(No Model.) 2 Sheets—Sheet 1.

F. A. PICKERNELL & F. W. DUNBAR.

TELEPHONE AND SIGNALING CIRCUIT.

No. 494,385. Patented Mar. 28, 1893.

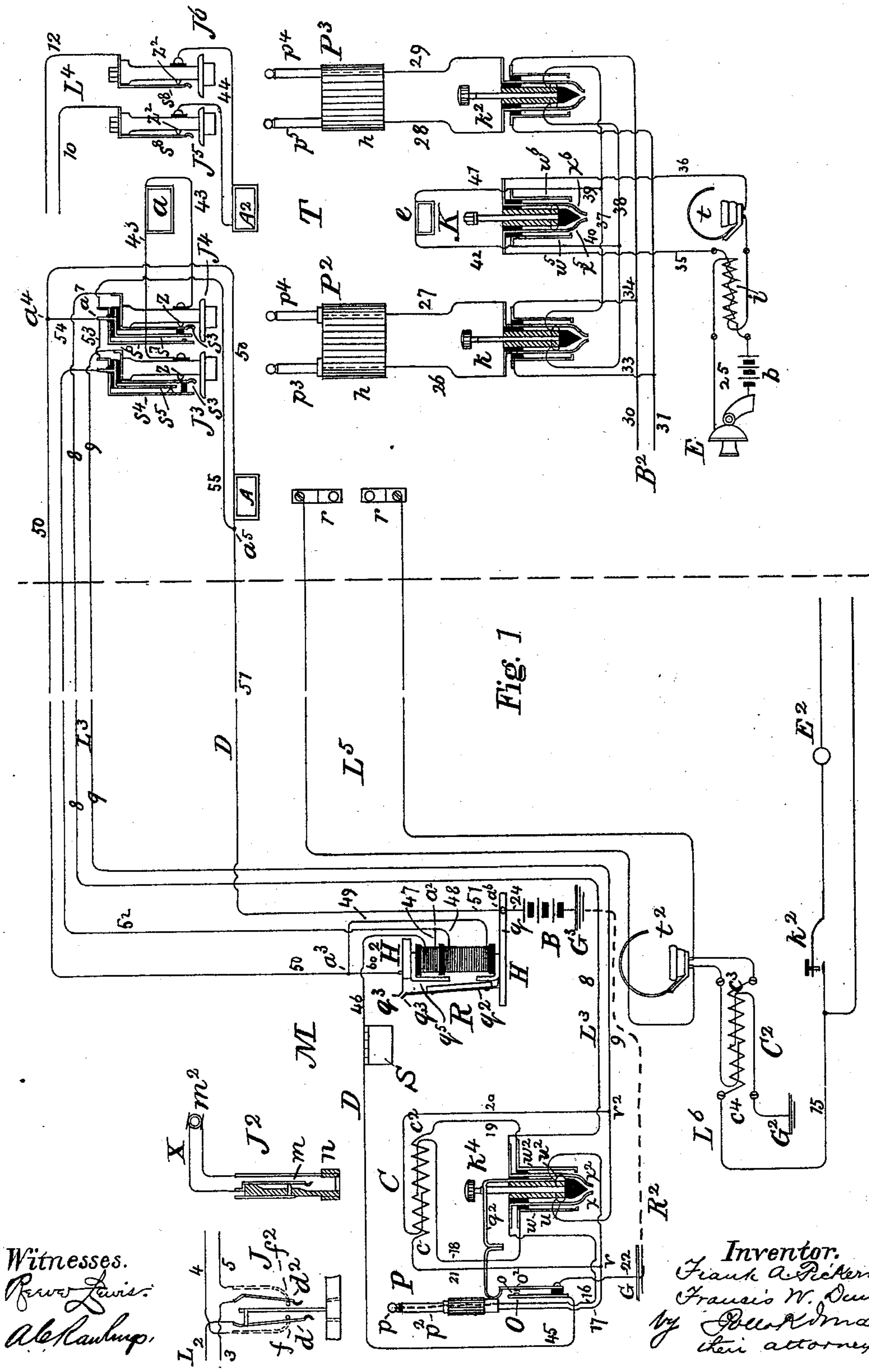

Fig. 1

Witnesses.
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(No Model.) 2 Sheets—Sheet 2.

