

H. G. WEBSTER.
TELEPHONE TRUNKING CIRCUITS.

APPLICATION FILED JULY 3, 1902.

3 SHEETS—SHEET 1.

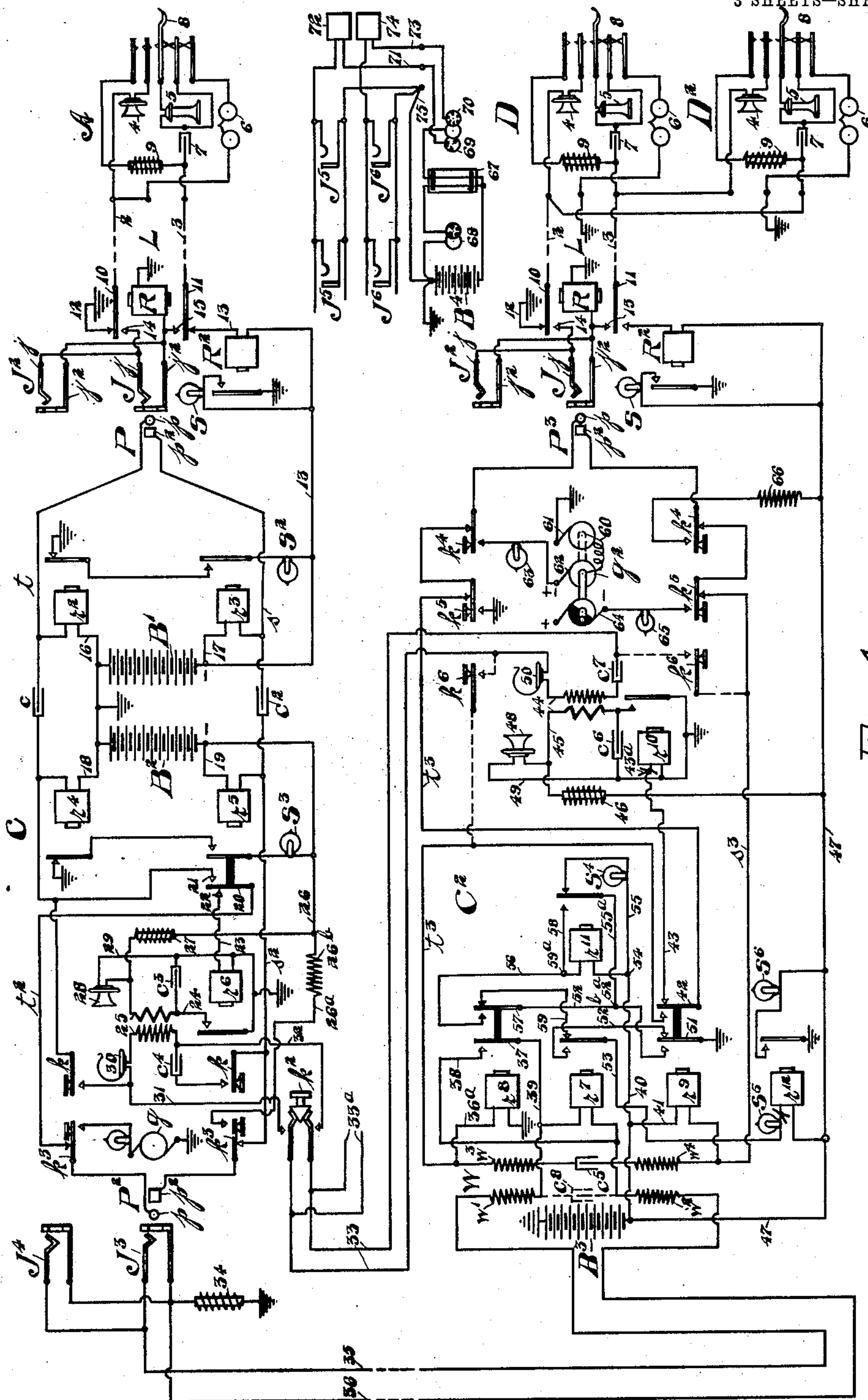


Fig. 1.

