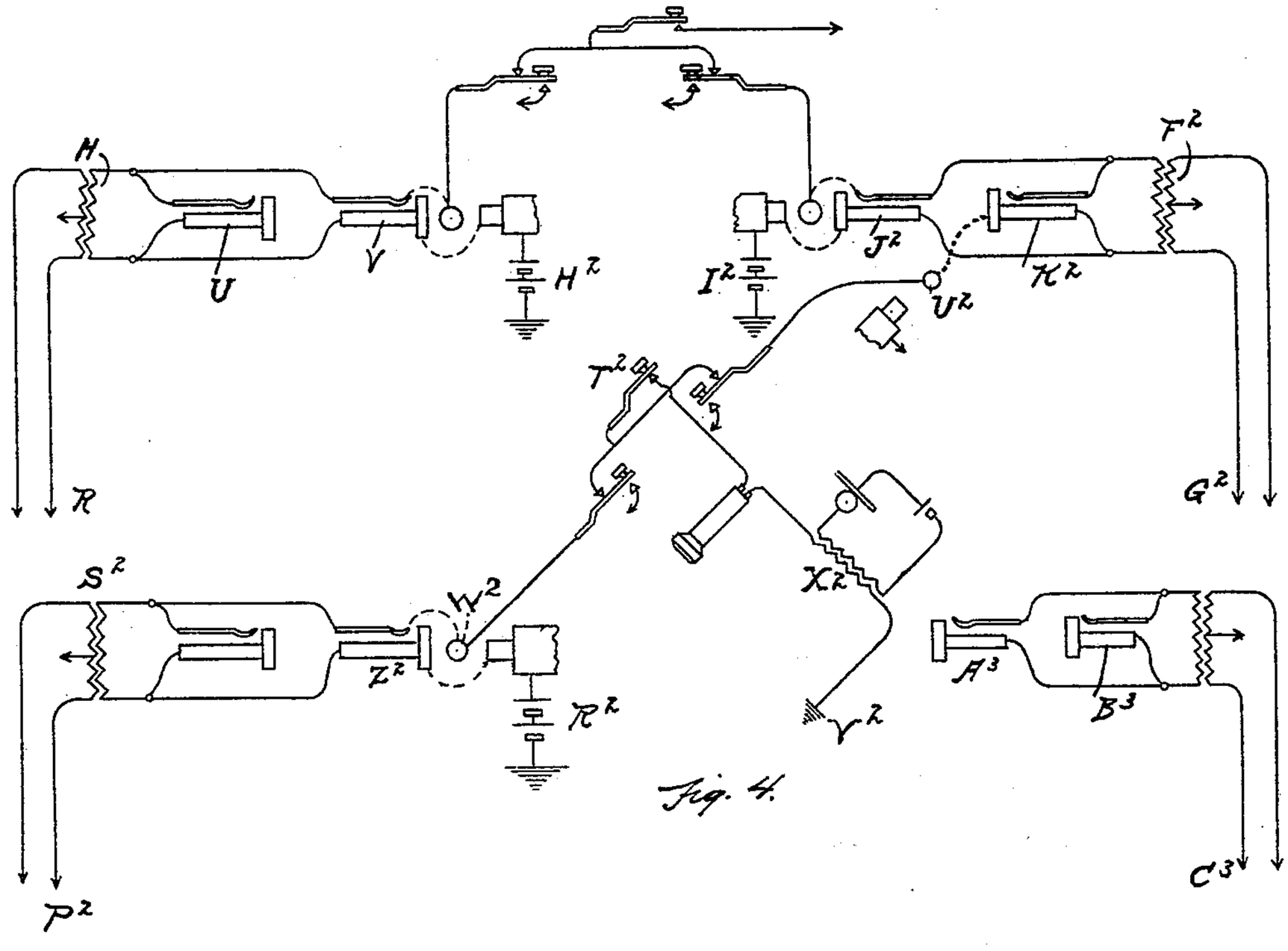

Fig. 4.

WITNESSES
Chas. Wisner
C. C. Jennings

INVENTOR
Charles L. Boyce
By Parker & Burton
Attorneys.

UNITED STATES PATENT OFFICE.

CHARLES L. BOYCE, OF DETROIT, MICHIGAN.

TELEPHONE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 620,733, dated March 7, 1899.

Application filed April 29, 1898. Serial No. 679,163. (No model.)

To all whom it may concern:

Be it known that I, CHARLES L. BOYCE, 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 Systems; and I declare the following to be a full, clear, and exact description of the same, 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.