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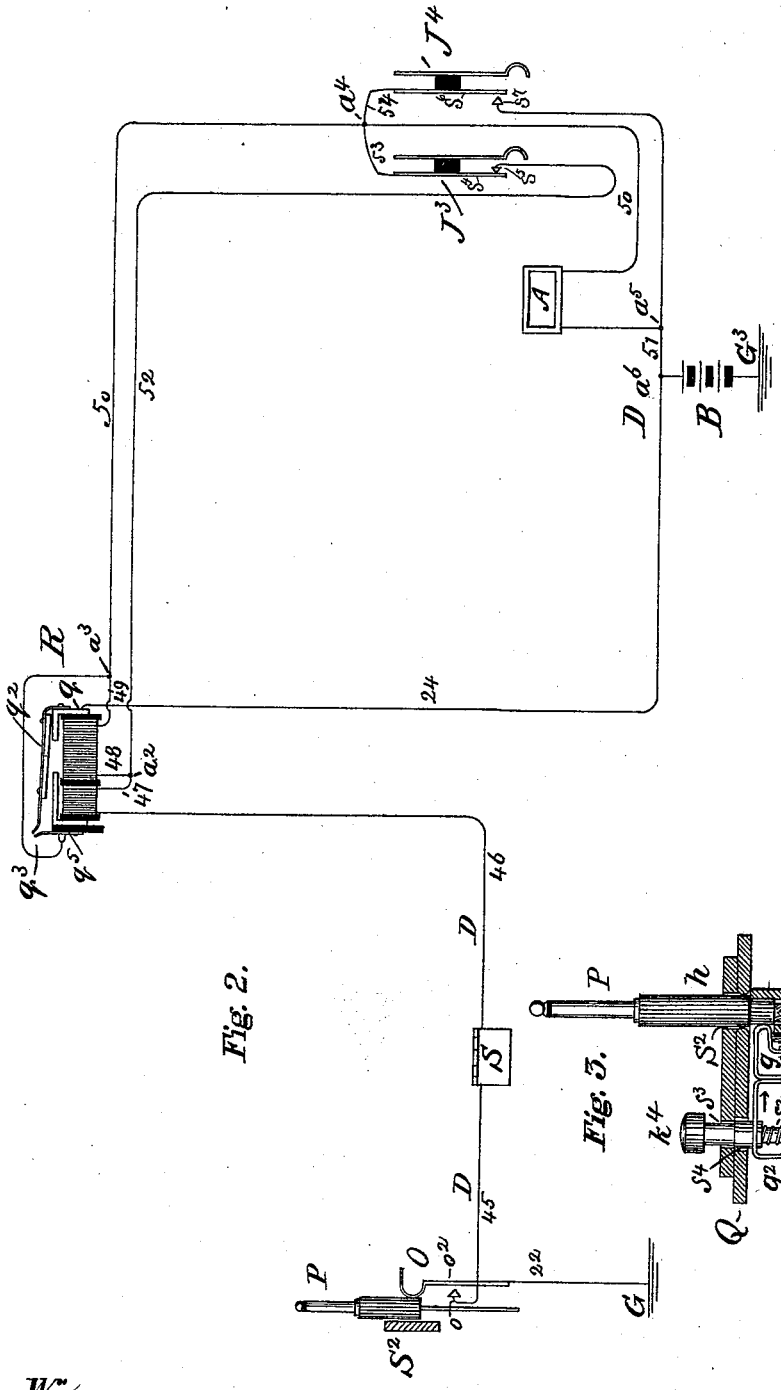

Fig. 2.

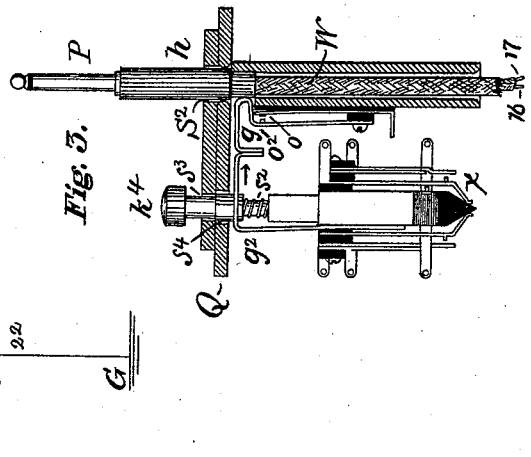

Fig. 3.

Witnesses.
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UNITED STATES PATENT OFFICE.

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TELEPHONE AND SIGNALING CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 494,385, dated March 28, 1893.

Application filed December 15, 1892. Serial No. 455,297. (No model.)

To all whom it may concern:

Be it known that we, FRANK A. PICKERNELL, residing at Newark, in the county of Essex and State of New Jersey, and FRANCIS W. DUNBAR, residing at New York, in the county and State of New York, have invented certain Improvements in Telephone and Signaling Circuits, of which the folowling is a specification.

This invention relates to transfer systems and their signaling apparatus in telephone central stations. Its objects generally stated, are to facilitate the work of transferring telephonic connections between local and toll line switchboards; to avoid the inconvenience in operation arising from the massing of switchcords; to provide a system of reciprocal signaling between the said local and toll boards; and to insure that when a repeating induction coil has been interposed in the circuit of the station trunk, forming the connection between the local and toll line boards (an arrangement frequently adopted in the interconnection of double and single conductor circuits) it can be automatically disconnected therefrom by the act of disconnecting the station trunk from the local telephone circuit. It is to be premised that in large telephone exchanges there are both local and toll lines. The local lines converge from substations to the central station and connect usually with a multiple switchboard, having a number of independent operators' sections. The toll lines are interstation trunks which extend between independent exchanges, and at each central station terminate in independent switchboards. Station trunks therefore are required in each central station, to serve as intermediary conductors between the multiple and toll line boards; and since it would be cumbrous to branch or loop these to all sections of the multiple board, it is customary to terminate them at one section only (usually the end section) and when a call from any substation comes in for a toll line connection at its regular section, to have the operator there, communicate over an instruction circuit with the end section operator instructing the latter to make the required toll board connection. It is also usual to establish and make use of such instruction circuits between the end section and other operators, as well as between the said end section operator and the toll board operator.

The different features of this invention are most highly advantageous when operated in association with a large exchange and a multiple switchboard; but are equally applicable to smaller exchanges and ordinary or single section switchboards, and in this specification it is to be understood that the term "local switchboard" includes either a multiple switchboard whose toll business is operated from its end section, or a single switchboard of any preferred construction.

Heretofore, office trunks have been provided at both ends with springjack or socket terminals, and this characteristic has necessitated two plugs and a cord conductor depending from both, for each connection between the said trunk jacks and the jacks of subscribers' lines. In consequence of this, the massing and tangling of cords becomes very objectionable; but retaining the same system, the only remedy for the trouble is to largely increase the amount of switchboard apparatus, and the use of complex springjacks. Employing the organization described in this specification, it becomes possible to terminate the station trunk in a cord and plug, instead of a springjack as heretofore, and to establish a connection with any local substation circuit by inserting the said terminal plug into the socket of such substation circuit directly. The number of cords is thereby at once halved, while but one motion also is then necessary.

