H. D. STROUD.

LINE SIGNAL SYSTEM.

APPLICATION FILED MAY 13, 1904.

948,979.

Patented Feb. 8, 1910.

2 SHEETS—SHEET 1.

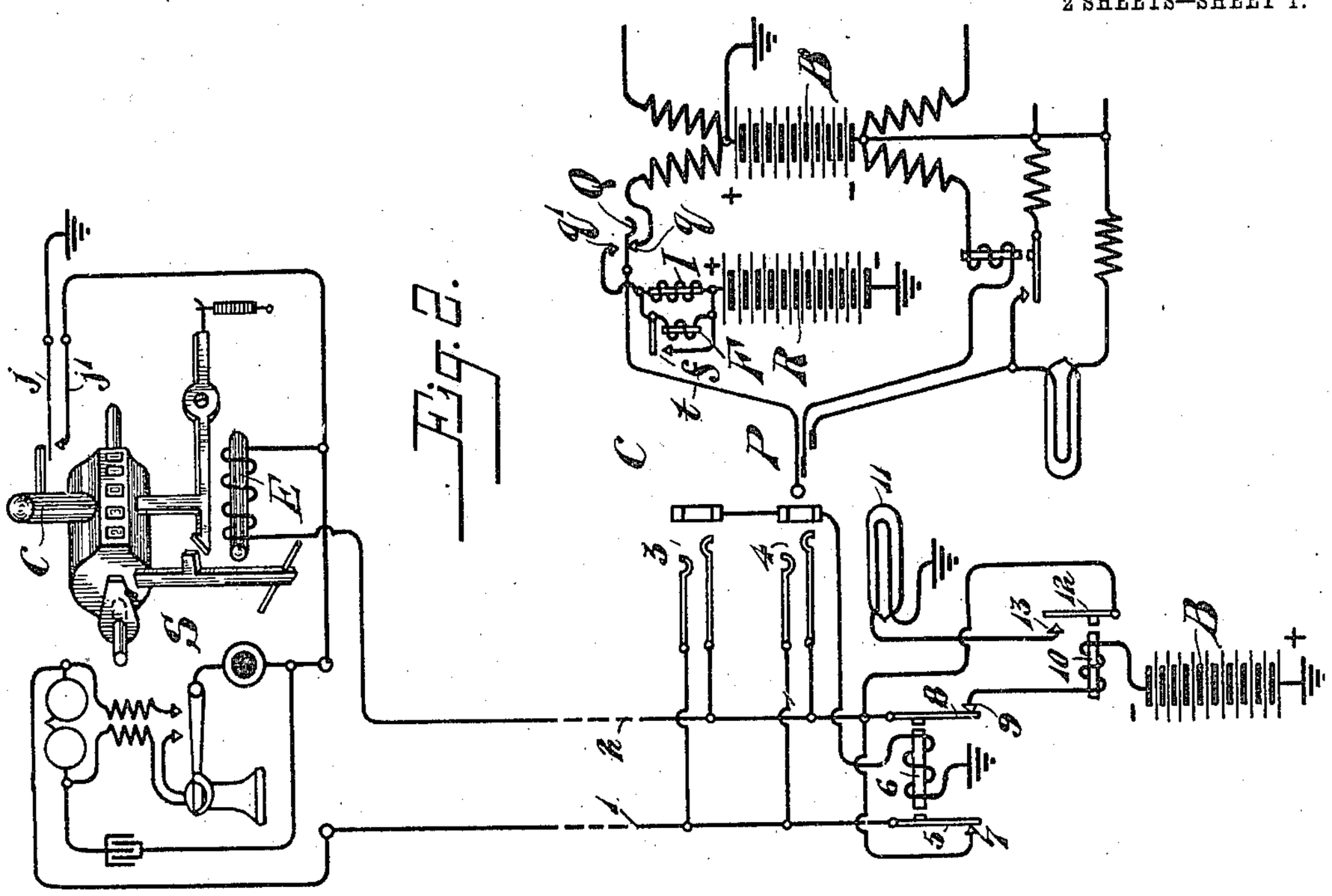

Fig. 2.