This invention relates to telephone systems, and has for its object improvements in that class of multiple or group telephone systems in which there is an automatic signal actuated at the central station by the closing of two normally-separated contacts at the subscriber's station. This can be accomplished by the action of the subscriber in placing the transmitting or receiving part of the telephone in position for use in talking. Generally the movement consists in lifting the receiver from the hook on which it commonly hangs preparatory to bringing the receiver to the ear of the subscriber.

Another object of the invention is to employ in connection with a multiple central-station switchboard a local talking-circuit, which is also used as a non-interfering testing-circuit.

Another object is to employ in a multiple or group telephone system a subscriber's line-signal operated by a derived circuit obtained from the two wires of the subscriber's metallic circuit.

Another object of the invention is to employ, in connection with a multiple or group telephone system, a self-restoring differentially-wound line-signal, of which one helix is placed to earth through a source of electricity and the other helix is normally open.

Another object of the invention is to provide a multiple or group telephone exchange system in which the subscriber's line-signal is returned to its normal position by placing a clearing-out signal in connection with the open leg of the differentially-wound line-signal.

Another object of the invention is to provide a metallic-circuit telephone-exchange system in which the action of the telephone-switch at the subscriber's station actuates the calling and clearing out signals at the central office by the use of a derived circuit obtained between the subscriber's station and the central office.

With these several and other objects in view the invention is embodied in the novel arrangement of circuits, connections, parts, and arrangement and combinations thereof, as hereinafter described, and particularly set forth in the claims.

In the accompanying drawings I have illustrated a practical method of carrying my invention into effect, but desire it to be understood that I do not limit my invention in its useful applications to the particular means therein delineated.

In said drawings, Figure 1 shows diagrammatically the circuits and apparatus used to meet the requirements of a modern metallic-circuit telephone-exchange system. Fig. 2 shows a detail of that portion of the system shown on Fig. 1, which comprises the part of the system for signaling the central station, restoring the line-relay to its normal position, and indicating to the operator that the subscriber has ceased using his telephone. Fig. 3 shows that part of the system employed to call a subscriber from the central station, and it also shows the talking-circuit between two subscribers when through service is established. Fig. 4 shows the "busy-line indicator"—that is, that part of the system which is used to ascertain whether or not the line of a subscriber called for is busy.

Figs. 2, 3, and 4 are separate parts of the system which is shown as a whole in Fig. 1. The detailed figures enable one to have a clearer understanding of the entire system than could be had from an explanation of the system with reference only to Fig. 1.

The symbols used on any sheet to designate a certain part of the apparatus or circuits will designate the same part of the apparatus or circuits when shown on any other sheet.

Referring to Fig. 2, this figure shows the method by which the subscriber signals the central station, the method by which the line-relay is restored to its normal position, and the method by which the operator is signaled for a disconnection, only that part of circuits and apparatus being shown to clearly illus-

trate this part of the invention. A and B are springs operated by telephone-switch D. Spring A is insulated at C, so that telephone-switch D will not make an electrical contact with it at this point. When telephone-switch D is down, no contact will be made between springs A and B. E is an inductive resistance and is of high resistance and electrical impedance. The helix of E is wound differentially, as shown. F and G are the outgoing and incoming lines of a subscriber's metallic circuit. H is a telephone repeating-coil. I is a differentially-wound line signaling-relay. J is a clearing-out relay. K is a compensating resistance and is of the same resistance as relay J. L is a battery of low internal resistance. M is a part of a telephone-switchboard plug. N and O are duplicate parts of switchboard spring-jacks and represent parts of multiples of a subscriber's line. P and Q are earth connections.

The method of operating is as follows: The subscriber removes telephone-receiver from switch D. Springs A and B are thereby connected, which completes a derived signaling-circuit between the subscriber's station and the central telephone-exchange, completing an electrical circuit between earth P at central telephone-exchange and earth Q at subscriber's station. Current from battery L will actuate armature of differentially-wound relay I, which gives the required signal to the operator to answer. The electrical circuit obtained is as follows: starting at earth P, through battery L to compensating resistance K, through coil 2 of differentially-wound line signaling-relay I to line-helix of repeating-coil H, where the circuit divides, wires F and G being used, and unites again after passing through inductive resistance E, then to earth Q through springs A and B.

That part of derived signaling-circuit which is composed of subscribers' line-wires, repeating-coil H, and inductive resistance E will not interfere with telephone communications, as connections are made to repeating-coil and inductive resistance in such a manner as to neutralize any disturbance caused by earths P and Q being connected to subscriber's circuit.