Heretofore it has been requisite to transmit an order over the instruction circuit, not only for connections between toll and local circuits, but also for disconnections; which thus involves two communications over the said instruction circuit for each connection. By employing the organizations described herein, it is only necessary to use the instruction circuit once, viz: in ordering the establishment of a connection; since the disconnection of the station trunk at the toll board end thereof, is enabled automatically to operate a signal at the local board indicating that disconnection is desired, whereby the

work of the instruction circuit is largely reduced, and time saved.

In the station trunks between the toll and local switchboards, it is requisite to provide means for including a repeating induction coil to be used in the interconnection of a double with a single line circuit, or whenever either the toll or local line is noisy. The mode heretofore employed, has been to have two terminal office trunk springjacks with the repeating coil connected between them, to be introduced or not, according to the springjack employed; or else to control the connection of the said coil by a switch, which in one position acts to introduce the coil, and in the other maintains the disconnection thereof; these arrangements however involve on the one hand a multiplicity of appliances, and on the other the liability owing to neglect, of the continued presence of the coil, (which of itself is disadvantageous) even when not required. In the invention herein described, the repeating coil is introduced when required, by a positive operation; but is automatically withdrawn from the circuit by the act of disconnecting the office trunk, and the consequent termination of the communication with which the said repeating coil has been concerned.

In the accompanying drawings which form a part of this specification, Figure 1 is a diagram of a portion of both toll and local board connecting apparatus, and their circuits, together with the station trunk and its associated signaling and other appliances. Fig. 2 is a diagram of the signaling circuit and apparatus of the said office trunk; and Fig. 3 is a detail illustrating the mechanism whereby is accomplished the automatic withdrawal of the repeating coil.

In Fig. 1, the organization is shown as having two general divisions, that marked M on the left of the central broken line, comprising the devices all ordinarily placed at the section of the multiple switchboard; and that marked T on the right of the said line being ordinarily placed at the toll switchboard. This figure shows several distinct circuits which to a certain extent are practically independent of each other. The circuit L is a local substation circuit represented on the section M as well as on the other sections (not shown) of the local switchboard, its wires 2 and 3 leading from the substation and from the next assumed section in one direction, and its wires 4 and 5 leading from the next assumed section in the opposite direction. The circuit X is merely a loop to a busy signal current generator or like device. The circuit L^3 is the office trunk between the local switchboard M and the toll board T, and has two conductors 8 and 9. This circuit at M is adapted for connection with any local telephone circuit, and at T with any inter-office trunk or toll line.

L^4 is the terminal loop of a toll line or inter-office trunk, extending by wires 10 and 12 to a distant station.

L^5 is an instruction circuit leading from contact terminals at the toll board to the operator's telephone at the local board.

L^6 is a conductor leading from other local switchboards to the operator's telephone at the board M with which it is inductively connected.

D is an independent associated signaling circuit extending between the local board M and the toll board T, and provided with shunt circuits and appliances to be hereinafter described.

J is a plugsocket or springjack belonging to circuit L, whose conductors 2 and 3 respectively have spring terminals d d^2 therein, provided with resting contacts f f^2 respectively, which may be connected with continuation wires 4 and 5 leading to other switchboard sections.

J^2 is a special springjack wherein the terminal plug of the office trunk can be placed if it be desired to indicate at the toll board that a local line called for, is busy; its circuit X which is a closed loop connects its spring contact m, and its frame or socket contact n with a magneto or other generator m^2, and thus operates a suitable annunciator at the said toll board.

P is a loop plug which has tip, and sleeve or stem conducting surfaces p and p^2 insulated from one another, forming respectively the terminals of the two conductors of the office trunk circuit L^3. It is adapted to be inserted in the jacks J or J^2, and the tip p makes contact with the inner spring d^2 of the former, and the sole spring m of the latter, while the stem p^2 makes contact with the longer spring d of the former, and the frame piece n of the latter. In either case the circuit L^3 ending in the said loop plug is closed through the circuits L or X having terminals in the said jacks. The plug P has no electrical relation with the signaling circuit D, but it has when in its resting socket, a mechanical relation thereto, maintaining the same discontinuous when in place, and permitting the same to become continuous or to close, when taken from its resting socket, for any purpose, by means of appliances shortly to be described.

The main conductors of the office trunk are represented between the key k^4 and the plug P by conductors 16 and 17 which in practice are comprised in a flexible cord W (see Fig. 3) of sufficient length to allow the plug to be inserted in any desired springjack, and which in a manner well understood, is provided with some form of automatic retractor, such as a weight suspended in the bight of the cord.

C is a repeating induction cord with two helices c and c^2 and is arranged to be interposed in the office trunk circuit, so that the terminal plug at the local switchboard end

thereof, may have an inductive connection only, with the springjack at the other end thereof, during communications in which the jack J represents an earth completed instead of a metallic circuit, or in certain other circumstances where the lines being noisy, it becomes desirable to divide the telephone or conversation circuit. This repeating induction coil attachment is controlled by the push key k^4, being interposed when the said key is depressed, but excluded when the said key is elevated; as will be more fully explained in connection with Fig. 3.

