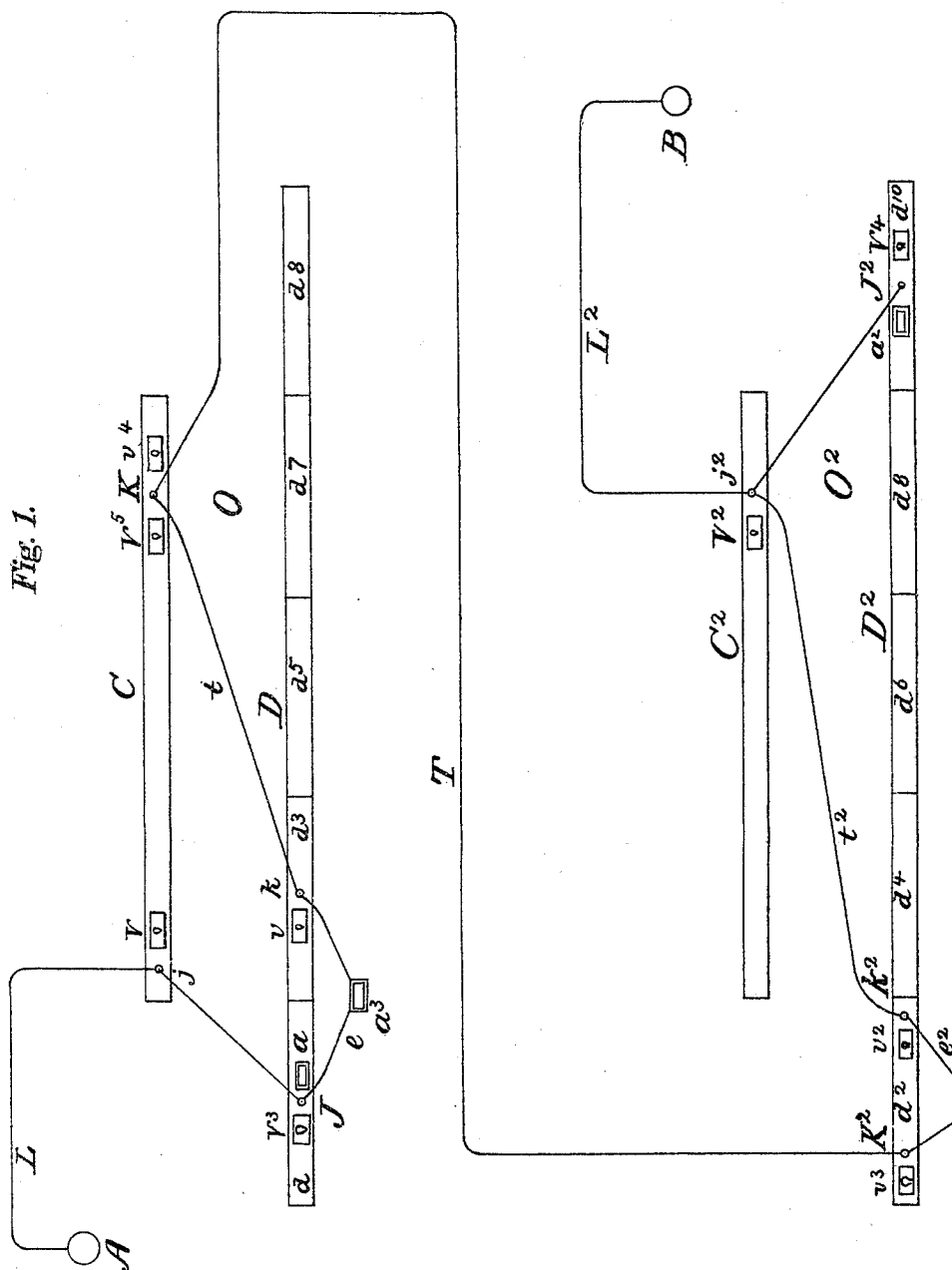


E. J. HALL.

TRUNK LINE SIGNALING APPARATUS AND CIRCUIT FOR TELEPHONE EXCHANGES.

No. 491,553.

