G. W. KUHN.

OPERATOR'S TRUNK CIRCUITS.

APPLICATION FILED SEPT. 5, 1918.

1,392,179.

Patented Sept. 27, 1921.

5 SHEETS—SHEET 1.

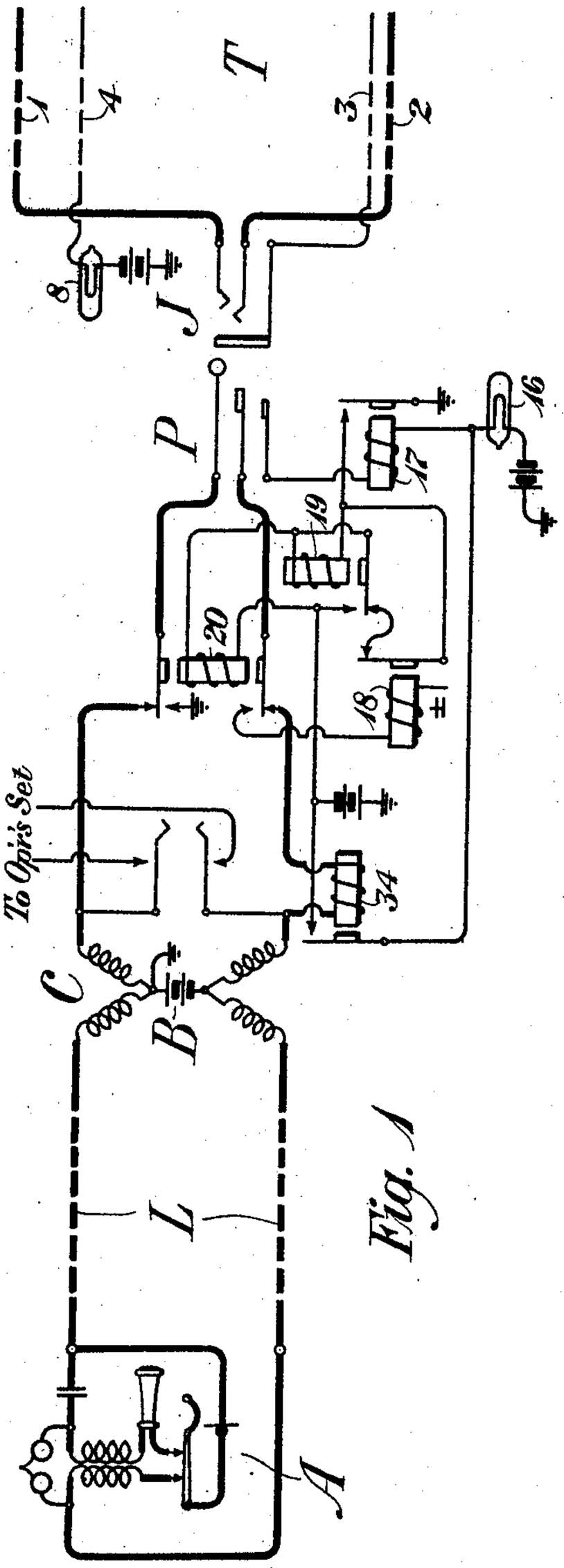


Fig. 1

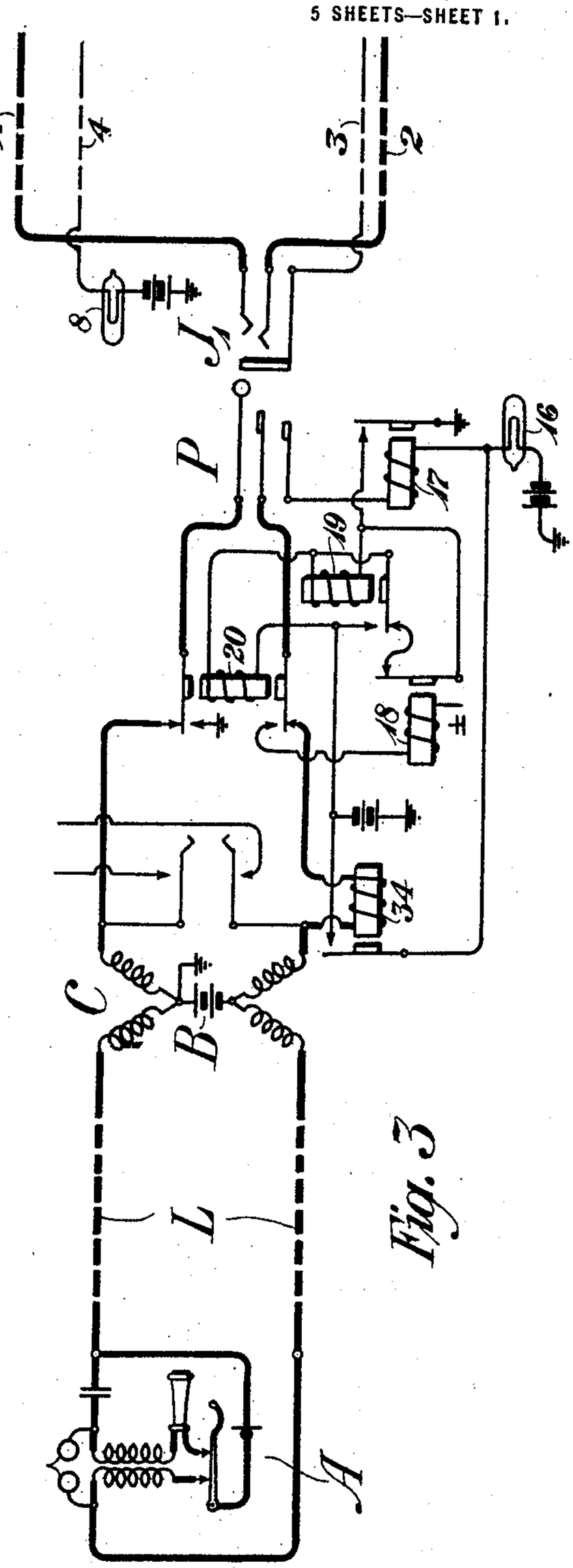


Fig. 3

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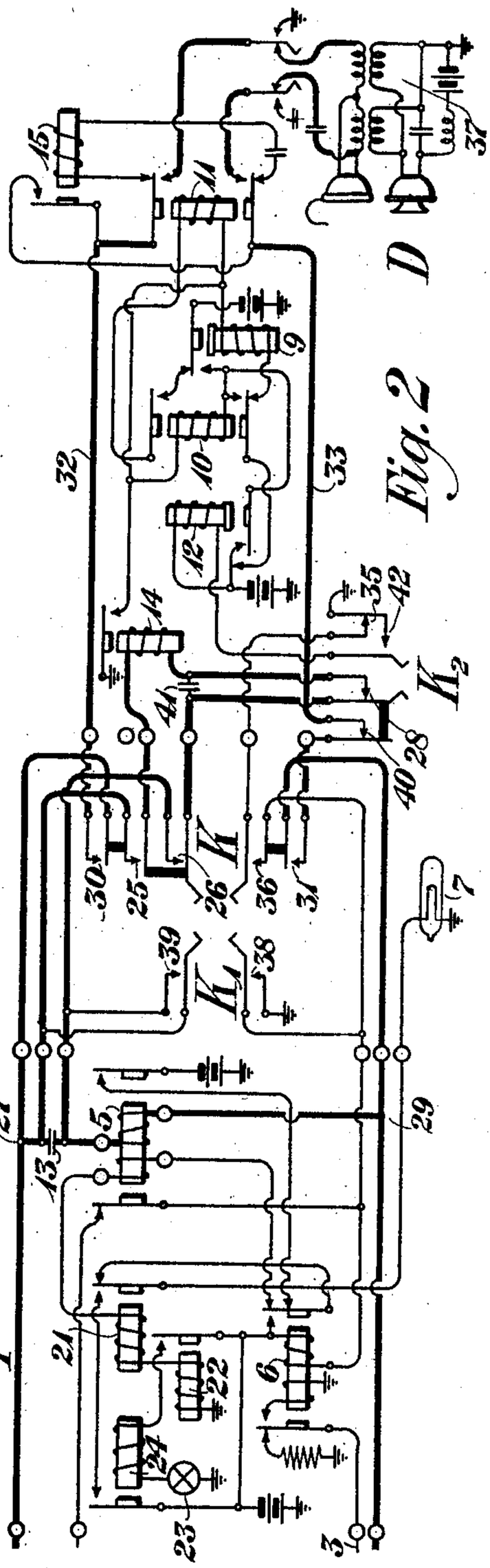