Witnesses.
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G. Beder

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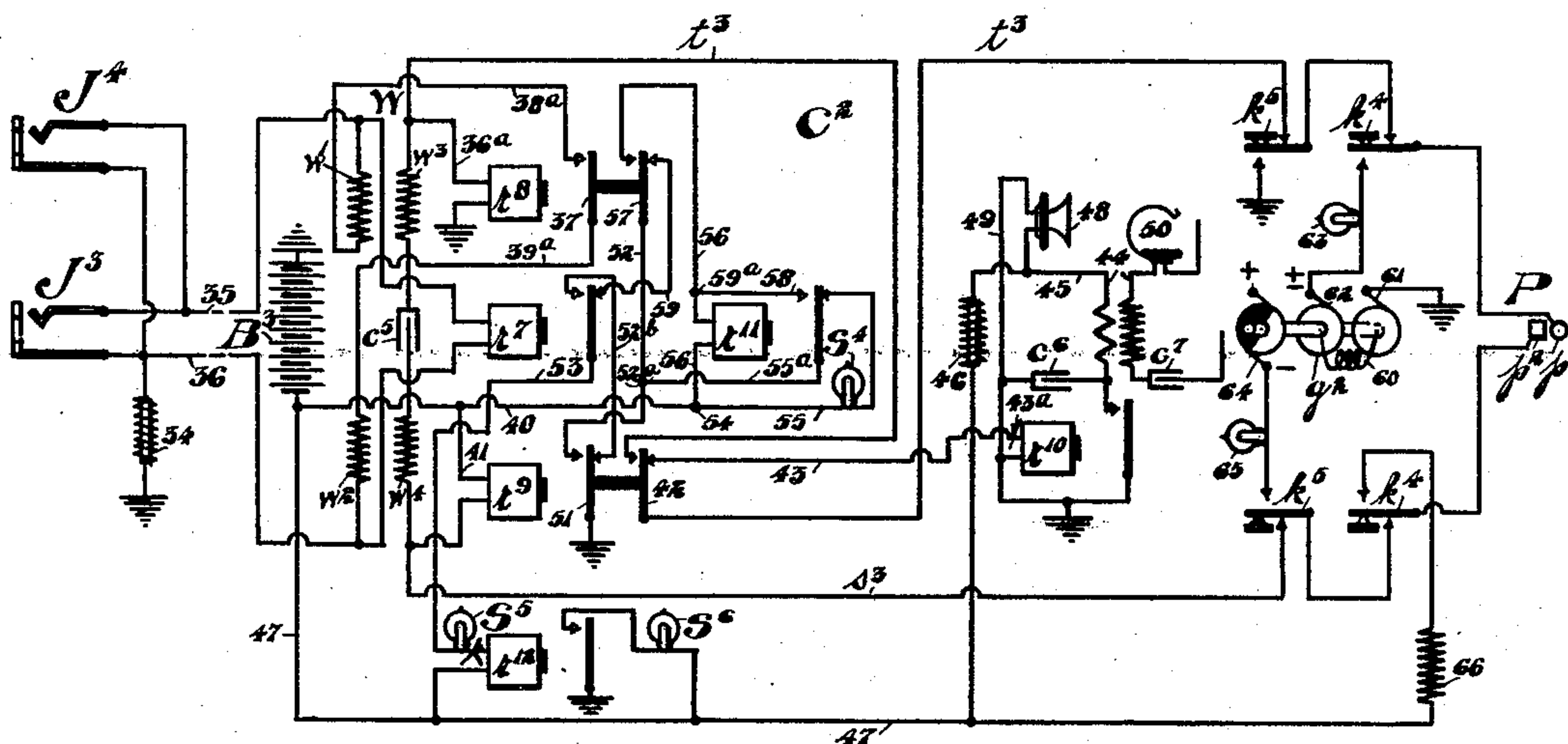


Fig. 2.