The subscriber's line-signal I is restored to its normal position by the operator placing M part of switching-plug in connection with N spring of switchboard-jack, which makes another circuit for current generated by battery L, through clearing-out relay J, M part of switchboard-plug, N spring of switchboard-jack, then to and through helix 3 of differentially-wound line signaling-relay I, then to earth Q at subscriber's station.

Helices 2 and 3 of line signaling-relay I have the same number of ampere-turns and are of equal resistances, and compensating resistance K is of the same resistance as clearing-out relay J, and current of the same polarity and potential is delivered to helix 2 as to helix 3 of relay I, and helix 2 is wound opposite to helix 3 of relay I. Consequently the magnetism of the core of relay I will be destroyed as soon as operator places M part of switching-plug in connection with N spring of switchboard-jack, and armature of line signaling-relay I will return to its normal position and armature of clearing-out relay J will be actuated. Armature of relay J will remain in a position of activity until subscriber's telephone is placed on switch D, which will destroy the electrical connection between springs A and B, thereby allowing armature of clearing-out relay J to return to its normal position, which gives the necessary signal for disconnection.

It is to be understood that the repeating-coil H and line signaling-relay I are individually and permanently connected to each subscriber's line entering a telephone-switchboard of this kind.

There are two clearing-out relays for each connecting-cord when a through connection is established—*i. e.*, one clearing-out relay for the calling subscriber and one clearing-out relay for the called subscriber.

It is to be understood that the line-relay is not cut off from the derived signaling-circuit when through connections are established between subscribers and that the clearing-out relays are not bridged to, do not loop through, and are not in any way connected to the talking-conductors of the connecting-cords between the answering and calling plugs, and therefore the clearing-out relays are not bridged to, do not loop through, and are not in any way connected to the local talking and ringing jack-circuits of the subscribers' lines that they are being used on.

It is to be understood that the line signaling-relay I is restored to its normal position when the operator inserts a switchboard-plug in any of the spring-jacks of a line by closing to earth through a source of electricity and a clearing-out relay, a normally open leg of differentially-wound line signaling-relay I, the clearing-out relay being located at that part of the switchboard where the plug is inserted.

It is to be understood that a permanently-fixed derived signaling-circuit is obtained from the two wires of a subscriber's metallic circuit by the use of a neutral point of an inductive resistance permanently bridged and connected across these two wires at the subscriber's station and the neutral point of the line side of a repeating-coil which is permanently connected to these two wires at the central office.

Fig. 3 shows the method of calling the subscriber from the central telephone-exchange and the talking-circuit between two subscribers when through service is established, only that part of the circuits and apparatus being shown to clearly illustrate this part of the invention. R and G^2 are circuits and apparatus at the subscribers' stations and will be readily understood by a person versed in tele-

phone-circuits by referring to the drawings. H and F^2 are telephone repeating-coils. One helix of each of these coils is permanently connected to the two wires of subscriber's metallic circuit. The other helix of each of these coils is permanently connected to the switchboard-jacks representing the subscribers' lines. S and T are like springs of subscriber R's switchboard-jacks and represent multiples of these springs. U and V are like bodies of subscriber R's switchboard-jacks and represent multiples of these bodies. D^2 and E^2 are like springs of subscriber G^2's switchboard-jacks and represent multiples of these springs. J^2 and K^2 are like bodies of subscriber G^2's switchboard-jacks and represent multiples of these bodies. H^2 and I^2 are batteries of low internal resistance and are placed in circuit to enable a "busy test" to be made. Their use will be explained when Fig. 4 is taken up. L^2 is tip of answering-plug. M^2 is body of answering-plug. N^2 is body of calling-plug. O^2 is tip of calling-plug. Y is an alternating-current generator. Z and B^2 are operator's ringing-keys. A^2 is operator's listening-key. C^2 is operator's telephone and local battery-circuit.

As the calling of the central by the subscriber and the action of the line and clearing-out relays has already been explained, it is deemed unnecessary to go over it again in the explanation that is now to be made of the method by which two subscribers are telephonically connected together. The method of testing for a "busy line" will be explained when Fig. 4 is taken up.