Fig. 2

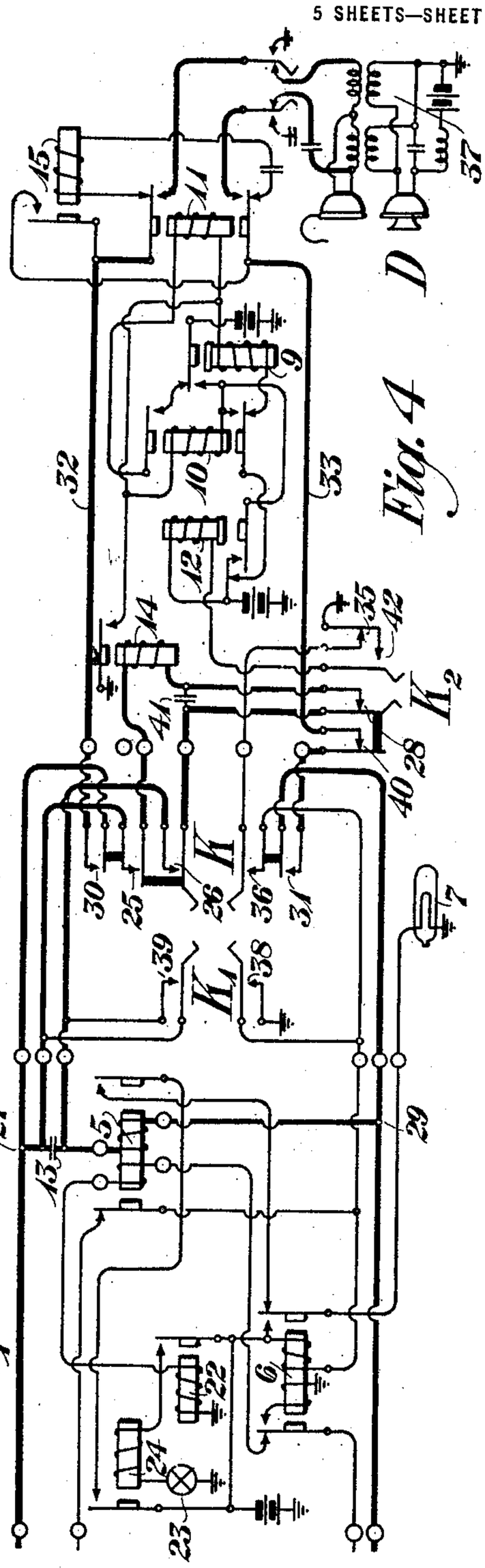

Fig. 4

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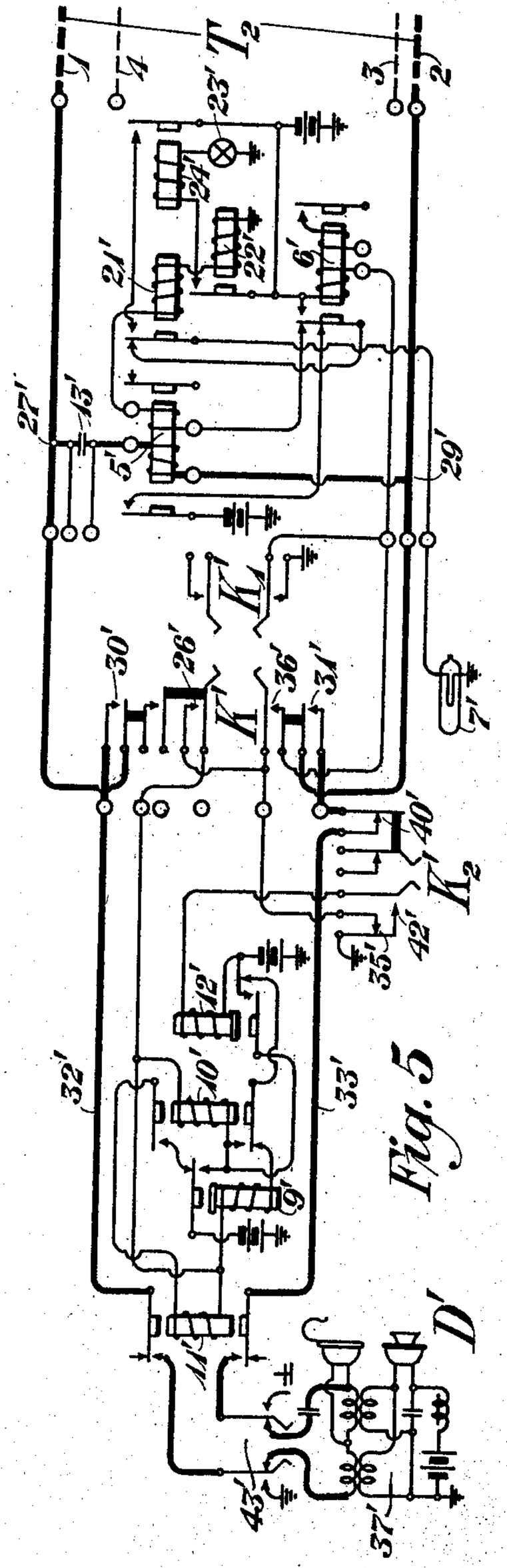

Fig. 5

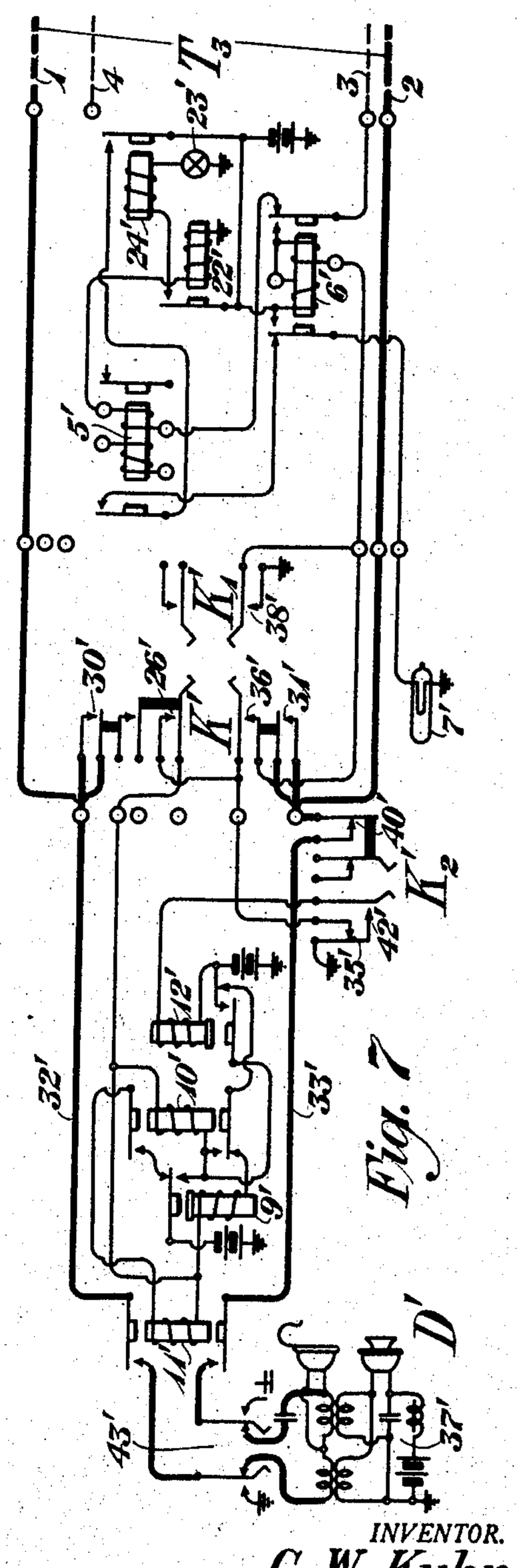

Fig. 7

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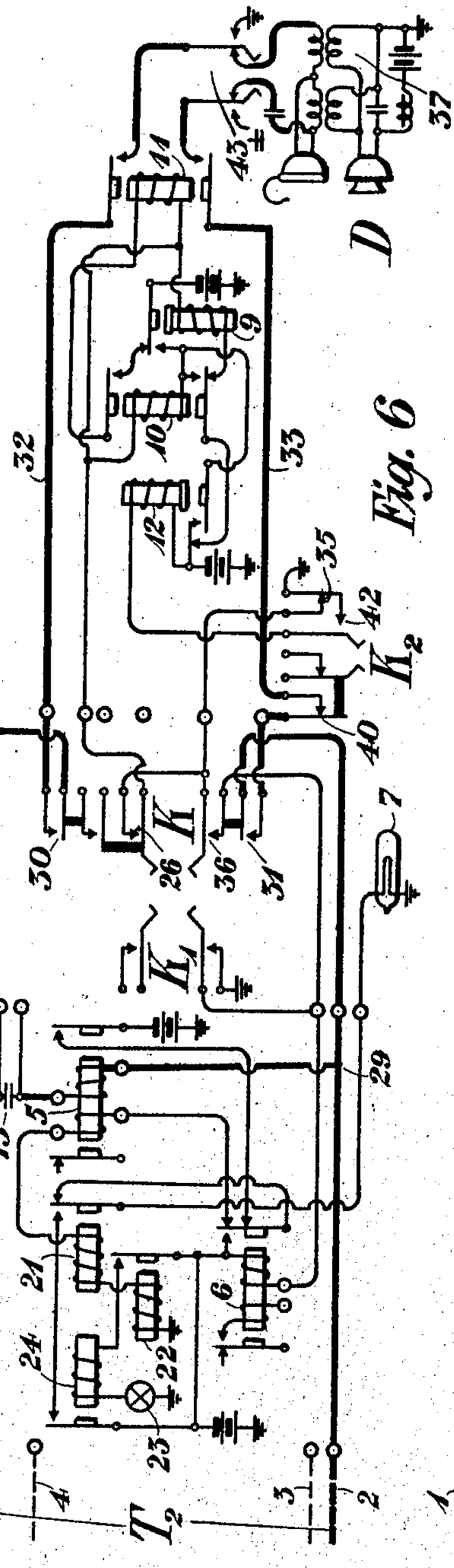