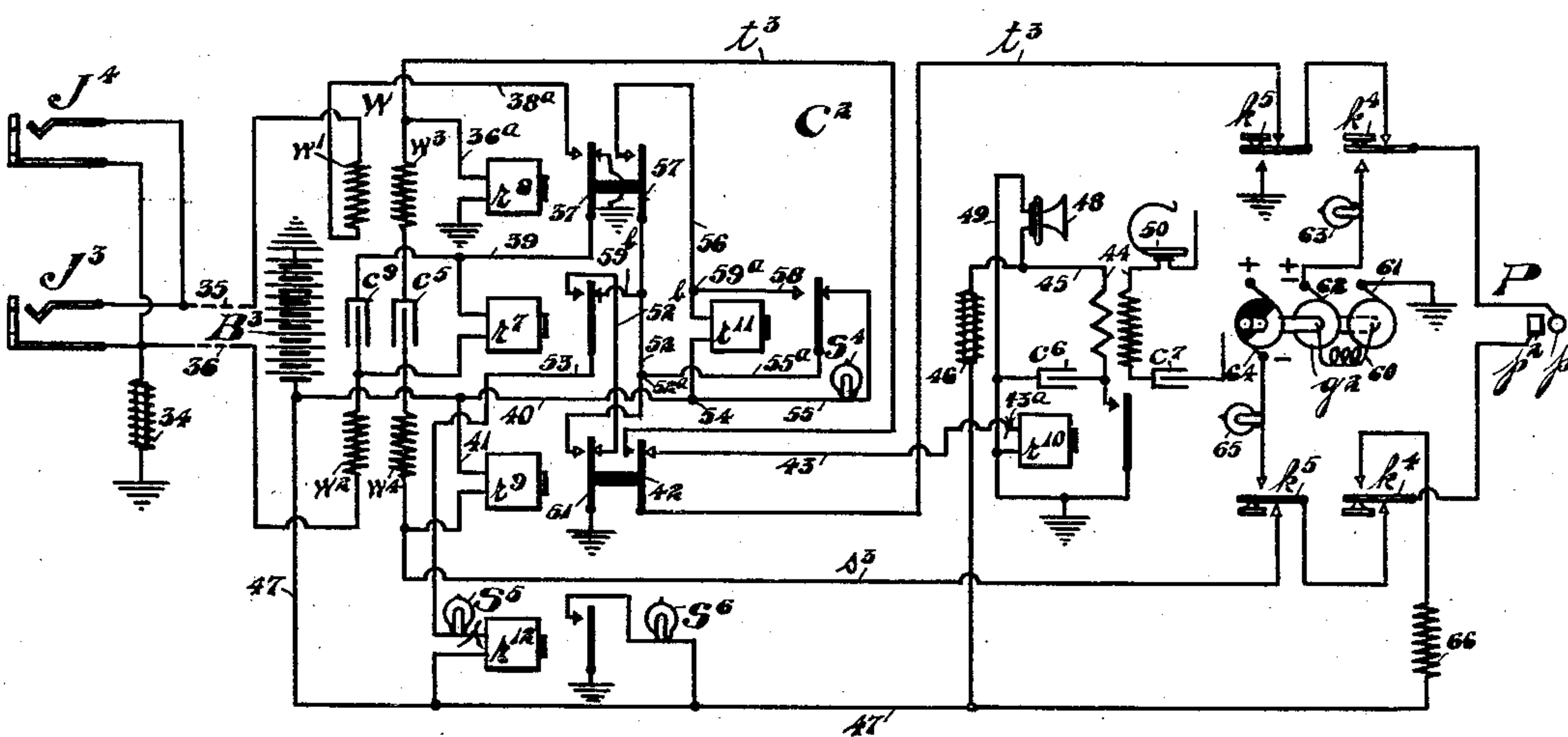


Fig. 3.