The operator at M has a portable telephone t^2 which, so far as this invention is concerned, is included inductively or conductively, only in instruction or order circuits, which are normally incomplete. It is connected in the order circuit L^5 extending from the toll board T, where it terminates in contact plates r r, to which the ends of the operator's telephone circuit may be applied, if it be desired to send an order. The plates r are of the form shown, in order that the twin plugs P^2 P^3 may readily and without care make contact with them for the purpose of closing the circuit and connecting the operator's telephone at T therewith. It may also be connected with a second order circuit L^6 extending by wires 15 from other sections of the local board M, at any of which the operator's telephones E^2 can connect therewith by means of keys K^2, or otherwise as desired. The connection of the circuit L^6 is shown as being effected through the intermediation of an induction coil C^2, one helix thereof c^3 being in closed circuit with the telephone t^2, while the other c^4 is placed in the order circuit 15, which is grounded at G^2.

R is a relay having wound over its iron core two helices of wire, H and H^2. It has a metallic frame piece q to which is hung in such a way as to insure a good electrical connection, the spring armature q^2 having a movable contact point q^3, arranged upon the attraction of the armature, to make contact with a front stop, which also I have called q^3, so that when the said contact is made, it may be described by that reference letter. The front end of the relay core is bent upward and over the spools in the form of a polepiece q^5, for the more efficient attraction of the armature. The coil H of the relay has a relatively large number of convolutions, and a relatively high resistance, one hundred ohms or thereabout. The coil H^2 of the relay has a relatively small number of convolutions and a relatively low resistance; ten ohms having been found satisfactory. When the relay core becomes sufficiently magnetized, its armature is attracted and closes the contact q^3, which normally is open. Once having been closed however, the armature will stay attracted with a much lower degree of magnetizing power than is necessary to first attract it, and make the contact.

S is a self setting or restoring annunciator of any desired form, such as a polarized needle, or a neutral magnet lifting its shutter into view when energized, and causing or permitting the same to disappear when demagnetized. The construction and resistance of its winding should be substantially equal to that of the low resistance relay coil H^2; that is to say it has relatively few convolutions, and offers a resistance of about ten ohms. It is placed directly in the main conductor portion of the signal circuit D. A signal circuit battery B, has one pole grounded at G^3, and the other connected by the wire 24 with the relay frame q. It is not essential, albeit convenient, that the relay and battery shall be placed at the local board M; they may be located wherever desired, provided that the connections are arranged in the manner to be described.

Referring to Fig. 3 it will be seen that the plug P when not in use has its non-conducting handle h, resting in a seat S^2 prepared for it in the table or keyboard Q, and is closely associated with the push key k^4 which controls the connection of the repeating coil C. The tip conductor 16 of the plug leads to the inner spring x of the key, and the stem conductor 17 thereof, leads to the contact point u^2 on the tubular sheath thereof, through which the key spindle works. The conductor 9 of circuit L^3 of which conductor 16 is the continuation, ends in the fixed contact u on the other side of said tubular sheath, and the conductor 8 of circuit L^3 ends in the inner contact spring x^2. When the key is undepressed, the said inner springs x and x^2 rest on the said fixed contact points u and u^2 respectively, and the circuit L^3 of the office trunk extends conductively to the tip and stem conductors of the plug P.

A branch including the wires 21 and 18, and the helix c of the repeating coil, extends from any point v on conductor 17, to the outer contact spring w of the key, where as long as the said key is undepressed, it remains discontinuous. A similar branch including the wires 19 and 20 and the helix c^2 extends from any point v^2 on conductor 9 of circuit L^3, to the outer contact spring w^2. When the key is depressed, its springs x and x^2 break contact with the fixed points u and u^2 and make contact with the outer springs w and w^2; and when the said key is again elevated, the reverse is the case. When the key therefore is depressed, the repeating coil is included in the circuit L^3 from the tip and stem of the plug P, which circuit considered as a whole then is no longer complete conductively, but inductively through the said coil C.

To render the subsequent elevation of the key k^4 independent of the action or volition of the operator, the apparatus now to be described has been devised. The shank of the key k^4 is encircled by the spring g^2, which has a hole through it for that purpose, and which is attached at its lower end to the frame of the key. The said shank has a square shoulder s^4. The

spring g^2 tends by its own resiliency to move in the direction of the plug P, and when the key is depressed, does move, and engages the shoulder s^4 as soon as the shank in its downward progress passes through the hole in the spring. Normally the said spring is prevented from moving by the spring g which in virtue of the presence of the plug handle h in its seat S^2 in the table Q presses it backwardly. But when the plug P is removed from its seat for insertion in a jack, the spring g is relaxed, and allows the spring g^2 also to move, and to engage the shoulder of the key when depressed, thus providing a retaining device therefor. It is only when the plug P is withdrawn from its seat and inserted in a local jack, that occasion arises for the use of the key k^4; consequently when it is necessary to interpose the repeating coil into the conversation circuit, the key may be depressed, and will remain so during the pendency of the connection because its collar is engaged by the spring g^2. Under these conditions the contacts below having been altered as described, the repeating coil is in circuit; when on the conclusion of the conversation the plug is removed from the local board jack, and restored to its seat, its shank will force the spring g, and thereby the spring g^2 outwardly, freeing the key spindle therefrom and permitting it to rise under the influence of the spiral spring s^2. This operation automatically disconnects the repeating coil from the conversation circuit, its presence there being no longer desirable.

Inasmuch as it is always necessary to withdraw the plug from the jack and restore it to its resting place on the completion of a communication, it follows that the repeating coil cannot be left in circuit from the neglect or heedlessness of an operator.