Fig. 6

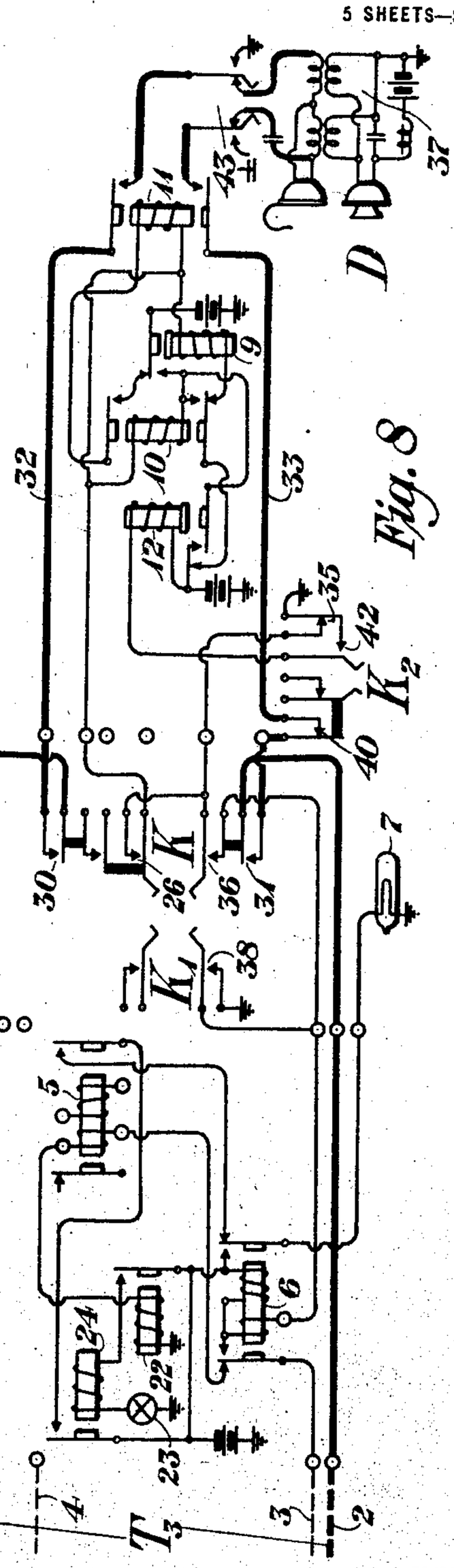


Fig. 8

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5 SHEETS—SHEET 5.

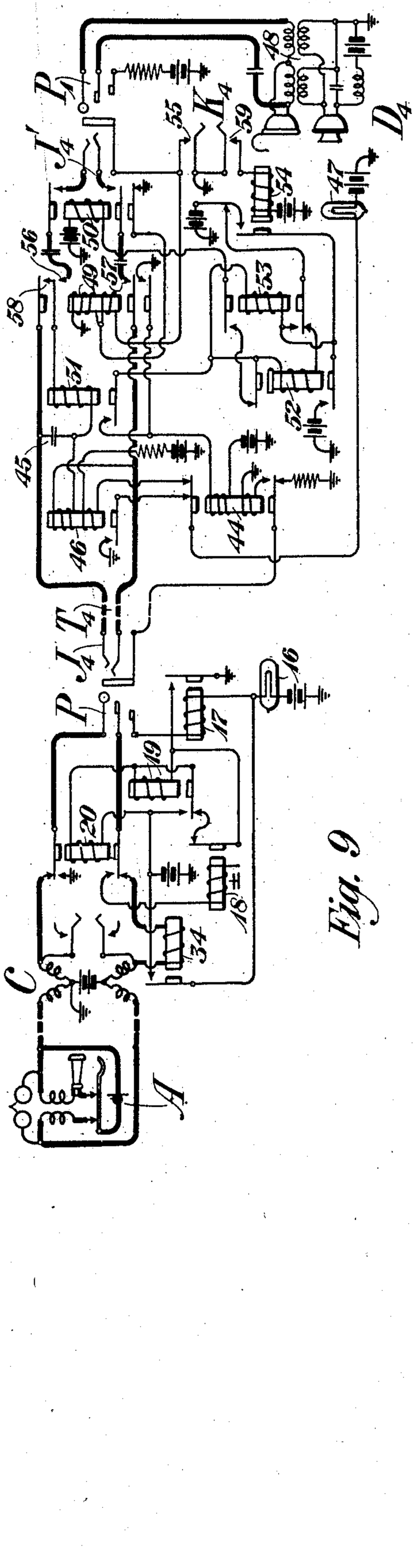


Fig. 9

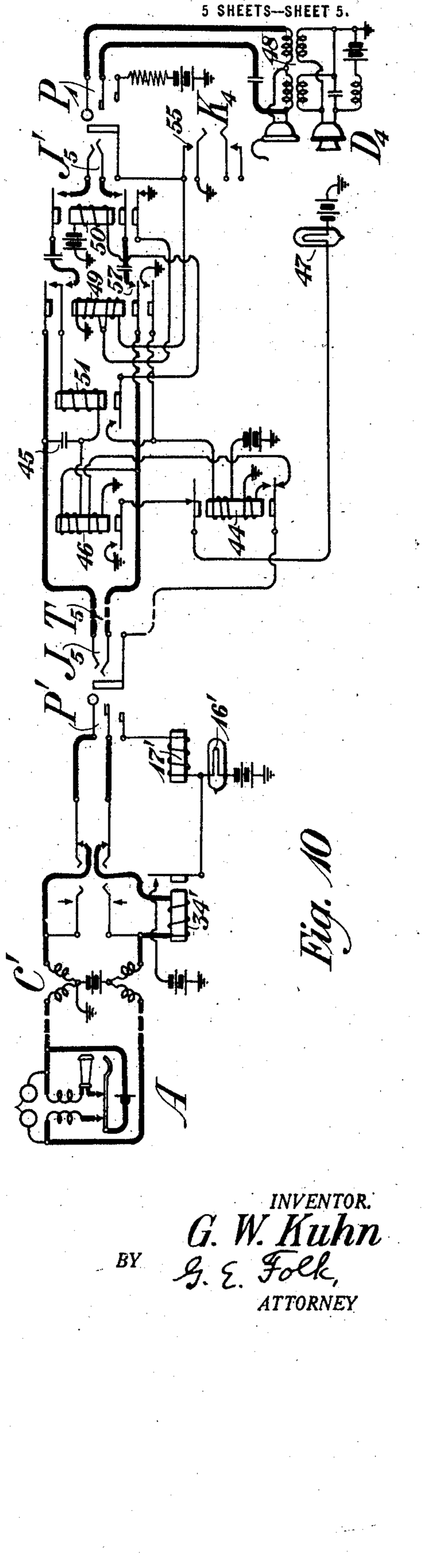


Fig. 10

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# UNITED STATES PATENT OFFICE.

GEORGE W. KUHN, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

## OPERATOR'S TRUNK-CIRCUIT.

1,392,179. Specification of Letters Patent. Patented Sept. 27, 1921.

Application filed September 5, 1918. Serial No. 252,765.

*To all whom it may concern:*

Be it known that I, GEORGE W. KUHN, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Operators' Trunk-Circuits, of which the following is a specification.

This invention relates to telephone circuits and more particularly to telephone trunk circuits leading to special positions.