Patented Feb. 14, 1893.



Witnesses.

Rever Lewis.
Arthur A. Erb.

Inventor.

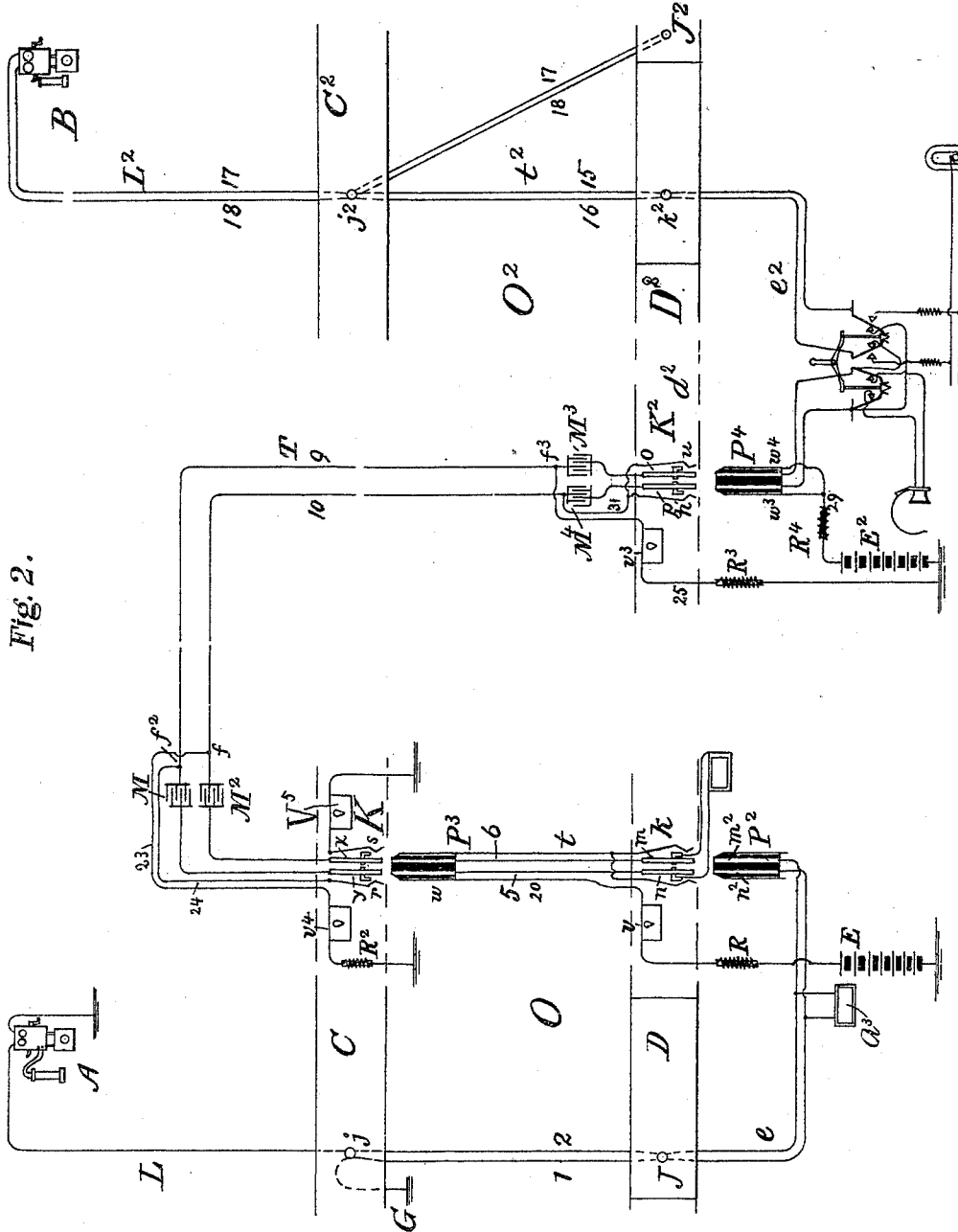
Edward J. Hall
 by *Mark Varnum*
 his attorney.

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Benjamin Lewis
Arthur A. Erb.