At the toll board T are the springjacks J^3 and J^4 of the two conductors of the office trunk; the two spring jacks J^5 and J^6 of each of any number of toll lines or inter-office trunks; (one pair only for clearness being shown) and a series of link connections (one only being shown) having plug terminals P^2 and P^3 with a listening key K, ringing keys k, and k^2 and a disconnecting annunciator e bridged between the two conductors of the link as usual; and also the usual transmitting and receiving telephone E and t, the former being in the local circuit 25 of a transmitter battery b and connected with the telephone loop through an induction coil i; the jacks and plugs at the toll board end of the office trunk are in the present instance shown as twinjacks and plugs, that being a form of metallic circuit connection alternative to the well known single loop jack and plug. The several circuit arrangements of each link connection are as usual, the member p^3 of plug P^2 being united by the cord conductors 26 and 28 and the two ringing key normal contacts with the member p^5 of the plug P^3; while the member p^4 of the plug P^2 is united similarly with the member p^4 of P^3.

B^2 is the loop from a call generator (not shown) and has branches 30, 31, to ringing key k^2; and 33, 34 to key k. The depression of either key acts to send a call current out through its own twin plug, cutting off the other at the contacts u.

The disconnecting drop e is permanently bridged between the link conductors 37 and 38 by the wires 39 and 40 and their extensions 41 and 42; and the telephones are connected in the bridge when desired, by the depression of the cam key K which presses the inner spring contacts x^5 x^6 which are the terminals of the telephone loop against the contacts w^5 and w^6 of the outer springs which are branch terminals of the bridge connection.

A is a signal annunciator of any ordinary type, and of a resistance approximately equal to that of the high resistance relay coil, say one hundred ohms. It is connected in the signal circuit D.

The springjacks J^3 and J^4 each have two other contact springs in addition to the springs s^3 of their main circuit, which may normally or when a plug is not inserted, rest upon the insulated contact pins z which are looped by the conductor 43 to the ordinary annunciator a. This annunciator is provided for use, only in case the regular signal circuit D should develop a fault, when signals could be transmitted temporarily over the conversation circuit. The two additional contact springs s^4 and s^5 of jack J^3 are normally in contact, but separate on the insertion of a plug in the jack; while the two additional contact springs s^6 and s^7 are normally out of contact, but are electrically united by the insertion of a plug in the jack socket; these constitute circuit changers determining the condition of shunt circuits.

The main station trunk circuit L^3 extends from the local switchboard M to the toll board T by the wires 8 and 9 which terminate respectively in the springs s^3, these being normally united through their anvil contacts z and the drop a. When the twin plug P^2 is placed in the jacks J^3 J^4, this normal union is dissolved, and the said trunk conductors 8 and 9 are extended to the two members p^5 and p^4 of the other twin plug P^3. The interstation trunk L^4 enters the central station by conductors 10 and 12 which are normally united through their contact springs s^8, resting contacts z^2, the loop 44, and the annunciator A^2. When the second twin plug P^3 is inserted in this or any like pair of jacks, this normal union is dissolved and the two conductors 10 and 12 of the toll line L^4 are extended through the office trunk L^3 to the terminal plug thereof P, and when the said plug P is inserted in the jack J of any line L, the said line and the toll line, are united for thorough oral communication. No portion of the conversation circuit so formed, has ordinarily any electrical

relation to the signaling circuit now to be described, although the plug P by its removal from, or replacement in its resting socket or seat S^2 mechanically actuates the circuit controller or closer O of the signal circuit D by uniting or severing its contact points o and o^2.

The signaling circuit irrespective of its route under any given conditions terminates at the two ground connections G and G^3 or such an equivalent return conductor as is indicated in the broken line R^2, and necessarily includes the battery or other generator B, and the circuit closer O, which is held open by the handle of the plug P when in place, and which is closed whenever the said plug is not in place. When the circuit is not in operation, and the plugs at both ends are not in use, the signaling circuit between the switchboards M and T is traceable as follows: earth at G, wire 22, circuit closer O, the points o and o^2 being separated, conductor 45, the self-setting annunciator S, conductor 46, low resistance coil H^2, of the relay R, conductors 47 and 48, high resistance coil H of the relay R, and conductor 49 at the local board, over conductor 50 to the toll board, thence through the high resistance signal annunciator A, and conductors 51, and a portion of 24 to one pole of the generator B, the other pole of which is earthed at G^3, or as before stated connected with the return conductor R^2. It will be also observed that a shunt circuit is provided around the high resistance coil H of the relay R, which shunt is closed by the normally established contact between the points s^4 and s^5 in spring-jack J^3 at the toll board, the said shunt circuit extending from the junction point a^2 on one side, to the junction point a^4 on the other side of the relay coil H, by way of conductor 52, jack contacts s^5 and s^4, and conductor 53. Under these conditions therefore, the low and high resistance signal indicators S and A and the low resistance relay coils H^2 are all in the signaling circuit D, which however is open at O, and the high resistance relay coil is connected therewith, but short circuited by the shunt. If now the plug P be removed from its seat S^2, the circuit closer O will operate and close the circuit of the generator B through the ten ohm signal S, the one hundred ohm signal A and the ten ohm coil H^2 of the relay. The signal S will not operate because the current is too enfeebled by the presence of the high resistance coils of A; the relay coil H^2 will not attract its armature, because, partly for the same reason, and partly because it has in any case but a feeble magnetizing power, it does not sufficiently magnetize its core q^5, to enable said core to attract the armature q^2; the relay coil H does not aid in magnetizing the said core, because it is shunted; but the one hundred ohm signal A at the toll board having a large number of convolutions, is able to develop a considerable magnetizing power, and does operate and give its signal, ordinarily by dropping a shutter. Thus the signal circuit having been quiescent, can by the action of an operator at the local board M in taking up the trunk terminal plug to make a conversation circuit connection, be automatically operated to give a signal at the toll board, indicating that a connection with the office trunk L^3 is desired, to which signal the toll board operator at once responds by inserting the plug P^2 into the trunk jacks J^3 and J^4, which action separates the spring points s^4 s^5 and also brings into contact the spring points s^6 and s^7, thus opening the normal shunt round the relay coil H, and closing an independent and normally open shunt round the high resistance annunciator A between the junction point a^4 on one side, and the junction point a^5 on the other side thereof, by way of conductor 54, point a^7, spring contacts s^6 and s^7, in jack J^4, and conductor 55. When therefore the office trunk L^3 is in use, the signal circuit D, is closed at O, and the circuit includes the low resistance signal S at the board M, and both coils of the relay R; while the annunciator A at the toll board is short-circuited by the closing of its shunt circuit at the points s^6 s^7 in the jack J^4; this signal A may thus be reset, and cannot again be actuated until the plug P^2 be withdrawn from its jack. In fact the shunt through the contacts in jack J^4 only becomes necessary to allow that operation. It could be dispensed with by using a self-setting annunciator similar to that marked S, but of the high resistance required. Under these conditions, the signal S still remains inoperative, because the resistance of the circuit being unchanged by the mere substitution of the one hundred ohm relay coil for the one hundred ohm signal A, the current in the circuit is no stronger than at first, and is too feeble to operate said signal with the said high resistance relay coil also in circuit. But the relay having both coils in circuit becomes operative, the numerous convolutions of its coil H compensating for the weakness of the current; the armature q^2 is attracted, and the relay points q^3 being brought into contact, a second or supplementary shunt circuit, is thus closed through said points round the resistance of the toll board signal A, between the two junction points a^6 and a^3 by the way of conductor 24, relay frame q, armature q^2, points q^3 and wire 60; the said annunciator A being already shunted between the two points a^4 and a^5 through the jack points s^6 and s^7, as before described. The battery current thus has now two low resistance routes to the points a^3, at which it enters the relay. These circuit conditions remain until the first motion tending to a disconnection is made. The only disconnecting or clearing out annunciator in the conversation circuit is the annunciator e in the link connection circuit at the toll board T. Therefore no matter which of the two connected substations sends the disconnecting signal, it is received at the toll board, and as a consequence the first motion of disconnection is in all cases