In carrying on the business of a telephone exchange it is customary to have attendants or supervisors at special positions or desks to render special service or to supervise service rendered by other attendants, and some means must be provided whereby subscribers or others may be put into communication with such attendants or supervisors. Trunks are therefore provided leading from the exchange switchboard to the desks or positions of information operators, repair clerks, trouble clerks, wire chiefs and the like, so that connections can be made to such desks or positions through the switchboard. In some instances it is desirable that communication be established between certain positions or desks directly, and in such cases trunks may be provided connecting the desired desks or positions independently of the switchboard.

It is one of the objects of this invention to provide trunks of the character above referred to which shall be so arranged as to minimize and render more uniform the clicks received by the subscriber or party connected to said trunk when the switching key for connecting the telephone apparatus at the special desk or position is operated. Another object of the invention is the provision of a trunk in which the noises or clicks received by the attendant at the special position, due to the operation of disconnecting the ringing current and substituting battery supply current for talking purposes, shall be substantially eliminated. Another object of the invention has reference to the provision of means to reduce the clicks received either by the subscriber or by the special attendant when the latter signals the switchboard operator by means of a so-called "flashing" key. A further object of the invention is to provide a means whereby when the special attendant operates a switching means to connect her telephone apparatus to the trunk, in response to a signal, the actual connection will be delayed by an interval sufficiently long to permit of disconnecting the ringing apparatus and substituting battery supply current, means being also provided which shall operate during this interval to assist in bringing about the automatic disconnection of the ringing current. A still further object of the invention has reference to the provision of a trunk circuit having a relay responsive to signaling current for controlling a signal, a switching means for connecting the attendant's telephone set to the trunk and a second relay controlled by the switching means for altering the condition of the signal, said relays and switching means being so arranged that by a simple change in the wiring the trunk may be made to operate upon either a ring-down or direct current signaling basis between a switchboard and a special position or desk, or upon either basis between two special positions or desks.

The invention may now be more fully understood from the following description when read in connection with the accompanying drawings, in which—

Figures 1 and 2 when taken together constitute a circuit diagram of one form of the invention as applied to a trunk operating on a ring-down basis between a switchboard and a special position or desk;

Figs. 3 and 4 constitute a circuit diagram of a form of the invention as applied to a trunk extending between a switchboard and a special position or desk and operating on a direct current signaling basis;

Figs. 5 and 6 constitute a circuit diagram illustrating a form of the invention applied to a trunk operating on a ring-down basis between two special positions or desks;

Figs. 7 and 8 constitute a circuit diagram embodying the invention in a trunk operating on a direct current signaling basis between two special positions or desks;

Fig. 9 is a circuit diagram of a modified form of the invention as applied to a trunk operating on a ring-down basis between a switchboard and a special position or desk; and

Fig. 10 is a diagram of the invention as applied to a similar trunk operating on a direct current signaling basis.

For convenience in reading the diagram, the sheet containing Figs. 1 and 3 should be placed at the left of the sheet containing

Figs. 2 and 4. In its turn, the sheet containing Figs. 5 and 7 should be similarly placed with respect to the sheet containing Figs. 6 and 8.

Referring now to Figs. 1 and 2, a subscriber's sub-station A of a well known type is shown connected by a line L to a central office at which the connection is extended by means of a cord C, only such features of the cord circuit being illustrated as are essential to an understanding of the invention. The cord circuit terminates in the usual calling plug P adapted to be inserted in the jack J of a trunk T leading to a special position or desk D. (See Fig. 2.) The trunk T comprises four conductors—a tip conductor 1, ring conductor 2, sleeve conductor 3 and a lamp conductor 4. At the special position or desk D, shown in Fig. 2, the trunk is provided with a talking key K for connecting the trunk to the operator's telephone apparatus, a holding key $K_1$, whereby the operator at the special position or desk may retain control of the trunk while her telephone apparatus is connected to another trunk, and double wound relays 5 and 6, the former being responsive to signals transmitted from the switchboard to control a signal lamp 7, and the latter responsive to the operation of keys K or $K_1$ to alter the condition of the lamp 7. When the talking key K is operated the telephone apparatus at the special position or desk is not immediately connected to the trunk but a chain of relays 9, 10 and 11 is set into operation to connect the subscriber's apparatus to the trunk after a predetermined interval. The purpose of this interval is to permit the ringing current to be disconnected from the trunk and the battery supply current connected thereto before the operator's set is connected, so that the noises or clicks due to this operation will not be received by the operator. The operator is also provided with a flashing key $K_2$ whereby she may flash the supervisory lamp of the cord circuit at the switchboard. A relay 12 is controlled by the flashing key to eliminate a portion of the interval due to the chain of relays previously referred to, as this feature is undesirable during the flashing operation.

In order to prevent the subscriber from receiving heavy clicks due to the operation of the talking key K or holding key $K_1$, a winding of the relay 5 is included in a bridge across the tip and ring conductors of the trunk, and a condenser 13 is included in series with this winding. The impedance of the relay 5 is such that when the talking key K or holding key $K_1$ is operated to connect a low resistance shunt about the condenser 13, for the purpose of operating the supervisory and tripping relays of the cord circuit, the current changes thereby produced will be smoothed out by the impedance of said relay, so that a disagreeable click is not received by the subscriber. The condenser 13 is so proportioned that when the key K or $K_1$ is restored to normal, thereby opening the direct current path about the condenser, the discharge due to this operation will be received by said condenser, thereby avoiding the annoying click usually received by the subscriber.

A low resistance relay 14 is included in the shunt closed about the condenser 13 by the actuation of the talking key A. Upon reringing this relay is momentarily deënergized during the open circuit period in changing from direct to ringing current, and is also deënergized each time the ringing current subsequently passes through zero. This causes the chain of relays to permit relay 11 to fall off and disconnect the operator's set until ringing ceases. As soon as the ringing current ceases, however, relay 14 is continuously energized and sets the chain of relays previously mentioned into operation to again connect the operator's set to the trunk after an interval sufficient to permit the electrical energy of the circuits to have reached a stage of equilibrium. Relay 15 is also provided for the purpose of assisting in tripping the ringing apparatus of the cord in a manner to be hereafter described.

The operation of the circuit illustrated in Figs. 1 and 2 is as follows: Assuming a call has originated at the sub-station A of Fig. 1 and has been answered by an operator at the switchboard by connecting the cord circuit C to the line L, upon ascertaining that the subscriber should be connected to the special position or desk at D, the operator inserts the plug P in the jack J. A circuit is thereby completed from battery, through the lamp 16, relay 17, sleeve conductors of the plug P and jack J, conductor 3 of the trunk and over the back left-hand contact of relay 6 to ground. The lamp 16 now glows and the relay 17 is energized to complete a circuit from ground over the front contact of relay 17, back contact of tripping relay 18, back contact of relay 19 and through the winding of ringing relay 20 to battery. Relay 20 is energized and applies ringing current to the trunk conductors 1 and 2, through the winding of the marginal tripping relay 18. The ringing current flows through the condenser 13 and the right-hand winding of relay 5, thereby energizing said relay. It will be noted that the left hand winding of relay 5 is normally short circuited since both of its terminals are connected to the same pole of the battery, in this case to the grounded pole. This renders relay 5 slow acting so that it does not respond to the momentary impulses due to the operation of the various controlling and switching keys of the circuit to

cause a false signal, but responds to continuous excitations by ringing current. Relay 5 at is right hand front contact completes a circuit from battery over the right hand back contacts of relay 6, through the left hand winding of relay 5, and through the windings of relays 21 and 22 to ground. Relay 5 is locked up over the circuit just traced and relays 21 and 22 are energized. Relay 22 completes a circuit through interrupter 23, through the winding of relay 24, which relay intermittently operates its armature to close a circuit from battery over the left hand front contact of relay 24, right hand front contact of relay 21, through the lamp 7 to ground, causing the lamp 7 to flash to indicate to the attendant at the desk D that a call is awaiting upon the trunk. The attendant at the desk now operates a key K, closing at contacts 25 and 26 a low resistance shunt about the condenser 13, so that a low impedance bridge to ringing current now extends across the tip and ring conductors of the trunk from point 27, over contact 25, through the winding of relay 14, over contact 28 of Key $K_2$ and contact 26 of key K, through the high resistance right hand winding of the relay 5 to point 29. The path thus established is of sufficiently low impedance to operate the tripping relay 18 of the cord circuit C. In order to further asist in operating this relay, especially for alternating ringing current, another path of low resistance is provided as follows: The actuation of key K at contacts 30 and 31 extends the tip and ring conductors of the trunk over conductors 32 and 33 and over the back contacts of relay 11 to the winding of relay 15. This relay responds to ringing current transmitted over the conductors 32 and 33 and at its contact closes a momentary short circuit across said conductors so that the tripping relay 18 is energized. Relay 18 thereupon opens a short circuit about the winding of relay 19 which is energized over a circuit from ground, front contact of relay 17 and windings of relays 19 and 20 in series to battery. Relay 19, upon being energized, attracts its armature, thereby holding open the short circuit about its winding and closing a short circuit about the winding of ringing relay 20, which is thereby deënergized and disconnects ringing current from the tip and ring contacts of the plug P. The supervisory relay 34 of the cord circuit is now actuated by direct current flowing from battery B through its winding, over the tip and ring conductors of the trunk T and through the bridge circuit perviously traced through the winding of relay 14. Relay 34 closes a shunt circuit about the lamp 16, which is thereupon extinguished. The relay 14 is also energized over this circuit with results hereinafter stated.