Fig. 3.



Fig. 4.



Inventor.

Edward J. Hall.
by J. M. Mauro
his attorney.

UNITED STATES PATENT OFFICE.

EDWARD J. HALL, OF MORRIS, NEW JERSEY, ASSIGNOR TO THE AMERICAN
TELEPHONE AND TELEGRAPH COMPANY, OF NEW YORK.

TRUNK-LINE SIGNALING APPARATUS AND CIRCUIT FOR TELEPHONE-EXCHANGES.

SPECIFICATION forming part of Letters Patent No. 491,553, dated February 14, 1893.

Application filed October 13, 1892. Serial No. 448,763. (No model.)

To all whom it may concern:

Be it known that I, EDWARD J. HALL, residing at Morris township, in the county of Morris and State of New Jersey, have invented certain Improvements in Trunk-Line Signaling Apparatus and Circuits for Telephone-Exchanges, of which the following is a specification.

This invention relates to the construction and operation of telephone circuits, and especially of trunk lines extending between central stations for the purpose of affording facilities whereby telephone substation circuits converging to any two central stations respectively, may be interconnected with one another.

The main objects of the present invention are to provide for divided switchboard and other central office systems of apparatus, a double conductor trunk circuit or line with an efficient and economical reciprocally operating arrangement of signals whereby a connection or disconnection made therewith by any other circuit or conductor at either end thereof shall be caused to automatically announce itself at the other end, and to accomplish this provision without necessitating the construction of additional main line conductors for such signal service.

In pursuance of this object the invention consists in combining systems of divided switchboards, including their necessary connection devices and office trunk conductors with inter-station trunk conductors fitted with a reciprocal signaling system, whereby connections and disconnections at either end of said trunk may be indicated at the other, without the necessity of constructing special conductors for such signaling system.

It also consists in so arranging the two main line conductors of a trunk line, that the said conductors respectively shall also be the main line conductors of independent signaling circuits terminating at the trunk line stations.

It also consists in providing that the conversation circuit extensions of such main line conductors shall connect therewith through the intermediation of condensers, tending thereby to form inductively complete double conductor telephone circuits, while the signal extensions of the two main line conductors

respectively shall directly and conductively connect with the ends thereof, and shall extend to earth or to a suitable return conductor, including in their circuit the signal devices and also electromagnetic resistances or self induction coils. Also in so arranging the signaling apparatus of the two circuits whose independent line sections are respectively the direct and return conductors of the main circuit that the signal receiving apparatus of one of them shall be at the same station as the signal transmitting apparatus of the other, the transmitting branch of each being normally open at the two terminal stations respectively, the two signaling circuits respectively being thus normally open at opposite ends of the trunk line, and each being permanently closed at its remaining end. Thus one of the said signaling circuits is closed through its signaling receiving appliances at A and normally open at the branch including its transmitting appliances at B, while the other is closed at B through its signal receiving appliances, its transmitting end being open at A.

It further consists in providing each signal circuit with a suitable source of electricity, and with means for its automatic closure by the act of making a conversation circuit trunk connection at its transmitting end; and for automatically breaking again the same circuit on the disconnection of said conversation circuit, whereby a suitable signal is caused to be set at either end of the trunk line, by the act of making a connection at the other; the said signal remaining set during the continuance of such connection; and being caused to disappear when the said connection is discontinued.

It also comprises certain details of construction and connection more specifically set forth in the several clauses of claims, recited at the end of this specification.

In a separate application for Letters Patent filed of even date herewith, I have described a system of divided switchboards with which is associated an arrangement of visual signals and circuits the whole being entitled an improvement in "central office apparatus and circuits for telephone exchanges" Serial No. 448,762; and in the present invention the same

specific form of signaling device and mode of operation and many of the same forms of apparatus may be employed or adopted, but I make no claim herein to such appliances, my present invention concerning itself solely with trunk line signaling, and with means and modes of accomplishing the same by circuits independent of the telephone circuit, which independent circuits however utilize the conductors of the said telephone circuit.

My present invention may however be regarded as being auxiliary to that described in said specification, since it is conveniently applicable to the said system of divided switchboards, and since I contemplate its operation in such an association.

