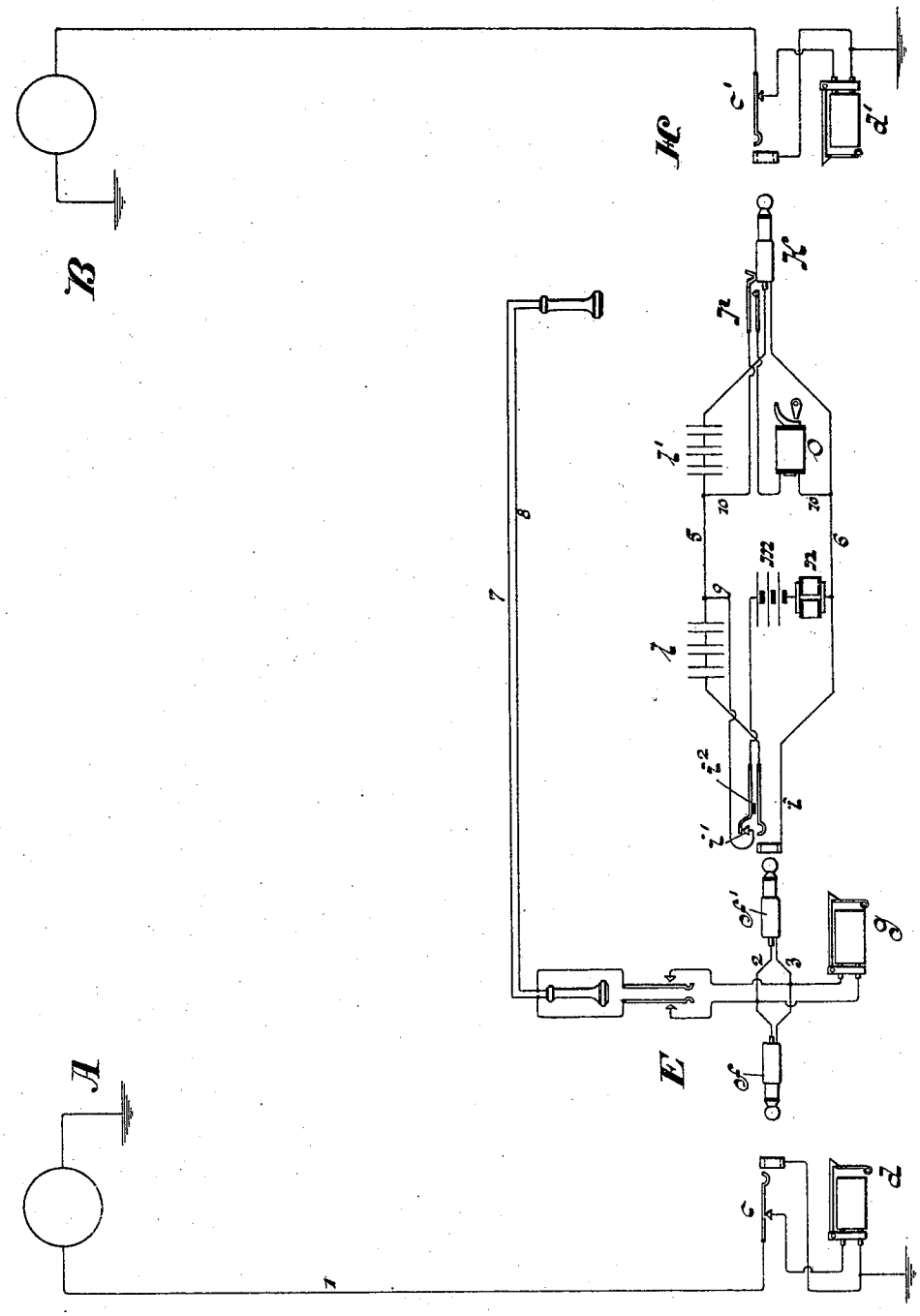
(No Model.)