While the above operations were being initiated, the actuation of the key K also closed a circuit from ground, over the contact 35 of key $K_2$, contact 36 of key K, through the right hand high resistance winding of relay 6 to battery. Relay 6 is energized over the circuit just traced and at its back contact opens the locking circuit previously traced through the left hand winding of the relay 5 and through the winding of relays 21 and 22. Relays 21 and 22 are deënergized, thereby causing the cessation of the intermittent operation of relay 24 and the intermittent flashing of the lamp 7. A locking circuit for the relay 6 is completed over its left hand front contact and through its low resistance left hand winding over the sleeve conductor 3 of the trunk. The relay 6 at its front right hand contact completes a circuit from battery over said contact and over the back contact of relay 21, through the lamp 7 to ground, causing said lamp to glow steadily indicating that the circuit is busy.

The operation of the key K, which resulted in operating the tripping relay to disconnect ringing current from the cord circuit and complete the direct current supply circuit, would ordinarily cause annoying clicks to be transmitted to the calling subscriber. These clicks are minimized and made substantially uniform by the high impedance of the right hand winding of relay 5, which smooths out the current changes. In order also to prevent clicks from reaching the attendant at the desk D, the telephone apparatus of said attendant is not immediately connected to the trunk upon the closure of the contacts 30 and 31 of the key K, but the actual connection is made by the relay 11 after a predetermined interval introduced by the relays 9 and 10. It will be remembered that when the key K was operated, with the resultant disconnection of ringing current from the trunk and the substitution of battery supply current therefor, the relay 14 was continuously energized. This relay closes a circuit from ground over its front contact, through the winding of slow release relay 9, lower back contact of relay 10, and lower back contact of relay 12 to battery. Relay 9, upon being energized, closes a circuit from ground over the front contact of relay 14, through the winding of relay 10, and over the front contact of relay 9 to battery. Relay 10, upon attracting its lower armature, opens a circuit previously traced for the relay 9 and closes a locking circuit from ground over the front contact of relay 14, through the winding and over the front contact of relay 10, and over the back contact of relay 12 to battery. Relay 10 now remains locked up so long as the relay 14 remains energized. The relay 9, after an interval, releases its armature, whereupon a

circuit is closed for the relay 11 from ground over the front contact of relay 14, winding of relay 11, upper front contact of relay 10 and back contact of relay 9 to battery. The relay 11 is now energized to disconnect the relay 15 from the trunk and to connect to the trunk the operator's telephone set 37. The time interval introduced by the relays 9 and 10 is sufficient to permit the electrical energy in the circuit to reach a state of equilibrium before the operator's set is connected, thus eliminating the annoying clicks which would otherwise be received in the set 37.

Should the operator desire to disconnect her talking set from the trunk T, she will operate the common key lever (not shown) of the keys K and $K_1$ to restore the talking key K to its normal condition. The contacts of the key K are so arranged that contacts 30 and 31 are opened before contacts 25 and 26 are opened. This results in the immediate disconnection of the operator's set before the direct current circuit of relay 14 is broken, so that the operator does not receive in her telephone set the clicks incident to this operation. Upon the opening of the circuit through the relay 14, the shunt about the condenser is opened and the discharge resultant from this action is absorbed by the condenser 13, so that the subscriber at station A does not receive a severe click. The opening of the circuit through the relay 14 results in the deënergization of said relay, which, upon releasing its armature, opens the circuit of relays 10 and 11, which are deenergized so that the operator's telephone set is restored to normal. The restoration of the key K opens at contact 36 the circuit previously traced through the right hand winding of the relay 6. This relay is not deënergized, however, at this time but is maintained energized by its left hand or locking winding. It will be noted that the relay 6 now holds open the left hand locking winding of relay 5. Relay 5 is now quick acting and may respond to momentary impulses due to the operation of keys but no false signal results since relay 6 also holds open the circuit of lamp 7. The opening of the direct current circuit through the relay 14, causes the deënergization of the supervisory relay 34 of the cord circuit C at the switchboard, thereby removing the shunt from about the supervisory lamp 16 which now glows, indicating to the operator that a disconnection should be made. The operator thereupon withdraws the plug P from the jack J, which opens a circuit through the locking winding of the relay 6. This relay is now deënergized and by releasing its right hand armature opens the circuit of the lamp 7 which is now extinguished, indicating to the operator at the special position or desk D that the disconnection has been made.

Should the operator desire to disconnect her talking set from the trunk T in order to listen in on another trunk terminating at the same desk without releasing the connection already established over the trunk T, she will operate the common key lever of the keys K and $K_1$ to restore the talking key K to normal and to operate the holding key $K_1$. The key $K_1$, upon being actuated, by means of its contact 38 performs the same function as was performed by the contact 36 of the key K. The closure of contact 39 of key $K_1$ substitutes a short circuit about the condenser 13 for the low resistance shunt previously traced through the winding of relay 14. This maintains the direct current path through the bridge circuit, including the right hand winding of the relay 5, so that the supervisory relay 34 of the cord circuit C is maintained energized. The circuit will now remain in this condition until the operator desires to return to the connection, which she may do by operating the key lever to restore the key $K_1$ and operate the key K to talking position, whereupon the relay 14 is again energized and sets into operation the chain of relays 9, 10 and 11 to connect the operator's set to the trunk.

Should the operator at the special position or desk D desire for any reason to secure the attention of the operator at the switchboard, she may do so by intermittently actuating the flashing key $K_2$. This results in intermittently opening the direct current circuit through the relay 14 by means of the contact 28 of the key $K_2$, thereby causing the supervisory relay 34 to be intermittently deënergized with the consequent flashing of the supervisory lamp 16. In order to prevent the operator at the special position or desk D from receiving annoying clicks due to the opening and closing of the direct current circuit, the contacts of the key $K_2$ are so arranged that a contact 40 is opened to disconnect the operator's telephone set from the trunk before the contact 28 opens the direct current circuit. Similarly the contact 28 is closed to complete the direct current circuit before the contact 40 is closed to connect in to the operator's telephone set. In order to prevent the subscriber at station A from receiving annoying clicks due to this operation, a condenser 41 is connected as shown, so that every time the contact 28 is opened a short circuit normally closed about said condenser, is also opened to permit the condenser to absorb the discharge due to the opening of the battery circuit, the condenser 41 in this instance functioning in a similar manner to that previously described for the condenser 13. The rush of current due to the closure of the battery circuit is smoothed out by the high impedance of the right hand winding of the relay 5 as before.

During the flashing operation it is unde-

sirable that the time element due to the chain of relays 9, 10, and 11 should be introduced each time the key $K_2$ is flashed, as the key $K_2$ might be operated at such a rapid rate that the relay 11 would not have time to respond and would remain deenergized during flashing. If then the operator at the switchboard should answer she would find no one connected to the circuit.

To obviate this difficulty the key $K_2$ is so arranged that each time it is operated a contact 42 is closed to energize a slow release relay 12. The relay 12, upon attracting its armature, opens the initial energizing circuit of the relay 9, and at its front contact closes an operating circuit for the relay 10 independent of the slow release relay 9. Consequently the latter relay is not now effective, and each time the relay 14 is energized a circuit is closed for the relay 10 over the front contact of the relay 14, through the winding of the relay 10 and over the front contact of the slow release relay 12 to battery. Relay 10 at once completes the circuit of relay 11 to connect the operator's set to the trunk. It will thus be seen that a large portion of the time element introduced by the chain of relays is eliminated.

Should the operator at the switchboard rering over the trunk T while the telephone set 37 of the attendant at station D is connected to the trunk, the relay 14 will be momentarily deënergized, due to the fact that the direct current circuit has been broken by the ringing relay. The deënergization of relay 14 at once opens the circuits of relays 10 and 11, thereby disconnecting the telephone set 37 from the trunk and said telephone set remains disconnected as long as ringing current is being applied to the trunk. As soon as ringing ceases, however, and the cord circuit is restored to normal, the direct current circuit is again completed through the relay 14 which again sets into operation the chain of relays 9, 10 and 11 to connect the telephone set to the trunk after a suitable interval as before. This prevents ringing current from being transmitted to the telephone set 37.