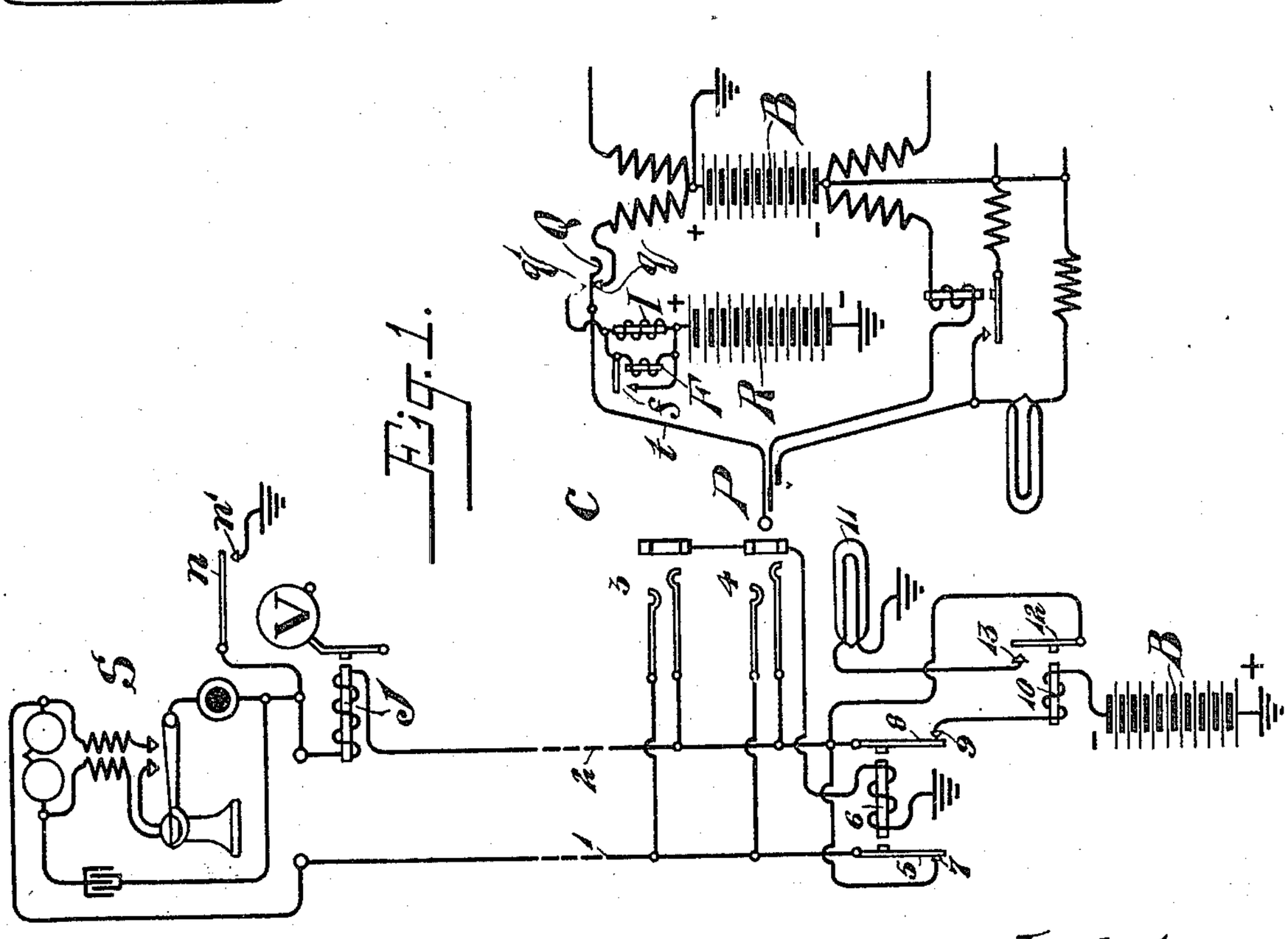

Fig. 1.

Witnesses.