C. E. SCRIBNER.

SIGNALING CIRCUIT FOR TELEPHONE TRUNK LINES.

No. 574,279. Patented Dec. 29, 1896.



Witnesses:
John W. Sinclair
D. H. C. Danner

Inventor:
Charles E. Scribner.
by: Burton Brown his Attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

CHARLES E. SCRIBNER, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE WESTERN ELECTRIC COMPANY, OF SAME PLACE.

SIGNALING-CIRCUIT FOR TELEPHONE TRUNK-LINES.

SPECIFICATION forming part of Letters Patent No. 574,279, dated December 29, 1896.

Application filed May 14, 1896. Serial No. 591,525. (No model.)

To all whom it may concern:

Be it known that I, CHARLES E. SCRIBNER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Signaling-Circuits for Telephone Trunk-Lines, (Case No. 424,) of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention concerns the operation of signals in connection with trunk-lines between offices of telephone-exchanges. It is a device for preventing interference with the operation of the signals by currents arising from sources foreign to the signaling-circuit, such as differences of potential in the earth at the different exchanges or in their vicinity.

It is well known in the art of telephony that in the vicinity of electric railways or other systems of electrical appliances employing heavy electric currents and connected at various points with the earth differences of electrical potential are found at different localities which of course produce or tend to produce currents through conductors, such as telephone-lines which happen to connect these different points. The electromotive forces between different localities not infrequently rise as high as fifteen volts and occasionally as high as forty or fifty volts. Such electromotive forces between different localities in the vicinity of electric railways are not constant either in amount or direction, but fluctuate in amount from moment to moment and sometimes become reversed in direction. In a telephone-exchange system comprising grounded lines or metallic-circuit lines with ground branches covering an area whose different parts are subject to such differences of electrical potential the foreign electromotive forces seriously interfere with the operation of signals on the lines. The wires centering in any given office may be at substantially the same potential, so that no seriously disturbing current will be set up in them, but when different offices become connected together through the medium of interoffice trunk-lines heavy currents tend to pass through the trunk-lines from the grounded station of one office to a grounded station of another or to any ground connection on the trunk-line. Hence when there is a ground connection on any line of any office of the system, this ground branch will furnish a path for current from earth into the exchange system when that line becomes connected with a trunk-line, and although the trunk-circuits may be metallic circuits and free from ground branches the extraneous current is likely to find a circuit through the apparatus to some ground branch at a distant point and operate the signals associated with the trunk-line circuit. As these signals are usually automatic in operation and their indications are accepted as final by the operators great inconvenience and confusion in the connection and disconnection of lines may be occasioned by such interference.

It has been proposed heretofore to interpose in all ground branches of a system of telephone-lines polarization-cells or counter-electromotive-force cells adapted to oppose any constant current tending to flow through them to prevent the creation in the circuits including them of currents arising from electromotive forces in the earth. The present invention involves a specific modification of the same device; and it consists in isolating a portion of a conductor of a trunk-line or other signaling-circuit by means of two groups of polarization-cells, one included in the circuit at each extremity of the isolated conductor, the branches or other circuit connections, constituting the return portion of the signaling-circuit, being connected with this conductor intermediate of the polarization-cells. It will be understood that these polarization-cells prevent the passage through them in either direction of any continuous current impelled by a less electromotive force than the aggregate counter electromotive force of the polarization-cells and that only an inappreciable current arises from the discharge of these cells when the impressed electromotive force ceases. On the other hand, rapidly-alternating currents, such as telephonic currents, may be transmitted through the cells without any sensible diminution in volume.