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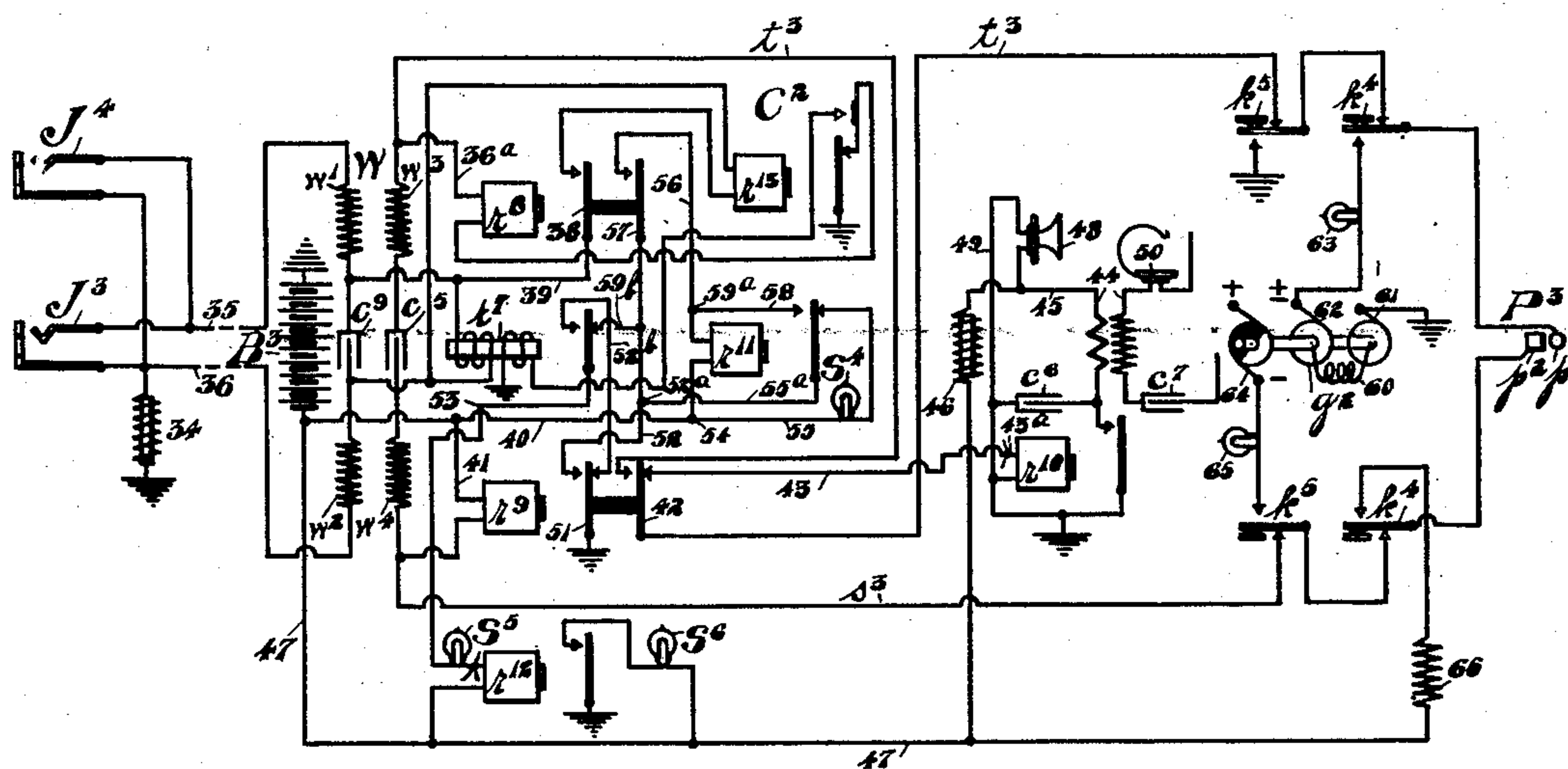


Fig. 4.