The operation of making a telephonic connection between subscribers R and G^2 is as follows: The operator answers subscriber R by placing tip L^2 and body M^2 of answering-plug in connection with spring T and body V of subscriber R's jack and pressing listening-key A^2, which connects operator's telephone C^2 with subscriber R by induction through repeating-coil H. After finding that subscriber R wants subscriber G^2 the operator completes the connection by placing tip O^2 and body N^2 of calling-plug in connection with spring D^2 and body J^2 of subscriber G^2's jack. The operator rings subscriber G^2 by pressing ringing-key B^2, thereby putting alternating current generated by Y to earth X at the central telephone-exchange, subscriber G^2's bell being actuated by an induced current, the primary ringing-circuit being local to the switchboard of the central telephone-exchange. Subscribers R and G^2 are now telephonically connected and will talk through repeating-coils H and F^2 by induction, the switchboard-circuit being local between earth connections W and X.

The talking-circuits are so arranged that the ordinary grounded switchboard ringing and listening keys can be used.

It is to be noticed that the local talking and ringing jack-circuit is normally open and in its normal condition has no earth connections and with the exception of its inactive connection with repeating-coil is normally not connected with any other part of the switchboard apparatus or circuits.

Fig. 4 shows the method employed to ascertain whether or not the subscriber's line that is wanted is busy, only the necessary circuits and apparatus being shown to illustrate this part of the invention.

As like symbols on different figures have the same meaning and as an explanation has already been made of all the symbols used, it is thought unnecessary to explain them again.

Subscriber P^2 calls for service with subscriber G^2. The operator at the central exchange answers by placing switching-plug W^2 in connection with switching-jack Z^2. Telephonic service is now established between subscriber P^2 and operator as operator's listening-key T^2 connects operator's telephone X^2 with switching-plug W^2. A continuous current will flow from battery R^2 through body of that spring-jack of subscriber's multiples that is in circuit to and through one helix of repeating-coil S^2, then through spring of that spring-jack of subscriber's multiples that is in circuit, then to tip of plug W^2, listening-key T^2 to earth V^2 through operator's telephone X^2. Subscriber G^2's line is then tested and is found busy. The busy test is given to the operator by an increased battery-discharge through telephone X^2. This increased battery-discharge is obtained by connecting tip U^2 with body K^2 of subscriber G^2's line, a through connection having previously been established between subscribers G^2 and R. The same busy test would have been obtained if tip U^2 had been placed in connection with body U or body V of spring-jacks representing subscriber R's line or body J^2, which represents the body of another spring-jack of G^2's line. The cause of this increased battery-discharge will be clearly understood by observing the local conditions of subscribers R, G^2, and P^2's combination talking and testing circuits. The potential of battery R^2 has been greatly reduced at operator's listening-key T^2 on account of comparatively high resistance of repeating-coil S^2 being placed in circuit. Batteries R^2, H^2, and I^2 are of low internal resistance and are of the same potential at their poles. Current will flow from battery H^2 through repeating-coils H and F^2 and will somewhat increase the current flowing to earth V^2 through X^2. Current from battery I^2 becomes the principal factor of this test system, as the potential at listening-key T^2 when the test is made will be nearly equal to that at the pole of battery I^2, as there is practically no resistance between the battery and T^2 when this test is made, and an increased current is thereby sent to earth V^2 through operator's telephone X^2, which gives the operator the busy test. If subscriber P^2 had asked for service with subscriber C^3, tip U^2 would have been placed in connection with body A^3 or body B^3 of spring-jacks, and as

these bodies have no connection with earth and are open the electrical conditions of subscriber P^2's local talking and test circuits, in connection with operator's telephone X^2, would not have been changed, the constant current from battery R^2 would have remained unchanged, and there would have been no increase or decrease in flow of current to earth V^2 through operator's telephone X^2, and on account of this absence of increase or decrease in flow of current through the operator's telephone X^2 the operator would have known that C^3's line was not busy and could be used.

It is to be understood that no auxiliary test-circuits are employed and that a local talking-circuit, by the addition of batteries of the same potential and of low internal resistances inserted in the circuit, furnishes the necessary multiple-switchboard busy test. These batteries, although shown separately on the drawings, could be combined into a single battery, a battery of the secondary type being preferable.

What I claim is—

1. A derived signaling-circuit obtained by the combination with a metallic-circuit telephone-line normally disconnected from earth at subscriber's station thereon, of an inductive resistance permanently bridged across the two wires of the metallic circuit at the subscriber's station, a telephone repeating-coil permanently connected to the terminals of the metallic circuit at the central office, a line signaling-relay permanently connected to the neutral point of the line-helix of said repeating-coil, a source of electricity connected to earth, and means for connecting the neutral point of said inductive resistance at subscriber's station to earth, whereby line signaling-relay will be actuated, substantially as described.