Should the attendant at the special position or desk D desire to initiate a call over the trunk T, the key K will be operated to its talking position. This closes a circuit from ground over contact 35 of key $K_2$, contact 36 of key K, through the right hand winding of relay 6 to battery. Relay 6, upon attracting its right hand armature, closes a circuit from battery over its right hand front contact and the back contact of relay 21, through the lamp 7 to ground, causing said lamp to glow steadily and indicating the busy condition of the circuit. At the same time that a circuit was completed through the right hand winding of the relay 6, a circuit is closed from ground over the contact 35 of key $K_2$, contact 36 of key K, back left hand contact of relay 5 and over the conductor 4 of the trunk circuit through the line lamp 8 at the switchboard to battery. The operator at the switchboard, upon observing that the lamp is lighted, will answer the call in the usual manner, whereupon a direct current circuit will be completed through the relay 14, which sets into operation the train of relays to connect the operator's telephone set at the special position or desk D to the trunk.

By a slight modification of the wiring of the relays 5 and 6, the trunk circuit of Figs. 1 and 2 may be arranged as shown in Figs. 3 and 4 so that all signals may be actuated by direct current instead of operating on a ring-down basis, as in Figs. 1 and 2. The wiring of the keys K, $K_1$, $K_2$ and the various relays for controlling the connection of the operator's telephone set will be the same as before. The difference between the two circuits will be apparent from a description of such portions of the operation of the circuits of Figs. 3 and 4 as are different from the corresponding operations in connection with the circuit of Figs. 1 and 2.

When the operator at the switchboard inserts the plug P in the jack $J_1$ of the trunk $T_1$, a circuit is completed from battery, through the supervisory lamp 16, relay 17, sleeve contacts of the plug P and jack $J_1$, over the sleeve conductor 3 of the trunk, back left hand contact of relay 6, through the left hand winding of relay 5, and through the winding of relay 22 to ground. Relays 17, 5 and 22 are operated over this circuit. The operation of relay 22 closes the intermittent circuit previously traced for the relay 24. The operation of relays 5 and 24 closes an intermittent circuit from battery over the front contact of relay 24, front right hand contact of relay 5, back right hand contact of relay 6, and through the lamp 7 to ground. The lamp 7 now flashes to indicate that a call is awaiting upon the trunk. The energization of relay 17 initiates the automatic ringing operation of the cord circuit C before described. In this case ringing current would be transmitted to the trunk $T_1$ as described in connection with the trunk T, thereby further energizing the relay 5 through its right hand winding. As this relay has been already operated by direct current over the sleeve circuit of the trunk, however, the ringing current in this case performs no useful function and need not be applied. If the cord circuit should be equipped for hand-ringing only, the operator at the switchboard would, in this case, not operate her ringing key. The attendant at the special position or desk D, upon observing the flashing of the lamp 7, will throw the key K to talking

position as before, thereby causing the relay 6 to be energized and locked up over the sleeve circuit of the trunk. The relay 6 at its right hand front contact opens the intermittent circuit of the lamp 7 and closes a steady circuit therefor as before. By opening its left hand back contact, the relay 6 opens a circuit previously traced through the left hand winding of relay 5 and the relay 22. The actuation of the key K also connects the relay 14 in a direct current bridge across the tip and ringing conductors of the trunk, as in the case of the circuit of Figs. 1 and 2. The operations resulting in the actuating of the tripping relay of the cord circuit to disconnect ringing current (in case ringing current had been applied), the actuating of the supervisory relay, and the connecting of the operator's set to the trunk take place as already described. The other features of the circuit of Figs. 3 and 4 are the same as those of Figs. 1 and 2.

Where it is desired to provide a direct trunk between two desks, instead of providing for the interconnection of the two desks through the switchboard, a trunk having the essential features already described may be provided as shown in Figs. 5 and 6. In this case two desk positions D and D′ are shown interconnected by a trunk $T_2$ adapted to operate on a ring-down basis. In the actual laying of the cable for the trunk, four conductors, 1, 2, 3 and 4 may be laid as before, but in this case the conductors 3 and 4 are of no utility. The wiring of the keys K and $K_1$ will be modified slightly, as will more clearly appear from a description of the operation. The relays 5 and 6 will be wired substantially the same as in Fig. 2, with the exception that certain connections having no function in this circuit will be omitted. Similar apparatus will be provided at each end of the trunk $T_2$, the apparatus at the position D′, corresponding to the similar apparatus at the position D, being designated by similar reference characters primed.

The circuit may now be clearly understood from a description of the operation which is as follows: Assuming an attendant at the station D′ desires to communicate with an attendant at the station D, the key K′ will be thrown to talking position, thereby completing a circuit from ground, over the contact 35′ of key $K_2'$ and contact 36′ of key $K_1'$ and through the left hand winding of relay 6′ to battery. Relay 6′ is operated and at its front left hand contact closes a circuit from battery, over said contact, over the back contact of relay 21′ and through the lamp 7′ to ground, causing said lamp to glow indicating that the circuit is busy. A circuit is also completed from ground over the contact 35′ of key $K_2'$, contact 26′ of key $K_1'$, through the winding of slow release relay 9′, over the lower back contact of relay 10′, and over the back contact of slow release relay 12′ to battery. Relay 9′ is now energized and at its front contact closes a circuit for relay 10′, which in turn opens the circuit of the relay 9′ and completes a locking circuit over its lower front contact. After an interval the relay 9′ releases its armatures, whereupon a circuit for the relay 11′ is completed from ground, over the contact 35′ of key $K_2'$, contact 26′ of key K′, through the winding of relay 11′, upper front contact of relay 10′, and over the back contact of relay 9′ to battery. Relay 11′ is now energized to connect the operator's telephone set 37′ to the trunk.

The operator now actuates the ringing key 43′, thereby transmitting ringing current over the trunk and through the bridge circuits, including the high resistance windings of relays 5′ and 5 at stations D′ and D respectively. Relays 5′ and 5 are energized by the ringing current but the energization of relay 5′ performs no useful function at this time, since the relay 6′ had already been energized. At station D, however, the energization of the relay 5 closes a clearly apparent circuit over its front right hand contact, through its left hand winding and through the windings of relays 21 and 22. The lamp 7 is now caused to flash in the same manner as described in connection with Fig. 2, thereby apprising the operator at station D that a call awaits her upon the trunk. The operator at station D now actuates the key K to talking position, thereby completing a circuit for the relay 6 similar to that already traced in connection with the relay 6′ at station D′. The relay 6 opens the flashing circuit of the lamp 7 and closes a steady circuit for said lamp similar to that described for the lamp 7′. The actuation of the key K also results in setting the chain of relays 9, 10 and 11 into operation to connect the operator's set 37 to the trunk in a manner similar to that described in connection with station D′. The two operators are now in communication. No clicks are produced by these operations since direct current is not applied to the trunk $T_2$, the operators' sets being local battery sets in both instances. The flashing keys $K_2$ and $K_2'$ are of no utility in connection with this trunk circuit and are merely provided in order that the trunk circuit may be readily transformed to a circuit of the type shown in Figs. 2 or 4.

The trunk circuit of Figs. 5 and 6 may be made to operate on direct current signaling basis instead of a ring-down basis, as shown in Figs. 7 and 8, by a slight change in the wiring of the relays 5 and 6 and the key $K_1$ at station D, the corresponding elements at

the station D′ being similarly modified. The circuit changes will be apparent from a description of the operation. The attendant at station D′, upon calling the attendant at station D, will simply operate her key K′ to talking position, thereby causing her telephone set 37′ to be connected to the trunk in the same manner as already described in connection with Fig. 5. The actuation of the key K′ also closes a circuit from ground, over the contact 35′ of key $K_2$′, contact 36′ of key K′, through the two windings of the relay 6′ in series to battery. The relay 6′ is energized and at its left hand front contact completes a steady circuit for the lamp 7′, which is now caused to glow indicating that the circuit is busy. At its right hand front contact relay 6′, connects the left hand winding of the relay 5 and the winding of the relay 22 at station D in parallel with its low resistance winding over a circuit as follows: from battery, through the left hand high resistance winding of relay 6′, over the right hand contact of said relay, conductor 3, left hand back contact of relay 6, the left hand winding of relay 5 and winding of relay 22 to ground. Relays 5 and 22 are energized over the circuit just traced, and relay 22 closes the intermittent circuit of the relay 24. Relays 5 and 24 close an intermittent circuit for the lamp 7 from battery, over the front contact of relay 24, right hand front contact of relay 5, back contact of relay 6, and through lamp 7 to ground. The lamp 7 now flashes, indicating to the attendant at station D that a call awaits upon the trunk. The attendant at station D now throws the key K to talking position thereby setting the chain of relays into operation to connect her telephone set 37 to the trunk. The actuation of the key K at the same time closes the circuit from the ground, over contact 35 of key $K_2$, contact 36 of key K, and through the two windings of relay 6 in series to battery. Relay 6 is now energized and at its left hand contact opens the circuit previously traced for relays 5 and 22, thereby causing the lamp 7 to cease flashing. At its right hand front contact relay 6 closes a steady circuit for the lamp 7 which now glows continuously. The two attendants are now in communication. Should one of them desire to disconnect her telephone set from the trunk without releasing the connection, she may do so by restoring the talking key and actuating the holding key $K_1$ or $K_1$′ as the case may be. Assuming the key $K_1$ to be actuated, a holding circuit over the contact 38 of said key is provided for the relay 6 to hold said relay in its energized position so that the lamp 7 remains lighted. The restoration of the key K to normal at contact 26 opens the circuit of the relays 10 and 11, thereby disconnecting the operator's set 37.