made there, and consists in the withdrawal of the plugs P^2 and P^3. This action mechanically recloses the shunt circuit around the high resistance relay coil by reuniting the points s^4 and s^5 in the jack J^3, and thereby reduces the magnetizing power of said relay; but the armature is not retracted, nor are the points q^3 separated, because the magnetizing power of the low resistance relay coil H^2 though insufficient to attract the armature, is quite sufficient to sustain said attraction; and the second shunt circuit around the toll board annunciator A remains thus closed. The same action also opens the first shunt circuit round the said annunciator by permitting the points s^6 s^7 in jack J^4 once more to separate. The signal circuit D is now relieved from the resistance of the annunciator A, as well as that of the relay coil H and consequently the coil H^2 of the said relay is to some extent strengthened, and the current also becomes strengthened, so that it now excites the low resistance magnet of the signal S at the local board, which operates, displaying its signal, and indicating at the local board M that a disconnection has been initiated at the toll board I, by the withdrawal of the plug P^2.

The purpose of the signal S is to notify the local board operator to complete the disconnection by withdrawing in turn the plug P from its jack, and replacing the same in its seat S^2, and until this is done the visual signal S will continue its display. It is however a self-restoring or selfsetting indicator, and as soon as the plug is restored to its seat, and the circuit controller is thereby operated, the current thus being withdrawn from the signaling circuit, the said signal S is displayed no longer and disappears. The order in which these operations have taken place is that which is followed when the connection is called for by some substation connected with the home switch-board. Such an order reaches the operator at the section M thereof, by means of the instruction circuit L^6 connected with his telephone t^2 and leading from other sections. The same operations take place when the connection is intimated by some station outside, and to be reached over some circuit L^4, in which case the toll board T communicates with the operator at the local board M by touching the ends of the twin plug P^2 to the terminal plates r of the instruction circuit L^5 leading to the operator's telephone t^2; although the order of the operations would be different. In the first case the toll board operator is apprised that a connection is desired by the operation of the drop A consequent upon the removal of the plug P from its seat, and connecting his plug to the jack J^3 associated with such drop, he answers the substation which has been connected at M with the trunk L^3, and finds what station is wanted. In the second case, the toll board communicates orally with the operator at M as described, and states the number of the local substation wanted, and the trunk to be used, whereupon the operator at M inserts the plug end of said trunk in the jack of that number if the wanted line be not already busy, and leaves it so, until the display of the signal S indicates the conclusion of the message. But if the line be busy, the operator places the plug P in the busy jack J^3 and this operates the clearing out drop e at the toll board, indicating that the connection desired cannot for the present be had. It thus appears that though the signal circuit is quite distinct from the talking circuit, no connection or disconnection can be made with either terminal of the office trunk forming part of such talking circuit without in some way affecting the said signal circuit. The signal circuit has a shunt circuit for the high resistance relay coil normally closed, but opened by the insertion of the plug at the toll board; and two shunt circuits for the toll board annunciator A, both normally open, one of which is closed whenever the plug P^2 is placed in its jack regardless of other conditions, while the other can only be closed when the plug is placed in its jack at the same time the local board plug P is removed from its resting place, but once closed remains so until the plug P is replaced in its seat, even though the plug P^2 be withdrawn. The object of this is to provide that the signal S once displayed will continue in sight and to display itself until the plug P shall have been withdrawn from any jack in which it has been used, and that being dependent upon such withdrawal, it shall immediately thereupon display itself no longer.

The entire series of signaling operations may be summed up as follows:

First. When the plug P is taken from its seat S^2, the visual self setting signal S does not work because it is in series with both the low resistance relay coil, and the high resistance signal A at the toll board. The relay does not work because its high resistance coil is shunted through the points s^4 s^5 in the jack J^3, while its low resistance coil is in series with the signals S and A; but the signal A does work, and gives its signal at the toll board.