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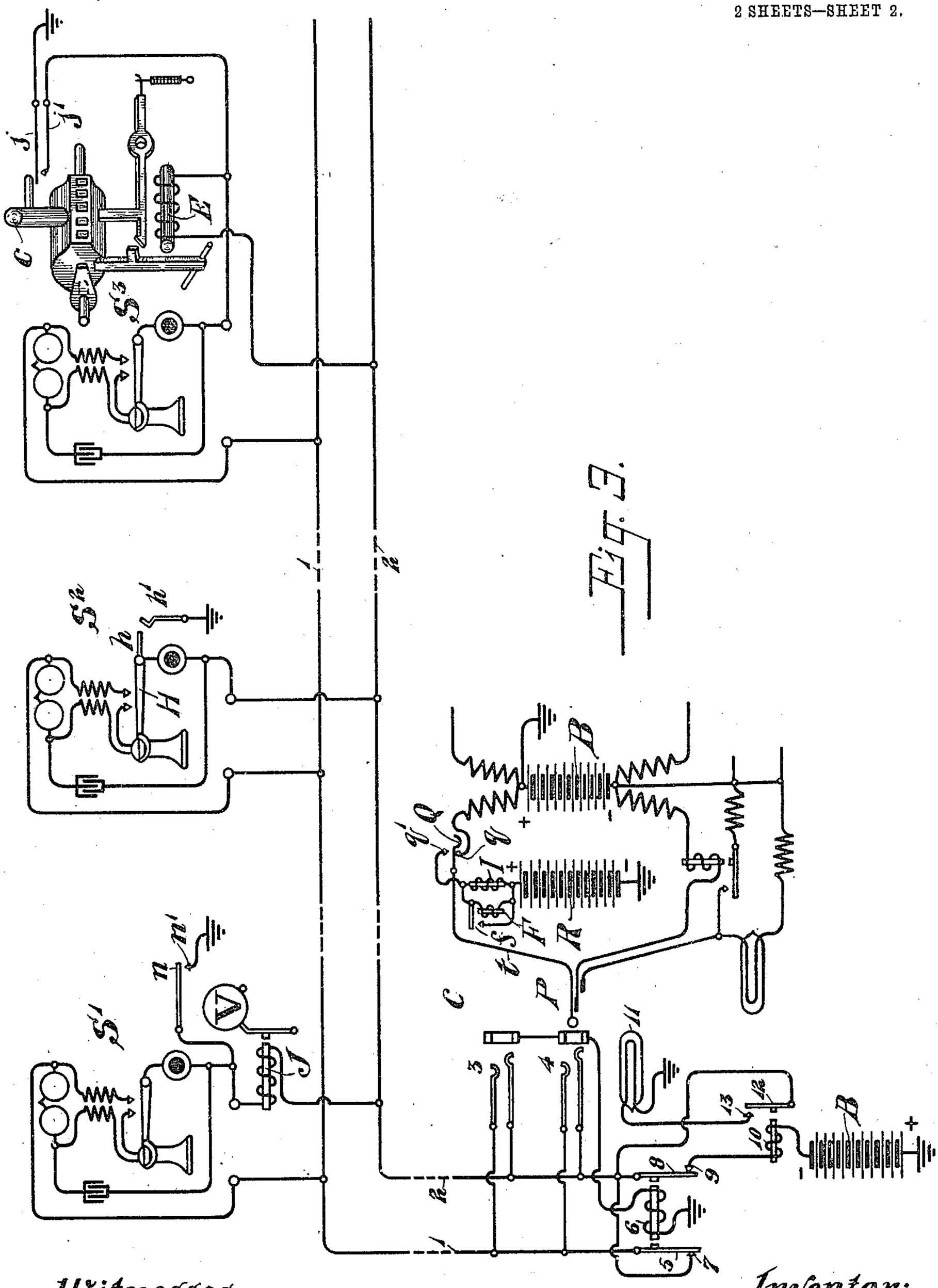

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UNITED STATES PATENT OFFICE.

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LINE SIGNAL SYSTEM.

948,979. Specification of Letters Patent. Patented Feb. 8, 1910.

Application filed May 13, 1904. Serial No. 207,878.

To all whom it may concern:

Be it known that I, HAROLD D. STROUD, a citizen of the United States of America, and a resident of Chicago, county of Cook, and State of Illinois, have invented a new and useful Improvement in Line Signal Systems, of which the following is a specification.

This invention relates in general to improvements in the class of telephone systems wherein the telephone user is charged for service on the basis of the number of times he uses his telephone. Such systems may be broadly classified under the term "measured service" systems in contradistinction to that class of telephone systems wherein the subscriber is charged a fixed amount regardless of whether he uses his telephone much or little. Systems of this latter type may be classified under the term "flat rate" systems.