In the drawings which form a part of this specification, Figure 1 is a general diagram, showing the course of a compound telephone circuit through two central stations fitted with divided switchboards and united by a trunk line. Fig. 2 is a diagram illustrative of the principles of my invention, and Figs. 3 and 4 are respectively, forms of signal receiving apparatus either of which is well adapted for use in connection with my invention.

Similar letters and figures of references in the several drawings refer to similar features.

In Figs. 1 and 2, O and O² are central telephone stations, C and D form the divided switchboard of O; and C² and D² the divided switchboard of O².

D and D² are answering or terminal switchboards, subdivided into operators' sections, each of which is provided as usual with call receiving and transmitting appliances, and with a set of plug and cord connectors, in the circuit of which by means of suitable keys and switches the operators' appliances may be looped or bridged in a manner well understood. At these boards calls are answered, initial connections and disconnections are made, and the substation required on any call, may be rung up; and the answering spring-jack of the substation lines are distributed between them.

The connecting boards C and C² need not be subdivided. On these are mounted spring-jacks or plugsockets for all of the entering substation lines, and by means of the said jacks, complete connections resulting from calls received at the terminal switchboard are effected with any desired circuit, as more fully specified in my said separate application to which reference has been made.

To each central station in practice, a number of substation lines converge, although to avoid complication I have shown but two.

L is a circuit leading from a substation A to central station O, and L² a similar circuit leading from a station B to the central station O². L entering its central station, passes first to its jack or socket *j* on the connecting board C, and thence to its jack or socket J at some one section of the terminal board D where also it is provided with a call annunciator *a*;

and in like manner L² is led successively through jacks *j*² and J² to its annunciator *a*².

A series of office trunks are provided in this system extending between each section of the terminal board to different points on the connecting boards, and by means of these, the plug receiving connection of a calling circuit on the terminal switchboard may be electrically united with the plug receiving connection of a called circuit at the connecting board. Again for the sake of an easy understanding, I have shown but one such office trunk at its each central station. At station O, the said trunk is represented by the letter *t* and at O² by *t*². Preferably the said office trunks each have a springjack or socket terminal at their terminal board ends, and a connecting plug adapted for insertion in the line jacks at their connecting board ends; *k* and *k*² represent such springjacks, while the plugs are shown as being inserted in appropriate sockets K and J² respectively to form a through connection.

At the several terminal switchboard sections *d*, are provided in the usual way link connections, each composed of flexible conductors with plug terminals, which when thrust respectively into springjacks, effect a thorough connection between the conductors represented by the said jacks, at the same time severing any original circuit formed through the jacks in question. Such link connections are shown at *e* at sections *d* and *d*² of terminal switchboard D, and at *e*² at section *d*² of terminal switchboard D².

It will be observed that in the drawings, the link *e* is shown as uniting the jack J of line L to the jack *k* which is the office trunk terminal; the said jacks are shown as being not located on the same but on adjacent terminal sections, a fact which however has no significance. The link *e* forms the initial union of a through connection, and it is usually desirable that the switchboard section initiating such a connection, shall also initiate the disconnection when due. For this cause a "clearing out" or "disconnecting" signal *a*³ is associated with the link *e*.

The link connection *e*² at station O² is shown as uniting an office trunk jack *k*² to a second jack K², which as will hereinafter appear, forms one end of a trunk line extending between the two central stations; since connections as well as disconnections made thereby are uniformly in pursuance of orders made over said trunk line from the distant station, no disconnecting signal for the link connection *e*² is required or provided.

T is an inter-station trunk line extending between the two central stations O and O². It unites a springjack K on the connecting board at one of the said stations O with a springjack K² on the terminal board at the other station O². Where such trunk service exists, it usually is convenient to place their connection beginning ends at the connecting

board, to be reached in the same way as any other called for line through an office trunk; and to provide a special section for incoming trunks, as at d^2 on the terminal board, so that trunk calls for other stations may be received in the same manner as other calls at the terminal board, and may reach a connection with the wanted line at the connecting board through office trunks also in the same way.