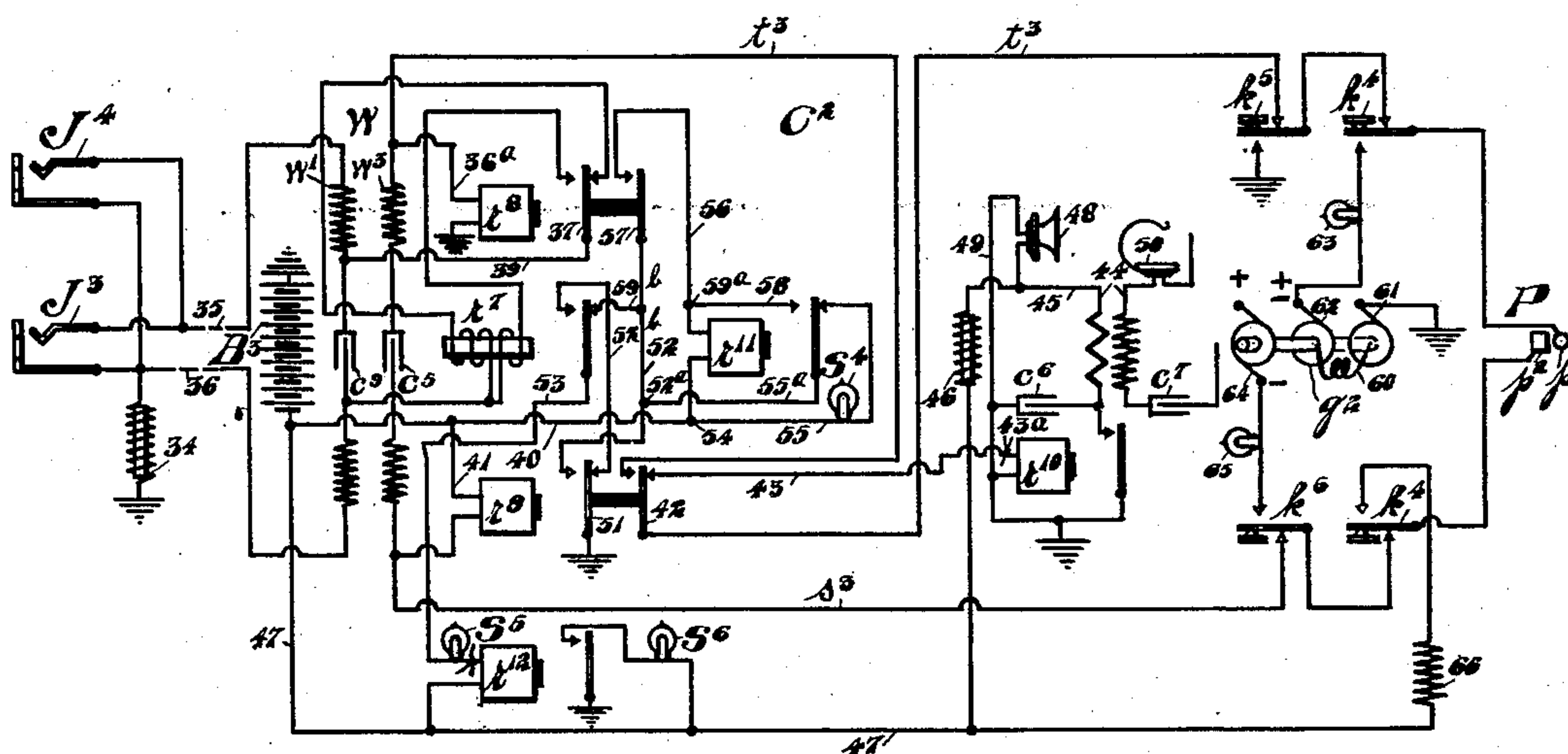


Fig. 5.

Witnesses.
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Inventor:-
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UNITED STATES PATENT OFFICE.

HARRY G. WEBSTER, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE TRUNKING-CIRCUITS.

No. 841,747.

Specification of Letters Patent.

Patented Jan. 22, 1907.

Application filed July 3, 1902. Serial No. 114,175.

To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented new and useful Improvements in Telephone Trunking-Circuits, of which the following is a specification.

My invention relates to improvements in telephone trunking-circuits and apparatus whereby telephone subscribers whose lines terminate at different central offices or central stations may be connected together for conversational purposes.

In an application filed by William W. Dean, Serial No. 113,581, dated June 28, 1902, a telephone trunking system is shown, described, and claimed in which circuits of the "Dunbar" or "two-wire" type are employed.

This invention relates to improvements upon the subject-matter of the said application of William W. Dean; and it consists, generally speaking, in so constructing and arranging the apparatus that pilot-signals common to a plurality of trunks may be employed, whereby when one of the trunks is used and the signals thereof operated the said pilot-signal is also operated to more readily attract the operator's attention to the fact that a trunk-signal has been operated.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 is a diagram of subscribers' lines terminating at different central offices, with a cord-circuit at one office and a trunk existing between said offices to connect the lines together for conversation. Fig. 2 is a diagram of a modified form of trunk. Fig. 3 is also a diagram of a modification of the trunk which may be employed. Fig. 4 is likewise a diagram of a modified form of trunk, and Fig. 5 is also a diagram of a modification in the trunk used.

Referring to Fig. 1, L designates one of the plurality of subscribers' lines terminating at the central office C. This line extends in two limbs 2 and 3 from the subscriber's station A to the said central office C, where it is fitted with suitable answering and multiple jacks or connection-terminals J J². At the subscriber's station the usual telephone instruments are provided and consist of a transmitter 4, a receiver 5, a ringer or call-bell 6, and the con-