This invention particularly relates to that class of measured service systems wherein the measuring device, whether in the form of a coin-collector or of a call-recording meter, is placed at the subscriber's station, rather than to that class wherein the measuring device is placed at the central office.

It also relates to a system which has for its object the arrangement of the apparatus and circuits in such manner as to be adaptable to measured service lines using either call meters or coin-collectors, and to flat rate lines, making it possible for the same operator to handle indiscriminately either type of line, the duties required of her being the same in all cases.

It also relates to a system which has for its further object to so arrange the apparatus and circuits, that stations provided with coin-collectors, those provided with call-registering devices, and those operating upon the flat rate plan, may be indiscriminately used on party lines; the duties of the operator being the same in handling connections originated at any of these types of stations. Such a system of mixed service I have described in my application, Serial No. 207,877, filed May 13, 1904.

This invention has particularly for its object an improvement upon the system of that application.

A path of minimum resistance from the central office to the subscriber's station is provided over which the signaling may be accomplished, this path consisting of the two line wires in multiple rather than a single line wire with a ground return or with two line wires used as a metallic circuit, as has heretofore been done. By this means many practical advantages are secured among which may be mentioned the fact that the accidental grounding of either side of the line will at once convey to the central office an unmistakable indication of trouble; the breaking of one side of the line will still enable the subscriber to signal the central office, and thus, while it may not enable him to talk with the central office will at once show that there is trouble on the line; the two sides of the line in this case are normally subject to equal potential and therefore the click in the subscriber's telephone when the operator answers a call is greatly reduced, thus removing one serious cause of complaint existing in present telephone systems.

In the application filed by me, Serial No. 208,176, filed May 16, 1904, I have described and claimed a coin collecting device and the form of circuit with which it may be operated. In the system of this application an electromagnetic device in the form of a locking relay was located at the substation, this serving to hold the calling circuit closed after it has been momentarily closed by the passage of the coin. In another application of the same date, Serial No. 207,876, filed May 13, 1904 I have described a call-registering meter adapted to be used at the subscribers' stations, and in the system described in that application a similar locking relay was necessary for accomplishing the same purpose. In still another application, Serial No. 207,877, filed May 13, 1904, I have described and shown a system wherein the locking relay is dispensed with at the subscriber's station, and in order to maintain a more lasting signal than that caused by the momentary flash of the lamp due to the momentary closing of the signaling circuit at the subscriber's station, I have so arranged the signal-receiving device at the central office as to cause it to lock after being momentarily actuated in the manner mentioned. In all of these applications the signaling, whether done by means of a deposited coin, the operation of the registering device, or in the case of the mixed system in

the last-mentioned application, by the removal of the subscriber's receiver from its hook, was accomplished over one limb of the line with a ground return. This application contemplates the use of the same form of substation apparatus as described in the three applications above mentioned.

This invention is alike applicable to the placing of the locking relay at the subscriber's station or at the central office, but the drawings of this application I have illustrated with the locking relay at the central office only.

Referring now to the drawings in which like letters indicate the same parts, Figure 1 is a diagram of a subscriber's line wherein the subscriber's station equipment is a coin-collecting device; Fig. 2 is a diagram of the line circuit wherein the substation is equipped with a call-counting device; Fig. 3 is a diagram of a party line serving three stations, equipped respectively with a coin-collecting device, a call-registering meter and a signaling device adapted to flat rate service.

Referring to Fig. 1, 1 and 2 represent the limbs of the subscribers' lines connecting the subscriber's station apparatus, S, with the central office equipment, C. The arrangement of the subscriber's station includes the ordinary common battery station apparatus for talking and signaling purposes. In addition to this apparatus there is added to the subscriber's station a coin-collecting device which preferably is of the general form shown in my application above referred to, Serial No. 208,176 except that no locking relay or buzzer is required. The essential parts, electrically speaking, of this apparatus are shown diagrammatically in Fig. 1, J being the returning magnet placed under the control of the central office operator after a connection is made, and which by the operation of its armature throws the deposited coin into the return chute in case the connection called for is not completed. A pair of contact springs, n and n', are momentarily closed as a necessary result following the depositing of the coin into the coin chute, by a subscriber.