The main linespringjacks at the two switchboards as well as the office trunk connections are associated each with some suitable visual signal indicator, which may be operated by the making of connection or disconnection at the associated jack or trunk connecting appliance as fully described in my said separate application for patent. To be adapted for this purpose, it is necessary to provide an indicator which will become set at any point of a circuit, when a change of condition is made at a second point; which will stay set until a reversal of such change is made; and which will then respond to such reversal; thus furnishing a signal denoting the making, continuance and the dissolution, of the engagement of any circuit conductor where such signal is desired. Such a visual indicator may be formed of the self restoring portion of the annunciator described in Letters Patent of the United States No. 481,120 granted to Frank A. Pickernell August 16, 1892, and shown in Fig. 3 of this specification. Fig. 4 shows the conventional incandescent or glow lamp, which also is well adapted for the purpose in hand, requiring of course to be properly proportioned to each individual case. I am not however restricted to the use of these devices since many other well known forms of needle and shutter annunciators will answer equally well.

In the drawings V , V^2 , V^3 , V^4 and V^5 represent the main circuit signal indicators, and v v^2 the office trunk signal indicators.

In the present invention, both termini of the inter-station trunk conductors T are also provided with suitable automatically operated visual signal indicators v^3 and v^4 these each being arranged likewise to be responsive to connections and disconnections made at the other terminus, and to be connected and operated in a manner presently to be described.

In Fig. 1, the two substation circuits L and L^2 , the office trunks t and t^2 , the link connections e and e^2 and the inter-station trunk T are all shown as being connected up to form a compound or through circuit extending between the substations A and B through the central stations O and O^2 .

Referring now more specially to Fig. 2, L^2 is a metallic circuit, 17 and 18 being the direct and return conductors thereof, both of which have separable contacts in the springjacks j^2 and J^2 . In a central station where both metallic and earth completed substation circuits center, the circuits of the latter class loop through the switchboards, so that in

their springjacks they may offer two conductors for connection with the two of the metallic circuits. L is such a looped earth completed substation circuit, and 1 and 2 are its conductors which pass through the springjacks j and J , and to earth at G . This double conductor construction makes it necessary of course, that the office and interstation trunk circuits t , t^2 and T shall in like manner be formed with double conductors, and accordingly the office trunk t has conductors 5 and 6; t^2 has two conductors 15 and 16, and the two conductors of the inter-station trunk circuit are marked respectively 9 and 10. The same form of springjack may be used for all of the circuits and conductors and any form of four contact jack will answer. Such a form is indicated at k , K and K^2 , where m , n , o , p , x , y respectively are the main contact springs which only are necessary so far as the main conductors are concerned. The plug connectors employed must of course be of like but converse construction to the jacks, and comprise four insulated conducting surfaces, two of which n^2 and m^2 taking the plug P^2 for an example, register and make contact with the jack spring contacts m and n .

Of the two plugs of the link connection e , one in Fig. 2 is supposed to be inserted in the jack J , while the other P^2 is ready for insertion in the jack k . The plug P^3 of the office trunk t is ready to be inserted in the jack K of the interstation trunk line T . One of the plugs P^4 of the link e^2 is ready to be inserted in the other jack K^2 of said trunk, while its mate is in the jack k^2 of the second office trunk; and finally the plug end of the said office trunk t^2 is inserted in the jack j^2 of substation circuit L^2 . When all of the plugs are so inserted, the compound conversation circuit is completed and when both substation circuits are metallic, is a double conductor circuit throughout: while when one of the substation circuits, is earth completed, the said compound circuit is still practically of the double conductor type, since its trunk line is composed of two wires and since one at least of its ends is looped.