In a particular form of the invention I have employed a metallic-circuit interoffice trunk-

line connected with the usual spring-jack at one central office and terminal plug at the other office, and have placed in the one conductor of the trunk-line a group of polarization-cells at each office. In a bridge of the circuit at one office I place a source of current, together with suitable switch-contacts for controlling the flow of current in the circuit, and at the other station in another bridge of the circuit I place a visible signal of ordinary type, both of the bridges being applied to the isolated line conductor between the groups of polarization-cells. With this arrangement all current coming from extraneous sources is diverted by the polarization-cells from the portion of the line conductor which is connected with and forms the circuit of the signals. At the same time the transmission of telephonic or ringing currents may take place as usual. This form of the invention is illustrated in the accompanying drawing, which represents two telephone-switchboards, assumed to be at different offices, with an interoffice trunk-line having a terminal at each of the switchboards.

The apparatus at the substations A and B is of usual character. The substation A is connected by a grounded circuit 1 with a spring-jack *c* and thence with an annunciator *d* in a switchboard at a central office E. In this switchboard are located the usual pairs of connecting-plugs *f* and *f'* with their plug-circuit 2 3. A clearing-out annunciator *g* is connected in a bridge of the plug-circuit. The plug-circuit is equipped also with the usual listening-key for connecting the operator's telephone with the circuit. It is to be assumed that it has also a ringing-key for looping a source of current into the circuit of plug *f'*.

The substation B is connected by another grounded circuit 4 with a spring-jack *c'* and annunciator *d'* at a central office H.

Between the offices E and H extends a trunk-line circuit 5 6. This trunk-line terminates at the office E in a spring-jack *i*, provided with contact-pieces which constitute normally open terminals of the line-wires. At the station H the trunk-line terminates in the contact-pieces of a plug *k*. At each end of the line conductor 5, adjacent to the spring-jack at station E and to the terminal plug at station H, is included a group of polarization-cells *l* and *l'*, respectively. These polarization-cells may be unformed or partially formed Planté cells of sufficiently large area to be of low internal resistance. When such a cell is polarized, it opposes to the current tending to charge it a maximum electromotive force approximating two volts. Hence in the conductor 5 each group *l* or *l'* of cells should comprise such a number that the maixmum possible counter electromotive force of the cells in series in each group should be greater than the impressed electromotive force of any current which tends to circulate in the line from an external source. I have found six cells to be sufficient for practical use.

The signaling apparatus associated with the trunk-line is of any well-known form suitable for performing the work required. In the figure it comprises a battery *m* in a branch 9 of the trunk-line circuit at office E, together with an impedance-coil *n* and a pair of normally-closed switch-contacts *i'* and *i²* in the spring-jack *i*, adapted to be separated when a plug is inserted into the spring-jack, and a visible signal *o* in a branch 10 at the office H, the latter branch being controlled by a plug-seat switch *p* of terminal plug *k*.

Let it be assumed that subscriber at station A demands connection with station B of office H. After receiving the call by means of annunciator *d* in the usual way, inserting the plug *f* into spring-jack *c*, and receiving orally the order of the subscriber at station A, the operator at office E inserts plug *f'* into the spring-jack *i* and at the same time, by means of the order-wire circuit 7 8, requests the operator at office H to connect the trunk-line 5 6 with the line to the required station B. When the terminal plug *k* of the trunk-line is raised from its socket and inserted into the spring-jack, the bridge 10, including the visible signal *o*, becomes completed, but since circuit 9 through battery *m* at station E is now interrupted at spring-jack *i* the signal remains inert. When, after the completion of conversation, either of the subscribers operates his generator of signaling-current, the clearing-out annunciator *g* is excited, whereupon the operator at office E removes the plugs *f* and *f'* from the spring-jacks into which they are inserted. The circuit 9 now becomes closed, whereby a current is permitted to flow from battery *m* through the signal *o* at office H, causing the display of this signal. The operator at office H, perceiving this indication, removes plug *k* from the spring-jack *c'* and returns it to its socket, breaking the circuit through the bridge 10.