The coin-collecting apparatus is of such construction that no action whatever is necessary on the part of the operator to throw the coin into the cash box when the connection called for is successfully made, the coin being held in suspense in the coin chute to be automatically thrown into the cash box by the action of the next deposited coin whether by the same or another person.

At the central office 3 and 4 represent spring jacks associated with the line circuit in a manner well understood in the art. The limb, 1, of the line passes to one of the contacts, 5, of the cut-off relay, 6. The back contact, 7, of this relay instead of being connected to ground, as in ordinary practice, is connected permanently to the contact lever, 8, of the cut-off relay, thus under normal conditions, connecting the limbs 1 and 2 of the line through a path of practically no resistance. The limbs 1 and 2 of the line thus pass, under normal conditions, to the contact lever, 8, of the cut-off relay and thence to the back contact, 9, of this relay and through the coil of the line relay, 10, to the negative side of the battery, B, the opposite or positive terminal of which is grounded. The lamp, 11, is connected with the local circuit of the relay, 10, the connection being so made that the current which passes through the local circuit to illuminate the lamp when the contacts 12 and 13 of the line relay, 10, are closed, passes also through the coil of this relay thus serving to keep the relay energized even though the circuit over which it was originally energized is broken. The local circuit of the line lamp, 11, also includes the normally closed contacts 8 and 9 of the cut-off relay, 6, so that when this latter relay is energized, the local circuit, including the lamp, 11, and the coil of the relay, 10, will be broken, thereby restoring the line relay to its normal condition and putting out the line lamp.

The cord circuit at the central office is of a type widely used, the details of which are well understood. The key, Q, is however, associated with the tip strand, t, of the answering plug, P, in such manner that the normal connection between the tip of the answering plug and the positive side of the battery, B, bridged across the cord circuit is broken at the contact, q, when this key is operated, and another contact, q', is closed by means of which the battery, R, of approximately 90 volts is connected between the tip strand, t, and the ground. In circuit between the battery, R, and the contact, q', is an impedance coil, I, around which is bridged a suitable buzzer, F. The buzzer preferably acts to short-circuit its coil by closing the contact, f, when it attracts its armature. The impedence coil, I, and buzzer, F, are common to all the cord circuits of one operator's position, being in the common lead connecting the battery, R, with the contacts, q', of the various keys, Q. The operation of these circuits may now be understood. By virtue of the back contact, 7, of the cut-off relay being connected to the contact lever, 8, of the cut-off relay, the subscriber is not able to attract the attention of the operator by merely raising his receiver from its hook, as in a flat rate service. He must therefore, preferably after raising his receiver from its hook, deposit a coin in the slot, which in its passage through the chute causes the spring, n, to momentarily engage the spring, n', thereby mo-

mentarily closing the circuit which may be traced from the negative side of the battery at the central office through the coil of the relay, 10, contacts 9 and 8 respectively of the cut-off relay, thence immediately to the limb, 2, of the line and through the contacts 7 and 5 respectively to the limb, 1, of the line. These currents flow over the two limbs of the line in multiple, passing from the limb, 2, through the restoring magnet, J, to the spring, *n*, and from the limb, 1, through the primary winding of the induction coil, hook lever and the transmitter also to the spring, *n*, and thus the current from both limbs of the line passes to ground from the contact, *n'*. The resistance of the path over which signaling is thus accomplished is only approximately half of that encountered where a single limb of the line is used with a ground return or approximately one-fourth of that encountered where the two limbs of the line are used in series, as in most modern systems.