For the purposes of initially signaling either central station from the other, over the main trunk T ; of indicating at either end thereof the occupied condition of said trunk line at the other; and for the prompt and automatic announcement at either terminal station of connections and disconnections made at the other, I associate with the said trunk a system of reciprocal visual signs whereby the simple act of making a connection with the trunk line by inserting a plug in its springjack, or of making a disconnection therewith by withdrawing a plug from its springjack at either end, is enabled to operate a visual indicator of the class to which I have hereinbefore referred, such an indicator being responsive both to said connections and disconnections and remaining set as long as the use of the line continues. When both ends of such

a system are located in the same station, it is sufficiently economical to provide special conductors for the said system; but when the trunk line extends between two stations, it is desirable on account of considerations both of economy and simplicity, to dispense with all conductors which are not absolutely essential; and in view of such considerations I have devised means for operating the necessary automatic visual signals reciprocally using no other main conductors than the direct and return conductors 9 and 10 of the conversation circuit trunk line itself, these constituting respectively and severally the main conductors also of the two independent signaling circuits required. To accomplish this, condensers M , M^2 , M^3 , and M^4 are interposed between each end of both conductors 9 and 10 and their respective springjack contacts. I have found condensers with a capacity of three microfarads or thereabout to answer perfectly. These form no bar to the practical continuity of the circuit with respect to conversation currents, while they render it impassable for steady currents such as are used in operating the visual signals.

The trunk line springjack K at O , has two local contact springs r and s , for signaling circuits; and the spring jack K^2 at O^2 also has two local signaling circuit spring contacts h and u . These last may if desired be electrically united. A branch conductor 23 is led to an earth connection at station O from any point f on the main trunk conductor 10 outside of the condenser, and in its circuit is included the visual signal indicator v^4 and an electro-magnetic or inductive resistance R^2 . At the same station a second branch 24 is extended from the point f^2 on the main trunk conductor 9 to the local springjack contact r of the jack K . At station O^2 , the main conductor 9 which is thus left normally open in the jack K at O , is provided with an earth branch 25 joining it at the point f^3 , and included in the circuit of said branch is the visual signal indicator v^3 and the electro-magnetic resistance R^3 ; while the main conductor 10 which has a closed circuit branch to earth at station O , is at O^2 provided with a branched conductor 31 connecting directly to the normally insulated contact springs h and u of the jack K^2 . At station O , the office trunk plug P^3 has a conducting contact surface w adapted when inserted in jack K to register and make contact with the spring contact r . This surface is united to an extra conductor 20 leading to an earth connection through the visual signal indicator v , the electro magnetic resistance R , and an electrical generator E which conveniently may be a primary or secondary battery. And in like manner at station O^2 the plug P^4 has conducting surface contacts w^3 and w^4 adapted when the said plug is inserted in the jack K^2 to register and make contact with the spring contacts h and u . These surfaces are both united to a branch conductor 29 leading through the inductive resistance R^4 and bat-

tery E^2 to earth. Thus the two conductors 9 and 10 of the conversation circuit trunk line, each have a closed earth branch including a signal receiving instrument at one end, and a normally open earth branch at the other, the open branch of each being located at the station where is located the closed branch of the other. Each also has an inductive resistance in each earth branch; and a battery in one of them; and each also has a suitable circuit closer in the open branch, operating to close such branch by the insertion of the conversation circuit connecting plug, to maintain the battery current flowing therein, and through the indicator at the other station, as long as said plug remains inserted; and to open such branch and thereby the circuit of said battery by the withdrawal of the said plug. The battery of course may be placed at any point in the branch at either end.

The inductive resistance is made in a manner well understood, by winding insulated copper wire over a properly shaped iron core or cores, the iron preferably having a closed magnetic circuit, and may be wound to a real resistance of about fifty ohms, which alone it practically offers to a steady current such as that employed in the signaling circuit; but adapted in virtue of the arrangement and construction of its winding and iron core to offer an apparent resistance of thirty thousand ohms or thereabout to electrical changes occurring with a velocity of six hundred per second. These appliances are well known in the art, and are variously termed electro magnetic or inductive resistances, and retardation, choking or self-induction coils. Their presence prevents the diversion of the conversation currents through the earth branches, while permitting the free passage of the steady signaling current; and on the other hand the condensers prevent the passage of the signaling currents, but present no obstacle to the transmission of speech. It will therefore be seen that a connection made with the double conductor trunk line at station O to form a through telephone circuit, automatically closes the circuit of the battery E through one of the conductors 9 of such circuit and the visual signal v^3 at station O^2 , which thereupon is set; that the withdrawal of the said plug opens the said circuit, and thereupon effects the disappearance of such signal; and that in consequence of these operations, no connection or disconnection can be made at O with said trunk without notifying station O^2 of such action. And in the same way a connection made at O^2 with the said trunk line closes the circuit of the battery E^2 through the visual signal v^4 and gives thereby one signal indicating that the connection called for is made, while a disconnection produces a reversal signal and indicates that such trunk line is free at O^2 .