I have now traced the normal operation of the trunk-line signals. It will be obvious that with such a system of signals in a trunk-circuit which is not provided with any means for preventing the flow of current from sources extraneous to the signaling-circuit such currents might seriously interfere with the operation of the signals and cause premature disconnection of lines at office H. For instance, if a difference of potential existed between the ground at station A and that at the central office E when the lines to stations A and B were connected together, a current might flow from earth at station A through line conductor 1 to conductor 5 of the trunk-circuit, thence through the visible signal *o* to conductor 6 of the trunk-circuit, returning to office E and finding the path thence through the thimble of the spring-jack *c* to earth at the office E. Such a current might operate the signal *o* and bring about a dis-

connection of the lines. If a difference of potential existed between earth at office E and the ground at station B, a current might find circuit through the conductor 6, signal *o*, and line-wire 4, which also would operate the disconnection-signal. Similarly differences of potential between the grounds at office E and office H, or between station A and office H, might bring about the display of signal *o*. If the line to station B were a metallic circuit, still other conditions would arise which might cause the operation of signal *o*. When, however, the groups *l* and *l'* of polarization-cells are included in conductor 5, in accordance with the present invention, the flow of any current arising from the differences of potential ordinarily found between different grounds is effectually prevented. The flow of any current through the polarization-cells instantly develops a counter electromotive force which reduces the current to practically nothing. Any change in the direction or amount of the impressed electromotive force is met by a corresponding change in the counter electromotive force of the polarization-cells. When the impressed electromotive force ceases to act upon the polarization-cells, these appliances of course discharge their accumulated charge through any closed circuit which happens to exist, but the stored energy of a properly-constructed polarization-cell is so small in amount that no appreciable effect is produced on the signaling instruments. The polarization-cells are of extremely low resistance. When thus interposed in the path of telephonic or of rapidly-alternating signaling-currents, their presence in the circuit is inappreciable.

I am aware that prior to my present invention condensers have sometimes been used to prevent the passage of constant currents through conductors, in order to isolate particular portions of the conductor for particular purposes. It is well known, however, that condensers of suitable size for such use permit the flow of sufficient current in being charged and discharged to sensibly affect signaling instruments, and also that condensers diminish the volume of telephonic current in a circuit, and when several are used in series seriously impair telephonic transmission. The large bulk of condensers also is a serious objection to their use in considerable quantities in telephone-switchboards. The polarization-cells applied as herein described are free from all these objections.

Of course this invention is not limited to its application in signaling-circuits of trunk-lines, but is adapted for use in any case where it is desirous to isolate a portion of a conductor as to continuous currents.

I claim as new and desire to secure by Letters Patent—

1. The combination with a circuit having a source of current in it, of two groups of polarization-cells interposed in a conductor of the circuit, and a closed circuit including the said conductor intermediate of the polarization-cells together with a source of current and a signaling instrument, substantially as described.

2. The combination with a circuit grounded at different points, of two groups of polarization-cells at different points in a conductor of the circuit, and a signaling-circuit formed in part of a portion of said conductor intermediate of the polarization-cells and including the source of current and a signaling instrument, whereby interference with the operation of the signaling instrument by differences of potential at the ground connections is prevented.

3. The combination with a trunk-line, of two groups of polarization-cells interposed in a line conductor of the trunk-line, a signaling-circuit formed in part of the line conductor intermediate of said polarization-cells, a source of current at one terminal station, and a signaling instrument at the other terminal station included in said signaling-circuit, and a switch for controlling the operation of the signaling instrument, substantially as described.

4. The combination with a trunk-line terminating in a spring-jack at one station and in a plug at another station, of a group of polarization-cells interposed in a line conductor of the trunk-line at each station, a signaling-circuit formed in part of a portion of said line conductor intermediate of the polarization-cells, a source of current at one station and a visible signal at the other station in the signaling-circuit, and a switch in the spring-jack adapted to be opened when a plug is inserted into the spring-jack, controlling the continuity of the signaling-circuit, substantially as described.

In witness whereof I hereunto subscribe my name this 7th day of April, A. D. 1896.

CHARLES E. SCRIBNER.

Witnesses:
ELLA EDLER,
LUCILE RUSSELL.