As a result of the momentary ground thrown on the two sides of the line at the substation by the contacts, *n* and *n'*, current from the battery, B, flows over the path just traced through the coil of the line relay, 10, which attracts its armature, 12, which engages contact, 13, and causes the illumination of the line lamp, 11. Current from the battery, B, which causes the illumination of this lamp flows from the negative side of the battery through the coil of the line relay, 10, thence through the contacts 9 and 8, 12 and 13, lamp 11, to ground and to the positive side of the battery. The current flowing through this path serves to energize the relay, 10, which therefore keeps its armature attracted even after the circuit is broken at the points *n* and *n'*. It is evident therefore, that the relay, 10, will be held locked by current flowing through the lamp and will remain so, the lamp meanwhile remaining lighted until the operator in response to its signal inserts the answering plug, P, into the jack of the line. This act will cause the operation of the relay, 6, which will break the local lamp circuit between the points, 8 and 9, of this relay. The operator then proceeds to make the connection in exactly the same manner as if the subscriber were being charged on the flat rate plan, and if the called for party can be secured she completes the connection without special work. If, however, the called-for party for any reason cannot be secured, the operator in order to inform the calling subscriber of the fact presses the key, Q. This connects battery, R, to the tip strand of the calling plug and the circuit may then be traced from the positive pole of this battery through impedance coil, I, and buzzer, F, in multiple, to contact, *q'*, of the key, Q, thence to the tip of the plug, P, to limb, 1, of the line, through the talking apparatus at the subscriber's station and the coil of magnet, J, and back by means of limb, 2, of the line to the sleeve contact of the jack and plug, thence to the negative side of battery, B, from the positive side of which the circuit is continued through ground to the negative pole of the battery, R, which is grounded. The current flowing in the path causes the buzzer, F, to be set in operation, and thus by the vibration of its armature causes slight periodic fluctuations of the line current, and a consequent characteristic noise or "tone" in the receiver of the calling subscriber. Another result is accomplished by the actuation of the key, Q. The two batteries, R and B, are as has been shown, placed in series, thereby subjecting the circuit to a potential of approximately 120 volts which is sufficient to operate magnet, J, which is inert to ordinary currents used in the exchange. The operation of this magnet withdraws the support from the side of the coin which therefore passes through the return chute to the subscriber depositing it. By means of this arrangement, therefore, the operator is saved the work and time of throwing her listening key and telling the waiting subscriber that "the line is busy," or that the called subscriber "does not answer," the tone conveying to the subscriber the necessary information that the called for line is unavailable. At the same time and by the same movement the coin is returned to the subscriber, the necessity for returning the coin always being coincident with the necessity for informing the calling subscriber that the called-for line cannot be obtained.

In Fig. 2 is shown a circuit with the same central office equipment as in Fig. 1. At the subscriber's station, however, the coin collecting device of Fig. 1 is replaced by a call-registering device preferably of the type shown in my application, Serial No. 207,876. With this arrangement the subscriber calls the central office by pressing the button, C, which causes the register to act and also depresses spring, *j*, into contact with spring, *j'*, thus operating the line relay, 10, at the central office over two sides of the line in multiple with a ground return in exactly the manner described in connection with Fig. 1. The operator in response to the line signal answers the call and completes the connection in the same manner as in ordinary practice. If the call is unsuccessful, however, she presses the button, Q, in connection with the answering cord used, and thus by causing current from the batteries R and B in series to flow over the metallic circuit of the line, conveys the characteristic tone signal to the waiting subscriber; and also since the current passes through the crediting magnet, E, of the meter, credits a call to the subscriber, either

by turning the meter back one count, or by so arranging it that he will get his next call free.

The central office equipment of the two lines shown in Figs. 1 and 2 and the cord equipment are identical for these two forms of service. From the standpoint of the operator there is no difference between the methods of handling the service in response to calls from either class of lines.

In Fig. 3 is shown a party line comprising three substations, S^1, S^2 and S^3. In each of these the telephone instruments and the call-receiving apparatus are the same. The equipment of these stations, however, differs with respect to the devices for originating calls and for determining the amount of charge to be made for service. The equipment of station S^1 is the same as that shown in Fig. 1, this station being provided with a coin-collecting device. The station at S^3 has the same equipment as that of Fig. 2, this being provided with a call-counting device. At station S^2 is shown a substation equipment arranged for flat rate service, no measuring device or coin collector being provided. This is the same in all respects as the ordinary common battery subscriber's equipment with the exception that the hook-switch, H, carries an arm, *h*, which, as the hook rises, momentarily engages the spring, *h'*, which is connected with the ground. The current therefore flows momentarily over the two sides of the line in multiple through this ground connection, thus drawing up the line relay and causing it to lock, as in the two preceding cases. The apparatus at the central office is the same as that of Figs. 1 and 2.