I have not shown or described any call key or telephone loopkey system in association with the link connections e and e^2 at the sta-

tions O and O², as no such apparatus is required for a clear understanding of my invention, but it will of course be understood that any of the well known systems of apparatus in which a cam key is supplied with each link, controlling the terminals of a telephone and a generator loop may be employed.

Although I have described the reciprocal signaling feature of my invention as being associated with my system of divided switchboards, I desire it to be understood that it is by no means restricted to such association, but is adapted for use in connection with double conductor trunk lines in any system of switching apparatus.

Having thus fully described and specified my invention I claim:—

1. The combination substantially as hereinbefore described, of two divided switchboards located at different central telephone stations, and each comprising a terminal switchboard at which calls are answered, and a connecting switchboard at which connections called for are made; a series of substation lines centering at each of the said central stations, each passing through a connection device on the connecting board to a second connection device on the terminal board; an office trunk line at each central station extending from a plugsocket at the terminal board to a connecting plug at the connecting board; and a series of link connections at each terminal board, each comprising a flexible conductor and a connecting plug at both ends; with an inter-station trunk line uniting the connecting board at one station with the terminal board at the other station, and represented at each by a plugsocket, the said trunk line comprising a main line section, two inductively connected terminal sections therefor connected with the said plugsockets respectively, and a condenser interposed between each terminal section and the main line to constitute the said inductive connection thereof.

2. The combination of two divided switchboards located at different central telephone stations, each comprising a terminal switchboard at which calls are answered, and a connecting switchboard at which connections called for are made; a series of substation circuits converging to each of the said central stations, each passing through a plug socket on the connection board to a second plugsocket on the terminal board; an office trunk circuit at each central station joining a plugsocket at the terminal board to a plug connector at the connecting board; and link connections at each terminal board, each formed of a flexible conductor fitted at both ends with a connecting plug whereby the plugsockets of the substation and trunk circuits may be united; with an inter-station trunk line uniting a plugsocket on the connecting board at one central station, to a plugsocket on the terminal board at the other station, the said trunk line comprising a main line section, two

inductively connected terminal sections therefor connected with the said plugsockets respectively, and a condenser interposed at the junction between each terminal section and the main line section; and a system of automatic signals associated with said inter-office trunk line and consisting of a branch circuit at each end, permanently connected to the main line section thereof; one of the said branch circuits being closed through a signal indicator and a retardation coil, and the other including a battery, a retardation coil and a circuit closer being normally open but adapted to be closed by any connection made with its associated plugsocket of said trunk, substantially as hereinbefore described.

3. The combination of two divided switchboards located at different central telephone stations, each comprising a terminal switchboard at which calls are answered, and a connecting switchboard where connections called for are made; a series of substation circuits centering at each of the said central stations, each passing through a connection device on the connecting board to a similar device on the terminal board; an office trunk line at each central station fitted at the terminal board with a plugsocket, and at the connecting board with a plug connector; and link connections at each terminal board, each formed of a flexible conductor fitted at both ends with a connecting plug adapted for insertion in the line and office trunk sockets; with a double conductor or metallic circuit interstation trunk line uniting a plugsocket on the connecting board at one central station to a plugsocket on the terminal board at the other central station, the said trunk line comprising a double conductor main line section, two inductively connected terminal sections therefor looping to the said plug sockets respectively, and condensers interposed at the junctions between the two ends of each terminal loop section and the corresponding ends of the two conductors of the main line section; and a reciprocal system of automatic signals for said trunk line comprising a branch circuit at each end of both conductors thereof, permanently connected with its main line sections, one branch of each of the said trunk conductors at opposite terminal stations being closed through a signal indicator and a retardation coil, and the other including a battery, a retardation coil and a circuit closer being normally open in the plugsocket of said trunk line, and adapted to be closed by the insertion of a plug therein, whereby connections and disconnections of said trunk line at either end thereof may be automatically signaled to the other end substantially as specified herein.