denser 7. The switch-hook 8 is adapted in its normal position and when the receiver is placed thereon to open the circuit through the transmitter 4 and receiver 5 and to close it through the call-bell 6 and condenser 7. A retardation-coil 9 is connected at the substation when the hook is raised in parallel with the receiver 5 and condenser 7 to provide a path transparent to steady currents, but opaque to voice-currents. The line conductors 2 and 3 include, respectively, the armatures or springs 10 and 11 of the cut-off relay R, which is permanently legged to ground from the sleeve-contacts j² j² of the jacks J J². The armature or spring 10 is normally connected with ground through the conductor 12, while the opposite armature 11 is normally connected with conductor 13, containing the line-relay R² for the line, said conductor leading to the live or ungrounded pole of the central battery B', the opposite pole of which is grounded. The line-relay R² controls, through its armature, the circuit of the line-signal S. The forward contacts 14 and 15 of the cut-off relay R are adapted to connect the jacks and the switchboard-section of the line with the external line-circuit when the said cut-off relay is energized.

At the central office C the usual operator's cord-circuit is provided, said cord-circuit having an answering-plug P and a calling-plug P², each being provided with a tip-contact p and a sleeve-contact p², adapted to register with like contact-surfaces j and j² in the jacks of the line when the plug is inserted therein. The tip-contacts of the plugs are connected together by means of the tip-strands t and t² of the cord-circuit and the interposed condenser c, while the sleeve-contacts are likewise connected by the sleeve-strands s and s² and the interposed condenser c². A conductor 16 extends from the grounded pole of the battery B' to the tip-strand t and contains the winding of the tip supervisory relay r², associated with the answering-plug P, while the live pole of the battery is connected, by means of conductor 17, with the answering sleeve-strand s and includes the winding of the sleeve supervisory relay r³. These relays r² and r³ serve to control the circuit of the supervisory lamp S², associated with the answering-plug P, the former relay serving to normally close said circuit of the lamp, while

the latter relay normally opens the same. The battery B^2 is associated with the opposite or calling end of the cord-circuit and is connected by conductors 18 and 19 with the tip and sleeve strands t^2 and s^2 , respectively, the former conductor including the winding of the supervisory relay r^4 , while the latter conductor includes the similar relay r^5 . These relays serve in a manner similar to the relays r^2 and r^3 to control the circuit of the supervisory lamp S^3 , associated with the calling-plug P^2 .

The relays r^2 and r^4 are conveniently referred to as the "tip-relays" and relays r^3 and r^5 as the "sleeve-relays," since they are connected with and operated by current flowing over the corresponding strands of the cord-circuit. The tip-strand t^2 of the calling and testing plug P^2 is normally open through the extra spring or movable contact 20 of the sleeve-relay r^5 , but is adapted to be closed by the said spring and its forward contact 21 when the relay is energized. The back contact 22 of this extra spring 20 is connected, through the medium of conductor 23, with one side of the high-resistance and high-impedance relay r^6 , known as the "test-relay," the other side of which is grounded. The armature of this relay is likewise grounded, and its forward contact is connected with the primary winding of the operator's induction-coil 25 by means of the conductor 24. The other end of the said primary winding is connected, through the medium of conductor 26, to the live pole of the battery B^2 , a retardation-coil 27 being included in this circuit. The operator's transmitter 28 is joined on one side to conductor 26 intermediate her primary coil and the coil 27 and on the other side through conductor 29 to ground. A condenser c^3 is included in the operator's local circuit to facilitate talking and is connected as shown. The secondary winding of her induction-coil 25 is adapted to be included, together with her receiver 30 and a condenser c^4 , in a bridge between the strands of the cord-circuit by means of any suitable key and indicated diagrammatically by k k . Branch connections 31 and 32 lead from opposite sides of the receiver and secondary to an order-key k^2 , connected with an order circuit or wire 33, leading to the office C^2 . A grounded alternating-current ringing-generator g is adapted to be connected, through a resistance-lamp, with the tip-strand t^2 of the cord-circuit by means of the tip ringing-key spring k^3 , the sleeve-contact k^3 of said key being connected with battery-lead 26 through wire 26^a and resistance 26^b.