The particular circuit arrangement shown at the subscriber's station is not adapted to selective ringing on party lines, and therefore, whenever ringing current is sent to the line all bells respond alike. In this case selection between the stations is made by the usual code of long and short rings. The system is, however, equally adaptable to selective ringing, in which case the bells at the different stations would be arranged in accordance with any of the well-known systems of selective ringing, and the usual set of selective ringing keys would be provided for each of the calling plugs at the central office. The subscriber at station S^1 would send a call by depositing the proper coin in the slot of his device. At station S^2 he would call by simply removing his receiver from the hook, and at station S^3 by pressing the button of his call register. Each of these actions would produce the same effect at the central office and the operator would in all cases, regardless of the kind of apparatus used by the subscriber, complete the connection in the same manner. If, for any reason, it were not possible to complete the connection she would press the button, Q, of the answering cord, thus informing the calling subscriber by tone that the connection could not be made and returning the coin if the subscriber at station S^1 had made the call, or crediting the call if the subscriber at station S^3 made the call.

It is well known that, in the telephone systems now widely used, the click in the subscriber's receiver which occurs when the operator answers a call is due mainly to the breaking of the current which was flowing through the receiver before the operator inserted the plug into the jack. The click caused by the flow of current from the cord circuit immediately after the plug is inserted into the jack is much less severe. The reason for this is that the magnetic action in circuits containing impedance is always more abrupt upon the sudden breaking, than upon the sudden closing of a circuit.

Owing to the arrangement of the line circuit in my invention, the two sides of the line until the operator answers, have the same potential, therefore there is no flow of current through the subscriber's receiver. This condition is changed when the operator inserts the answering plug into the jack in response to a call, at which time the current flows from the battery, B, in the cord circuit through the subscriber's receiver. The click thus produced is, however, under no circumstances, painful, as is often the case with respect to the click due to the momentary breaking of the circuit when the operator inserts a plug in systems now in use.

I do not wish to limit myself to the exact details of circuits or apparatus shown. I have in the accompanying drawings illustrated the principles of operation as applied to the common battery multiple switchboard commonly known as a branch terminal relay board. In this particular multiple switchboard system the multiple jacks have three contacts each and three wires are necessary for each line extending throughout the multiple cables. This system therefore belongs to the class known as the three-wire multiple system. My invention may equally well apply to the so-called two-wire multiple system, wherein the jacks have only two contacts, and but two wires are required for each line in the multiple cable. It is also evident that my invention could be applied with equal facility to those systems using mechanical signals rather than lamp signals. In this event an electromagnetic line signal would be provided with a target placed within the view of the operator. The magnet of this signal would also carry a pair of contacts by means of which the locking circuit through the wind-

ing of the signal would be complete. The circuit would in this case be the same as that of the line relay of Figs. 1 2 and 3 with the line lamp, 11, omitted.

Other modifications might be made without departing from the spirit of my invention.

With reference to the use of the word "coin" in the claims: I do not wish to limit the meaning to current coin of the realm, but wish to construe the word "coin" as covering checks or tokens of all kinds as well as pieces of money.

What I claim as new and desire to secure by Letters Patent is:

1. In a telephone system, a metallic-circuit line extending from a substation to a central office; a signaling circuit comprising the two limbs of said line in multiple and an earth return; a source of current in said signaling circuit; a signal receiving electromagnet in said circuit at the central office; contacts in said signaling circuit at said subscriber's station for momentarily completing said circuit to energize said magnet; a local locking circuit including the coil of said magnet and contacts controlled by said magnet to close said locking circuit, whereby said magnet remains energized after the momentary completing of the circuit through said line; and a relay at said central office operated when connection is made with the line to open said locking circuit and deënergize said signal-receiving magnet, substantially as described.

2. In a telephone system, the combination of a pair of telephone line conductors; a cut-off relay; a line relay; a lamp; a battery; a main circuit containing said battery, a helix of said line relay, contacts of said cut-off relay, thence dividing and containing in one branch one of said line conductors and containing in the other branch other contacts of said cut-off relay and the other of said line conductors, the branches then joining and passing through contacts at a substation, whereby by the closing of said contacts said line relay will be energized over the circuit of the line conductors in parallel; and an auxiliary locking signal circuit containing said battery, helix of said line relay, contacts of said cut-off relay, contacts of said line relay and said lamp, substantially as described.

Signed by me at Chicago, county of Cook and State of Illinois, this 31st day of March, 1904.

HAROLD D. STROUD.

Witnesses:
E. A. GARLOCK,
KEMPSTER B. MILLER.