4. A double conductor trunk line extending between two telephone stations, the two conductors thereof constituting respectively the direct and return conductors of a conversation circuit, and each severally forming a portion of an independent signaling circuit.

5. A double conductor telephone or conversation circuit, and two independent signaling circuits extending between two telephone stations; the two conductors of the said telephone circuit constituting respectively the main conductors of the said two signaling circuits, substantially as described.

6. In combination with a double conductor interoffice trunk telephone circuit adapted to unite the telephone circuits centering in one office, with those centering in the other; a reciprocal signaling system comprising two independent signaling circuits for indicating at each end of said trunk a connection or disconnection made at the other, the two conductors of said telephone circuit forming respectively the main conductors of the two circuits of said signaling system substantially as described.

7. A double conductor trunk line extending between two distant telephone stations, constituting a main line section common to independent telephone and signaling circuits, the terminals of the remaining portion of said telephone circuit being inductively connected therewith through condensers, and the terminals of the remaining portion of the said signaling circuits being conductively connected with the two main conductors respectively, through electromagnetic resistances, or retardation coils, substantially as described.

8. An interoffice trunk line; a telephone branch or loop therefor at both terminal offices; and a condenser interposed at each terminus between the said trunk line and loop; combined with a normally closed signal branch including a signal receiving appliance, and an electromagnetic or inductive resistance, connected with said trunk at one of the said terminal offices; a normally open signal transmitting branch therefor, a source of electricity, and means as indicated for automatically closing the said transmitting branch and for including the said source therein at the other of said terminal offices substantially as described.

9. The combination with a double conductor trunk telephone line extending between two stations to form a part of a metallic telephone circuit, and a condenser in the circuit of each conductor at both stations; of an earth terminal branch connected with each end of each of the said conductors, the two earth branches of each conductor including respectively signal receiving and signal transmitting devices, the receiving devices of one and the transmitting devices of the other conductor being at the same station; a battery in one of the earth branches of both conductors, and an electromagnetic resistance or self induction coil in both earth branches of each conductor whereby the two conductors of said trunk line are enabled severally to form portions of inde-

pendent earth completed signaling circuits, substantially as described herein.

10. The combination substantially as hereinbefore described, of a metallic circuit or double conductor trunk telephone line extending between two telephone stations and having its two main conductors at each of the said stations connected through condensers respectively, with telephone loops to constitute a conversation circuit; with an associated reciprocal signaling system comprising the said two main conductors; a closed branch permanently connected with each at opposite terminal stations, and including a visual signal indicator; and an electromagnetic resistance or retardation coil; and a normally open branch for the other end of each, at the said opposite stations, including a battery or like generator, a similar electromagnetic resistance, and a circuit closer adapted to be operated, and to close and open the signaling circuit by connections or disconnections made with the telephone loop at the same station.

11. The combination of a metallic circuit or double conductor trunk line uniting two central telephone stations and composed of a double conductor main line section, two inductively connected terminal loop sections therefor, one at each station, a springjack in each of the said loop sections, and condensers interposed between the several ends of said loops and the corresponding ends of the main sections to constitute the said inductive connection; with two independent earth completed signaling circuits associated with said double conductor trunk to indicate at either end thereof a connection or disconnection made therewith at the other end; one of the said two signaling circuits being normally closed, and the other normally open at each of the two terminal stations, and each being composed of a separate one of the trunk main line sections, a closed and an open branch permanently connected with said section, an electromagnetic resistance in each of the said branches a visual signaling indicator responding to the closing and opening of the circuit in the closed branch, a circuit closer in the open branch mounted in the trunk springjack, and an electrical generator, whereby the insertion or withdrawal of a plug in or from the springjack at either end of the trunk line is enabled to operate the signal at the other without necessitating special signaling conductors, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 20th day of September, 1892.

EDWARD J. HALL.

Witnesses:

THOS. D. LOCKWOOD,
JOHN C. FREY.