A trunk-circuit is shown extending between the central offices C and C^2 , said trunk-circuit being fitted at the outgoing end with multiple jacks J^3 and J^4 and with a retardation-coil 34, legged to ground from the sleeve side of the circuit. The trunk extends in

two limbs 35 and 36 to the central office C^2 , where it is provided with suitable means for testing the condition of the wanted line for ringing the desired subscriber and with signals to enable the operator to properly attend the connection. The tip and sleeve trunk-conductors 35 and 36 terminate at the incoming office in windings w' and w^2 of the repeating-coil W , and between said windings the trunk-relay r^7 is connected, said relay being of high resistance. The opposite windings w^3 and w^4 of the repeating-coil W with an interposed condenser c^5 are connected between the tip-strand t^3 and the sleeve-strand s^3 of the flexible end of the trunk-circuit, said end being hereinafter referred to as a "trunk-cord." These strands terminate in the corresponding contacts p and p^2 of the trunk-plug P^3 . The tip-relay r^8 is legged to ground from the tip-strand t^3 of the trunk-circuit by conductor 36^a and controls, through its spring 37 and forward contact, a short circuit composed of conductors 38 and 39 of the high-resistance trunk-relay r^7 .

A sleeve-relay r^9 is connected on one side with the live pole of the battery B^3 by means of conductors 40 and 41 and on the other side with the sleeve-strand s^3 . This incoming end of the trunk is provided with a testing apparatus similar to that described for the cord-circuit at the central office C . The forward portion of the tip-strand t^3 is connected with spring 42 of the sleeve-relay r^9 , while the other portion is connected with the forward contact of said spring. The back contact of spring 42 is joined by conductor 43 with the common high-resistance and high-impedance test-relay r^{10} , the opposite terminal of which is grounded. The armature of this test-relay serves when actuated to ground one side of the operator's induction-coil 44, which winding is connected on the opposite side with a conductor 45, containing the resistance and impedance coil 46, and joined to conductor 47, which leads directly to the live pole of the battery B^3 . The operator's transmitter 48 is in a conductor 49, leading from conductor 45 to ground. A condenser c^6 is connected between conductor 49 and the side of the primary that is adapted to be grounded. The operator's receiver 50, together with the secondary of her induction-coil and the condenser c^7 , are connected permanently with the order-circuit 33, leading to the central office C .

The conductor 40 leads to the point 54, from which point the branch 55, containing the ringing-lamp S^4 , leads to the back contact of the armature of locking-relay r^{11} , said armature being connected by conductor 55^a to the point 52^a upon the conductor 52, extending between the spring 57 of tip-relay r^8 and the front contact of spring 51 of sleeve-relay r^9 , the latter spring being grounded, as shown. The conductor 56 extends from

point 54 to the front contact of spring 57 of tip-relay r^8 and includes the winding of the locking-out relay r^{11} . The forward contact of the armature of this relay is connected to conductor 56 at point 59^a by means of conductor 58. The back contact of spring 57 of tip-relay r^8 is joined by conductor 59 to the back contact of the armature of trunk-relay r^7 , the forward contact of which is connected by conductor 52^b with the back contact of spring 51 of sleeve-relay r^9 . The armature of the trunk-relay r^7 is connected with a conductor 53, leading to the battery-wire 47 and including the guard and disconnecting lamp S^5 and the pilot-relay r^{12} , said latter relay serving to control the circuit of pilot-signal S^6 . This incoming end of the trunk is equipped for selectively ringing subscribers upon a party-line. It comprises the ringing-key contacts $k^4 k^4$ and $k^5 k^5$, placed in the strands of the trunk-cord and adapted when actuated to suitably connect the alternating-current generator g^2 with the plug P^3 . This ringing-generator comprises the armature 60, the grounded brush 61, the brush 62, from which the alternating current is directed through the resistance-lamp 63 to tip-key spring k^4 when depressed, and brush 64 from the split commutator-ring, which is adapted to deliver a current of negative pulsations only through lamp 65 to the sleeve-key k^5 when the key is operated. The sleeve-contact of key k^4 when operated connects the sleeve of the plug to battery-lead 47 through resistance-coil 66 to maintain the cut-off relay of the line operated during ringing.

The subscriber's line shown in connection with this office is of the "party-line" type and is connected to subscribers D and D². The apparatus at these stations is similar to that at the station A and are likewise indicated, except that the bell 6 at station D is connected between the sleeve conductor 3 and ground, while at station D² the bell is connected between the tip conductor 2 and ground. The same type of normally disconnected jacks J J², line-relay R², cut-off relay R, and the line-signals S are employed and are designated by the same reference characters. The battery B³ furnishes current for the operation of these various relays and signals as well as for talking.