Second. When the plug P is removed from its seat S^2, the twin plug at the toll board having previously been inserted in its jack, the visual self setting signal S does not operate because it is now in series with both relay coils. The relay does work because its high resistance coil is included in the direct circuit of the battery; and the high resistance annunciator A at the toll board does not work, because it is shunted or short circuited through the jack points s^6 s^7.

Third. When, (the plug P, being removed from its seat or socket S^2,) the plug at the toll board has been inserted in its jack and is now withdrawn, the visual self-setting signal S (the appearance of which always instructs the operator that the plug P should be replaced in its socket) is operated, because the only resistance now in series with it is the low resistance relay coil. The relay remains

in operation, because its low resistance coil has only the signal S in series with it, and thus has quite sufficient magnetizing power to maintain the attraction of its armature. The high resistance relay coil and the high resistance coil of the toll board annunciator A are neither excited because they are both short circuited; the former through the jack points, the latter through the relay points. The function of the relay is therefore to maintain the resistance of the circuit sufficiently low to permit the operation of the signal S by establishing a temporary shunt around the signal A which shall automatically be broken as soon as the object of the said signal S is achieved and the plug P restored to its position of rest.

We have throughout this specification so far referred to the use of twin jacks J^3 and J^4 and twin plugs P^2 at the toll board end of the local trunk L^3. But double main conductor jacks, and double conductor plugs, such as the loop plug shown in connection with switchboard M, in which one conductor terminates in the tip and the other with the sleeve of the plug are well recognized as being equivalent devices and we may, and frequently do substitute them at the toll board for the twin form of appliance. In like manner we may use two single plugs instead of the twin plug, if we so elect. Furthermore it is evident that instead of placing the circuit closing contacts of the signaling circuit D in the resting socket of the plug P, we may place them in the jack J and connect and disconnect them by the insertion or withdrawal of the plug.

Having now fully described our invention, we claim—

1. The combination of an electric circuit; a plug connector constituting a movable terminal therefor; and a resting socket or seat for the said plug; with a key or circuit changer having a spindle capable of vertical movement in one direction when pressed, and in the opposite direction under the influence of a spring, in juxtaposition to the said resting socket; and a retaining device adapted to engage the said key when depressed during the absence of the said plug from its socket, and to maintain said depression; but to release the same upon the replacement of said plug, substantially as described.

2. The combination of a telephone circuit; a plug connector constituting a movable terminal or connection thereof and a resting socket therefor; an induction coil; and a circuit changing key controlling the connection of said induction coil with said circuit, associated with and mounted near to said resting socket; with a controlling spring for the said key depending for its position upon the presence or absence of said plug in its resting socket, and capable of engaging the said key if depressed to connect the induction coil, when the plug is absent from the said resting socket, but adapted to release the same and to cause the automatic disconnection of the said induction coil upon the replacement of said plug in said resting socket, substantially as described.

3. The combination of an electric circuit; a repeating induction coil adapted for inclusion therein; a press key or circuit changer controlling the connections of said coil with said circuit, the said key having a shouldered shank and adapted to move vertically in one direction when manipulated, and reversely by means of a spring; with a plug connector; a normal seat or resting socket therefor; a controlling spring for the said key fixed at one end, having a perforation encircling the shank of said key and adapted thereby to engage the shoulder thereof, and maintain the connection of the induction coil with the circuit; and a mechanical spring connection between the said plug seat and said controlling spring whereby the latter may be permitted to engage the key when the plug is absent from said plug seat, but is caused to release the said key on the replacement thereof, substantially as described.

4. The combination with an electrical circuit; and a plug connector therefor normally resting in a suitable socket or seat; of a repeating induction coil, adapted to be manually included in and automatically withdrawn from such circuit; a vertically moving key controlling the induction coil circuit connections, and adapted when depressed to connect the said coil with said circuit, and when retracted to withdraw the same therefrom; a retaining device for the said key adapted to engage the same and to maintain the depression thereof; and controlling mechanism for the said retaining device itself controlled by the removal from and replacement in its resting socket of the said plug, and adapted on said replacement to free the said key from the said retaining device; substantially as described.

5. A normally open signaling circuit comprising a main section including an electrical generator, a relay having independent high and low resistance helices, a relatively high resistance annunciator; a relatively low resistance self setting annunciator, and an automatic main section circuit closer; combined with a shunt circuit round the high resistance relay coil, normally closed through separable contacts in one of a pair of twin springjacks; an independent shunt circuit round the high resistance annunciator normally open between contacts in the remaining twin springjack; a twin plug for the said springjacks adapted when inserted to close the said annunciator shunt, and open the said relay shunt; and a supplementary normally open shunt round the said annunciator controlled by the said relay, and arranged to be closed thereby for the purpose of reducing the resistance of the main circuit, and of operating the said low resistance annunciator on the withdrawal of the twin plugs, substantially as described.

6. The combination with a trunk telephone line between two switchboards having a plug terminal in a resting socket at one, and springjack and plug connections at the other of said boards; with an independent associated signaling circuit, having at the plug terminal switchboard a self setting annunciator responsive (when the said plug terminal is removed from its socket) to the withdrawal of the plug from its jack at the other switchboard; and having at the said other switchboard an annunciator responsive to the removal of the trunk terminal plug from its said resting socket; substantially as described.