A comparison of the four forms of trunks just described shows that by a slight modification of the wiring of the relays 5 and 6 and the keys K and K′, the same apparatus may be used for four different types of trunks, namely, a ring-down trunk from a switchboard to a special desk; a direct current signaling trunk from a switchboard to a special desk; a ring-down trunk between two desks; and a direct current signaling trunk between two desks. This permits of considerable economy in the installation of circuits of this character as the same standard apparatus may be used for each installation.

In Figs. 9 and 10 are illustrated two simplified forms of trunks embodying the principal features of the trunk above described and adapted for use as incoming trunks for trouble positions. The trunk shown in Fig. 9 is adapted for working on a ring-down basis, while the trunk in Fig. 10 is arranged for direct current signaling. Referring to Fig. 9, assuming that a subscriber at station A has been answered by the operator at the switchboard and desires to be connected to trouble position at $D_4$, the operator at the switchboard inserts the plug P of the cord circuit in the jack $J_4$ of the three-wire trunk $T_4$ leading to position $D_4$. A circuit is thereby completed from battery, through the supervisory lamp 16, relay 17, sleeve contacts of the plug P and jack $J_4$ and over the sleeve conductor of the trunk and lower back contact of relay 44 to ground. The relay 17 is now energized and initiates the ringing operation in a manner similar to that already described with reference to the cord circuit of Fig. 1. Ringing current is then transmitted over the tip and ring conductors of the trunk circuit, through the condenser 45, and upper high resistance winding of relay 46, energizing said relay. The relay 46 is similar to the relay 5 of Fig. 2, and the condenser 45 corresponds to the condenser 13 of said figure. Relay 46 closes a circuit from ground, over its front contact, upper back contact of relay 44, low resistance winding of relay 46 to battery, thereby locking up the relay 46. A circuit is also closed from ground over the front contact of relay 46, upper back contact of relay 44, and through the lamp 47 to battery. The glowing of this lamp indicates to the operator at the position $D_4$ that a call awaits her upon the trunk. In response to this call the operator inserts the plug $P_1$ of her telephone set 48 into the jack $J_4$′ in which the trunk $T_4$ terminates at the desk position. A circuit is thereby completed from battery over the sleeve contacts of plug $P_1$ and jack $J_4$′, through the lower winding of relay 49, and over the lower back contact of relay 50 to ground. Relay 49 is energized over the circuit above traced

and at its upper front contact and middle front contact extends the trunk to the contacts of the relay 50. Relay 49 at its upper front contact also closes a shunt about the condenser 45 through the low resistance relay 51. This affords a direct current path of low resistance in bridge of the tip and ring conductors of the trunk whereby the tripping relay 18 of the cord circuit may be operated to disconnect the ringing current and substitute the battery supervisory current for the trunk. The current impulses due to this operation are smoothed out by the impedance of the relay 46 so that the subscriber does not receive severe battery clicks.

Returning for a moment to the relay 49, the energization of said relay also closed a circuit from ground, over its lower front contact and through the upper high resistance winding of relay 44. Relay 44 at its lower front contact closes a locking circuit through its lower low resistance winding over the sleeve circuit of the trunk. At its upper contact relay 44 opens the circuit previously traced for the lamp 47 and the locking circuit of relay 46. Relay 46 remains energized, however, due to the direct current flowing through its upper winding in series with the winding of relay 51 as soon as the battery supply current is transmitted over the trunk circuit. Relay 51 is now energized and completes a circuit from ground, over the lower front contact of relay 49, lower front contact of relay 51, through the winding of slow release relay 52, lower back contact of relay 53, and over the back contact of relay 54 to battery. Relay 52 is now energized and at its lower front contact closes a circuit through the winding of relay 53, and over the lower front contacts of relays 51 and 49 to ground. Relay 53, upon being energized, opens the circuit of relay 52 at its back contact and closes a locking circuit over its lower front contact. Relay 52 after an interval permits its armature to retract, whereupon a circuit is closed from ground, over the lower front contacts of relays 49 and 51, over the upper back contact of relay 52, upper front contact of relay 53, through the winding of relay 50 to battery. The relay 50 now attracts its armatures to connect the trunk through the jack $J_4'$ and plug $P_1$ to the operator's set 48. The chain of relays 52, 53 and 50 introduce a sufficient time interval in this operation to permit the electrical energy of the trunk circuit to reach a condition of equilibrium with regard to the current disturbances incident to operating the tripping relay of the cord circuit.

The subscriber at station A may now communicate with the attendant at the desk $D_4$. If during this connection the attendant at the desk $D_4$ should desire to secure the attention of the operator at the switchboard, she may do so by manipulating the flashing key $K_4$ which at its contact 55 short-circuits the windings of relay 49 so that each time the key is closed said relay is deënergized. The contacts of this relay are so arranged that the contacts 56 and 57 are opened before contact 58 is opened. This permits of the disconnection of the trunk from the operator's telephone set before the direct current circuit through the relay 51 is broken, thereby preventing the operator from receiving clicks due to this operation. The discharge due to the opening of the circuit through the relay 51 is absorbed by the condenser 45 to minimize the clicks received by the subscriber. The deënergization of relay 49 opens at its lower contact the circuit previously traced for the relays 50 and 53, causing these relays to be deënergized. In order to eliminate a portion of the time element due to the chain of relays 52, 53 and 50, when the flashing key is operated the slow release relay 54 is energized over contact 59 of the flashing key, which holds open the initial energizing circuit of the slow release relay 52 and connects battery directly to the winding of relay 53. Each time the relay 49 is again energized, after the operation of the flashing key $K_4$, a circuit is closed from ground over the lower front contact of relay 49, lower front contact of relay 51, through the winding of relay 53, over the front contact of relay 54 to battery. The relay 53 at once closes the circuit of the relay 50 so that the operator's set is connected to the trunk with less delay than when it was initially connected.

At the conclusion of the conversation the operator at the desk $D_4$ will withdraw the plug $P_1$ from the jack $J_4'$, thereby releasing relay 49, which in turn opens the circuit of relay 51. The opening of the circuit of this relay results in the deënergization of relays 50 and 53 and opens the circuit of the high resistance winding of relay 44. The opening of the circuit through the relay 51 also results in the deënergization of the supervisory relay 34 of the cord circuit, thereby causing the supervisory lamp 16 to glow and indicate to the operator that the connection should be taken down.

The circuit above described may be modified by a few slight changes in the wiring so that it will function as a direct current signaling trunk instead of a ring-down trunk as shown in Fig. 10. Where machine ringing is not employed the time interval introduced by the relays 52 and 53 is unnecessary as the disturbances due to the tripping operation do not take place. The trunk $T_5$ of Fig. 10 is illustrated in connection with the cord circuit C', in which machine ringing is not employed, and there-

fore these relays are omitted from the circuit of Fig. 10. The operator at the switchboard, upon inserting the plug P′ of the cord circuit C′ into the jack $J_5$ of the trunk $T_5$, closes a circuit from battery, through supervisory lamp 16′, relay 17′, over the sleeve conductor of the trunk, lower back contact of relay 44, and lower low resistance winding of relay 46 to ground. Relay 46 is thereby energized and completes a circuit from ground over its front contact, upper back contact of relay 44, through the lamp 47 to battery. Lamp 47 now glows to indicate to the operator at station $D_4$ that a call awaits her upon the trunk. The operator at $D_4$ now inserts the plug $P_1$ into the jack $J_5'$ of the trunk $T_5$, thereby completing a circuit for the relay 49 similar to that already traced in connection with Fig. 9. The energization of relay 49 closes a circuit from ground, over the lower front contact of said relay, and through the upper winding of relay 44 to battery. Relay 44 is now energized and at its lower back contact opens the circuit previously traced for relay 46, and at its lower front contact completes a locking circuit through its lower low resistance winding. At its upper contact relay 44 opens a circuit of the lamp 47, which is now extinguished. Relay 49, upon being energized, extends the trunk circuit to the contacts of relay 50 and shunts the winding of relay 51 about the condenser 45. A direct circuit is now completed through the relay 51 and the supervisory relay 34′ of the cord circuit. Relay 51, upon being energized, completes a circuit from ground, over the lower front contact of relay 49, lower front contact of relay 51 and through the winding of relay 50 to battery. Relay 50 completes a connection of the trunk to the operator's telephone set 48 and the subscriber at station A may now communicate with the operator.