2. A combination with a metallic-circuit telephone-line normally disconnected from earth at subscriber's station thereon of an inductive resistance permanently bridged across the two wires of the metallic circuit at the subscriber's station, a telephone repeating-coil permanently connected to the terminals of the metallic circuit at the central office, a differentially-wound line signaling-relay permanently connected to the neutral point of the line-helix of said repeating-coil, one helix of said differentially-wound line signaling-relay being permanently connected to a source of electricity and earth, the other helix of said differentially-wound line signaling-relay being normally open, means for connecting the neutral point of said inductive resistance at subscriber's station to earth, and means for closing the normally open helix of said differentially-wound line signaling-relay, as hereinbefore described.

3. A combination of a differentially-wound line signaling-relay, one helix of which is permanently connected to earth through a source of electricity, the other helix of which is normally open, and means for connecting the normally open helix of said differentially-wound line signaling-relay to earth, and a source of electricity, whereby said differentially-wound line signaling-relay becomes neutral when said normally open helix is connected to earth and source of electricity, as hereinbefore described.

4. A combination of a signaling-circuit, a differentially-wound line signaling-relay, made active by closing said signaling-circuit at subscriber's station, one helix of said differentially-wound line signaling-relay being normally open, a clearing-out relay, a source of electricity with earth connections, and means for connecting the normally open helix of said differentially-wound line signaling-relay to a source of electricity with earth connection through clearing-out relay, thereby allowing the line-signal to return to its normal position and making clearing-out relay active as long as the signaling-circuit is closed at subscriber's station, as hereinbefore described.

5. A combination of a signaling-circuit, a telephone repeating-coil, a local talking and ringing jack-circuit, a differentially-wound line signaling-relay, one helix of which is normally open, a clearing-out relay and means for closing the normally open helix of said differentially-wound line signaling-relay through clearing-out relay, whereby said clearing-out relay is not at any time connected with subscriber's local talking and ringing jack-circuit, as hereinbefore described.

6. A combination of a differentially-wound line signaling-relay, one helix of which is normally open, a resistance, an individual clearing-out relay, and means for closing the normally open helix of the differentially-wound line signaling-relay through said clearing-out relay, whereby the differentially-wound line signaling-relay becomes neutral to any current that may flow through it, and the clearing-out relay is made active as long as current is flowing through the differentially-wound line signaling-relay, substantially as specified.

7. A combination of a local ringing and talking jack-circuit, which is normally open and has normally no earth connection, a source of electricity and earth connection, and means for closing said local ringing and talking jack-circuit to earth through said source of electricity, whereby said local ringing and talking jack-circuit becomes also the local busy-test circuit, as hereinbefore described.

8. In a telephone system, the combination of a subscriber's metallic circuit, an inductive resistance permanently bridged across the wires of the metallic circuit, means for connecting the neutral point of said inductive resistance to earth, a repeating-coil having a connection from its neutral point to earth through a line signaling-relay, and a source of electricity and earth connection, substantially as described.

9. A combination of a signaling-circuit nor-

mally disconnected from earth at subscriber's station, a source of electricity with earth connection, a differentially-wound line signaling-relay, one helix of which is permanently included in said signaling-circuit, the other helix of which is normally open, a clearing-out relay, means for connecting said signaling-circuit to earth at subscriber's station, and means for connecting normally open helix of said differentially-wound line signaling-relay to said signaling-circuit through said clearing-out relay, whereby said differentially-wound line signaling-relay will be neutral to current flowing through said signaling-circuit and clearing-out relay will be actuated by current flowing through said signaling-circuit as hereinbefore described.

10. A combination of a metallic-circuit telephone-line normally disconnected from earth at subscriber's station, an inductive resistance permanently bridged across the two lines of the metallic circuit at the subscriber's station, two normally-separated contacts at the subscriber's station actuated by subscriber's-telephone switch, one of which contacts is connected to earth, the other of which contacts is connected to the neutral point of said inductive resistance, a telephone repeating-coil permanently connected to the terminals of the subscriber's line at the central office, a differentially-wound line signaling-relay, the neutral point of which is connected to the neutral point of the line-helix of said repeating-coil, one helix of said differentially-wound line signaling-relay being connected to earth through a resistance and a source of electricity, the other helix of said differentially-wound line signaling-relay being normally open, a source of electricity with earth connection, a resistance, a clearing-out relay, and means for connecting normally open helix of said differentially-wound line signaling-relay to source of electricity and earth through said clearing-out relay, as and for the purpose specified.

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

CHARLES L. BOYCE.

Witnesses:
CHARLES E. TARTE,
VIRGINIA M. CLOUGH.