7. The combination with a terminal connecting plug at one end of a trunk telephone circuit; a terminal twin springjack and twin plugs therefor at the other end of said circuit; of an associated signaling circuit having a circuit controller actuated by the removal and replacement of said terminal plug from its resting socket, and operating to close and open said signaling circuit; a circuit changer in each of the said twin springjacks operated by the insertion and withdrawal of the twin plugs thereof to close and open shunt circuits of the said signaling circuits; a relatively high resistance annunciator normally in the signaling circuit at the twin springjack end of the telephone circuit, and adapted to give its signal when the said signaling circuit is closed by the removal of said terminal plug; means for short circuiting or shunting the said annunciator when the said twin plug is inserted in the said twin springjacks, and for maintaining the said short circuit on the withdrawal of said twin plug, until the said signaling circuit is broken by the replacement of the terminal plug; and a relatively low resistance indicator in the said signaling circuit at the terminal plug end thereof adapted to give its signal only when the circuit having first been closed by the absence of the terminal plug from its resting socket, the high resistance annunciator is short circuited by the insertion and withdrawal of the said twin plug, and to restore its signal when the signaling circuit is opened by the subsequent replacement of the said terminal plug, substantially, as described.

8. The combination with a trunk telephone line between two switchboards fitted at one of said switchboards with twin springjacks adapted to receive a twin plug, and at the other with a terminal cord and plug having a suitable plug seat or resting socket; of an associated normally open signal circuit and apparatus independent thereof, comprising the following elements, a circuit closer mounted in the said plug seat actuated by the removal and replacement of said plug to close and reopen the signaling circuit; circuit changers mounted within the said twin springjacks at the other end of signaling circuit, actuated by the insertion and withdrawal of the twin plugs to establish and disestablish shunt circuits, and thereby vary the resistance of the main circuit; an annunciator normally in the signaling circuit at the springjack end of said trunk organized to respond to the closure thereof by the removal of the said terminal plug from its socket; a relay normally shunted from the signaling circuit but included therein by the operation of one of the said springjack circuit changers; a shunt circuit round the said annunciator closed by the operation of said relay; and a self setting annunciator at the plug end of said trunk, organized to respond only when the signaling circuit is closed by the removal of the terminal plug and when its resistance is reduced by the establishment of shunt circuits round the said annunciator by said relay, and round said relay by the withdrawal of said twin plug substantially as described.

9. The combination with an office trunk line extending between a local and a toll switchboard and provided at the former with a terminal plug and a resting socket therefor, and at the latter with twin terminal springjacks adapted to receive twin connecting plugs; of an automatic signaling system of circuits comprising a normally open main section; a battery therefor; a circuit controller placed in the resting socket of said plug, and operated by the removal and replacement thereof; an annunciator at the toll switchboard in said main circuit responsive to the withdrawal of said plug; a relay having independent high and low resistance coils or helices; a shunt circuit round the high resistance coil of said relay normally closed through contact points in one of said twin springjacks, but adapted to be opened on the insertion of the plug therein; an independent shunt circuit round the toll board annunciator normally open between contact points in the other of said twin jacks, and adapted to be closed by the insertion of the plug; a second normally open shunt circuit round the said annunciator controlled by the said relay; and a self setting indicator at the local board responsive to the withdrawal of the twin plugs at the toll board, only when shunt circuits are closed round the high resistance relay coil, and the toll board annunciator, and when the terminal plug at the local board is absent from its socket and resetting itself on the replacement of said plug, substantially as described.

10. The combination with a trunk telephone circuit between two switchboards terminating at one of said switchboards in a cord and plug, and a resting socket for said plug when not in use; of a normally open associated signaling circuit, including a battery; an automatic circuit closer therefor mounted in the said resting socket, and actuated by the removal of the said plug therefrom, and an annunciator in said signaling circuit at the other switchboard adapted to give its signal when

the said circuit is closed, and thereby to respond to the removal of said plug from said socket, substantially as described.

11. The combination with a trunk telephone circuit extending between two switchboards, terminating at one of said switchboards in a cord and plug, and at the other in a twin or loop springjack, and having a resting socket for said plug, and a twin or loop plug for said springjacks; of a normally open associated signaling circuit including a battery; an automatic circuit closer therefor mounted in said resting socket and actuated by the removal and replacement of said plug; a high resistance relay and annunciator connected with said signaling circuit; a low resistance annunciator capable of giving its signal on the closure of the circuit only after said high resistance has been shunted; a circuit changer in the said springjack shunting the said relay, and a supplementary shunt controlled by the said relay for the said high resistance annunciator; whereby the said low resistance annunciator may be operated and caused to give its signal when the terminal plug is not in its socket by the insertion in and withdrawal from its springjack of the said twin or loop plug, and whereby the said signal may be withdrawn by the replacement of said plug in its resting socket; substantially as described.

12. The combination with a telephone circuit extending between two points terminating at one of said points in a cord and plug; of a normally open associated signaling circuit including an electrical generator; an automatic circuit closer therefor actuated by connections and disconnections made by said terminal plug; and an annunciator in said signaling circuit at the other of said points, adapted to give its signal when its circuit is closed by the act of making a connection with said plug; substantially as described.

13. The combination, substantially as hereinbefore described with a telephone circuit, extending between two switchboards, and terminating at one of them in an extensible cord and plug; of a normally open associated signaling circuit including an electrical generator; an automatic circuit closer therefor actuated by the operation of said plug; two annunciators in the signaling circuit, the first responsive to the operation of said circuit closer directly and the second to the operation of said circuit closer, only when the first is shunted.

In testimony whereof we have signed our names to this specification, in the presence of two subscribing witnesses, this 10th day of December, 1892.

FRANK A. PICKERNELL.
FRANCIS W. DUNBAR.

Witnesses:
CHARLES D. M. COLE,
R. J. MORGAN.