Should attendant at station $D_4$ desire to secure the attention of the switchboard operator, she may actuate the flashing key $K_4$, thereby short-circuiting relay 49 over the contact 55. Relay 49, upon being deenergized, opens the circuits of relays 51 and 34′, thereby causing the flashing of the lamp 16′.

At the termination of the conversation the attendant at the desk $D_4$ may withdraw the plug $P_1$ from the jack $J_5'$, thereby deënergizing relay 49 so that the circuits of relays 51 and 34′ are held open continuously and the supervisory lamp 16′ glows to indicate to the switchboard operator that the connection should be taken down. The deënergization of relay 49 also opens the circuit of relay 50, as well as the circuit through the upper winding of relay 44. When the operator at the switchboard withdraws the plug P′, the locking circuit through the lower winding of the relay 44 is opened and the apparatus is restored to normal.

It will be seen that by means of this invention a trunk circuit has been devised which by slight modification may be used in a large number of ways. It will also be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a signaling system, a subscriber's station, a common battery link circuit for establishing connections from said subscriber's station, signaling apparatus associated with said link circuit, a trunk for extending connections from said subscriber's station through said link circuit to another station, an operator's set at said second station, a high impedance bridge across said trunk including an inductance, switching means operating regardless of the condition of said operator's set to establish a direct current path over said trunk to set into operation the signaling apparatus associated with said link circuit, said inductance being included in said direct current path to minimize the clicks received by the subscriber due to the establishment of said path, and a capacity associated with said inductance for taking up the discharge due to the breaking of said path, thereby minimizing the resultant click received by the subscriber.

2. In a signaling system, a subscriber's station, a common battery link circuit for establishing connections from said subscriber's station, signaling apparatus associated with said link circuit, a trunk for extending connections from said subscriber's station through said link circuit to a second station, a high impedance bridge across said trunk including a relay of high inductance, means controlled by said relay for signaling the second station, switching means to establish a direct current path over said trunk to operate the signaling apparatus associated with said link circuit, said relay of high inductance being included in said direct current path to minimize the clicks received by the subscriber due to the establishment of said path, and a capacity associated with said inductance for taking up the discharge due to the breaking of said path, thereby minimizing the resultant click received by the subscriber.

3. In a signaling system, a subscriber's station, a common battery link circuit for establishing connections from said subscriber's station, signaling apparatus associated with said link circuit, a special operator's station including an operator's set, a trunk for extending connections from said

subscriber's station through said link circuit to said operator's station, a high impedance bridge across said trunk including an inductance, switching means whereby said trunk may be connected to and disconnected from said operator's station at will, said switching means also functioning to control the establishment of a direct current path over said trunk to set into operation the signaling apparatus associated with said link circuit regardless of the condition of said operator's set, said inductance being included in said direct current path to minimize the clicks received by the subscriber due to the establishment of said path, and a capacity associated with said inductance for taking up the discharge due to the breaking of said path, thereby minimizing the resultant click received by the subscriber.

4. In a signaling system, a subscriber's station, a common battery link circuit for establishing connections from said subscriber's station, signaling apparatus associated with said link circuit, a special operator's station including an operator's telephone apparatus, a trunk for extending connections from said subscriber's station through said link circuit to said operator's station, a high impedance bridge across said trunk including an inductance, switching means associated with said trunk, means controlled by said switching means for connecting the operator's telephone apparatus to said trunk a predetermined interval after the operation of said switching means, said switching means also controlling the establishment of a direct current path over said trunk to operate the signaling apparatus associated with said link circuit, said inductance being included in said direct current path to minimize the clicks received by the subscriber due to the establishment of said path, and a capacity associated with said inductance for taking up the discharge due to the breaking of said path, thereby minimizing the resultant click received by the subscriber.

5. In a signaling system, a subscriber's station, a common battery link circuit for establishing connections from said subscriber's station, a trunk for extending connections from said subscriber's station through said link circuit to another station, a bridge across said trunk including an inductance and a condenser, and single switching means for connecting said trunk to said other station and for shunting a winding about said condenser.

6. In a signaling system, a trunk leading to an operator's position, operator's telephone apparatus at said operation's position, means responsive to signaling current for signaling the operator at said operator's position, means controlling the connection of said trunk to the operator's telephone apparatus, and means operating while said trunk is connected to said telephone apparatus for disconnecting said telephone apparatus during the flow of ringing current.

7. In a signaling system, a trunk leading to an operator's position, operator's telephone apparatus at said operator's position, means responsive to signaling current for signaling the operator at said operator's position, switching means for controlling the connection of said trunk to said telephone apparatus, means responsive to actuation of said switching means to connect said trunk to said telephone apparatus after a predetermined interval, and means operating while said trunk is connected to said telephone apparatus for disconnecting said telephone apparatus during the flow of ringing current.

8. In a signaling system, a trunk leading to an operator's position, operator's telephone apparatus at said operator's position, means responsive to signaling current for signaling the operator at said operator's position, switching means for controlling the connection of said trunk to said telephone apparatus, means responsive to actuation of said switching means to connect said trunk to said telephone apparatus after a predetermined interval, and means operating while said trunk is connected to said telephone apparatus for disconnecting said telephone apparatus during the flow of ringing current, and for causing said switch responsive means to again connect said trunk to said telephone apparatus a predetermined interval after the cessation of ringing current.

9. In a signaling system, a subscriber's station, a common battery link circuit for establishing connections from said subscriber's station, signaling apparatus associated with said link circuit, a trunk for extending connections from said subscriber's station through said link circuit to a second station, telephone apparatus at said second station, an extension for said trunk at said second station leading to said telephone apparatus, a high impedance bridge across said trunk, switching means for connecting said trunk to said extension, and means responsive to such connection for closing a low resistance circuit including a part of said bridge over said trunk to operate said signaling apparatus associated with said link circuit.

10. In a signaling system, a subscriber's station, a common battery link circuit for establishing connections from said subscriber's station, signaling apparatus associated with said link circuit, a trunk for extending connections from said subscriber's station through said link circuit to a second station, telephone apparatus at said second station, an extension for said trunk at said second station leading to said telephone apparatus, a high impedance bridge across

said trunk, switching means for connecting said trunk to said extension, means responsive to such connection for closing a low resistance circuit including part of said bridge over said trunk to operate said signaling apparatus associated with said link circuit and means for thereafter connecting said extension to said telephone apparatus.

11. A signaling system, a subscriber's station, a common battery link circuit for establishing connections from said subscriber's station, supervisory apparatus associated with said link circuit, a trunk for extending connections from said subscriber's station through said link circuit to another station, a high impedance bridge across said trunk, means to establish a low resistance bridge across said trunk to operate said supervisory apparatus, a condenser and associated with said bridge, said condenser being shunted when said low resistance bridge is closed, means to intermittently open said bridge to intermittently actuate said supervisory apparatus, thereby removing the shunt from about said condenser so that the discharge due to opening said low resistance bridge is taken up by the condenser.

12. In a signaling system, a trunk leading to a special operator's desk, an operator's telephone apparatus at said position, switching means associated with said trunk for connecting said operator's telephone apparatus thereto, a signal responsive relay associated with said trunk, a signal controlled by said relay and responsive to the actuation of said relay by signaling current, and a second relay associated with said trunk responsive to the actuation of said switching means to alter the responsive condition of said signal, and a plurality of terminals and connections for said relays and switching means whereby the trunk may be adapted for either common battery signal or ring-down signaling by a simple change in wiring.

13. In a signaling system, a trunk leading to a special operator's desk, an operator's telephone apparatus at said position, switching means associated with said trunk for connecting said operator's telephone apparatus thereto, a signal responsive relay associated with said trunk, a signal controlled by said relay and responsive to the actuation of said relay by signaling current, and a second relay associated with said trunk responsive to the actuation of said switching means to alter the responsive condition of said signal, and a plurality of terminals and connections for said relays and switching means whereby the trunk may be adapted for either common battery signaling or ring-down signaling from another desk or from a switchboard by a simple change in the wiring.

14. In a signaling system, a transmission circuit, a relay bridged across said circuit, said relay being provided with a normally short-circuited locking winding, a second relay associated with said transmission circuit, said second relay being also provided with a locking circuit, a signal, and circuits for said signal so controlled by said relays that when said second relay is unenergized said first relay is unresponsive to momentary impulses to operate said signal, and when said second relay is energized the circuit of said signal is no longer under the control of said first relay.

In testimony whereof I have signed my name to this specification this thirtieth day of August 1918.

GEORGE W. KUHN.