J⁵ J⁵ and J⁶ J⁶ are respectively "busy-back" and "don't-answer" jacks associated with the incoming trunks. These circuits comprise an induction-coil 67, having its primary in circuit with a rapidly-rotating circuit-breaker 68, and the battery B⁴, this battery being preferably the same battery as B³, though shown separately for convenience. The secondary of the induction-coil 67 is connected in circuit with the rapid circuit-interrupter 69 and the more slowly operating interrupter 70. From interrupter 69 a conductor 71 leads to the tip-contacts of

busy-back jacks J⁵ J⁵ through a 50-ohm resistance-coil 72, while interrupter 70 leads by conductor 73 through resistance-coil 74 to the tips of the don't-answer jacks. The sleeves of both sets of jacks are united by conductor 75 with the grounded pole of battery. The circuit-breaker 68 causes induced currents in the secondary circuits, which are interrupted at short intervals by breaker 69 and at longer intervals by breaker 70 to cause distinctive tones at the jacks J⁵ and J⁶, whereby when a trunk-plug is inserted in one or the other jacks a corresponding signal is transmitted to the waiting subscriber.

In tracing the circuits hereinafter the plan of pointing out the path for current from the live or ungrounded pole of the battery to the ground only will be followed for convenience, it being understood that the return-current will seek the grounded pole of the battery and that the circuit will therefore be complete.

The operation is as follows: The A subscriber desiring a connection with a subscriber located at another exchange removes his receiver from the hook, and thereby closes a path for current between the limbs 2 and 3 of his line through the transmitter 4 and retardation-coil 9, the condenser 7 and receiver 5 being connected in parallel with the retardation-coil. The closing of this circuit permits current to flow from the battery B' through conductor 13, line-relay R², spring 11 of cut-off relay R, limb 3 of the telephone-line, through the retardation-coil 9 and transmitter 4 at the substation, and thence over limb 2 back to the central office, and spring 10 of cut-off relay R through conductor 12 to ground. The line-relay R² is thus operated and closes the circuit of the signal-lamp S to ground from the conductor 13.

The operator upon seeing the line-signal exposed inserts the answering-plug P into the answering-jack J of the subscriber's line and connects her telephone 30 with the cord-circuit by depressing the listening-key $k k$ to receive the order from the subscriber. The insertion of the plug P closes a circuit through the cut-off relay R from the live pole of the battery B' through conductor 17, sleeve supervisory relay r^3 , sleeve-strand s , sleeve-contacts p^2 and j^2 of the plug and jack, thence through the winding of the cut-off relay R to ground. The operation of this relay disconnects the armatures 10 and 11 from the ground wire 12 and from the battery-lead 13 and connects them through the forward contacts 14 and 15 of said armatures to the normally disconnected jacks J J². The operation of the supervisory relay r^3 over the path just traced serves to close through its armature and front contact the circuit of the supervisory signal S², which is associated with the plug P; but it is prevented from glowing by the operation of the

tip supervisory relay r^2 , which is connected in the conductor 16 and receives current over telephone-line and the tip-strand t of the cord-circuit and through the conductor 16 to the grounded pole of the battery B' as soon as the cut-off relay R is operated. The supervisory signal S^2 therefore remains inert, while the battery B' furnishes current over the metallic telephone-line for the operation of the supervisory relays and for conversational purposes. The operator's transmitter 28 is receiving current at this same time from the battery B^2 over the conductor 26, through retardation-coil 27, thence through the transmitter 28 and over conductor 29 to ground. When sound-waves strike the transmitter 28, the current flowing therethrough is varied, which causes a variation of the charge in the condenser c^3 and a corresponding surge of current through the primary of her induction-coil 25. These induce voice-currents in the secondary, which are transmitted to the line, and the operator is therefore able to converse with the calling subscriber.

Upon learning that a subscriber in the exchange C^2 is desired the A operator depresses the order-key k^2 to connect her telephone with the order wire or circuit 33 and repeats the number of the wanted subscriber to the B operator, whose head-telephone 50 is permanently connected with the said order-wire. The latter operator designates to the A operator the trunk to be used for the connection and proceeds to test the condition of the wanted line with the tip of the plug of the incoming trunk named. If the line is idle, no "click" will be received; but if busy the sleeve-contacts of the jacks of the line will be connected with the live pole of a battery through the sleeve-contact and strand of the inserted plug. A complete circuit will therefore be established from the sleeve-contact of the tested jack, which, it is assumed, is connected with the live pole of the battery through the tip of the plug P^3 , tip-strand t^3 , spring 42, and back contact of sleeve-relay r^3 , conductor 43, through the common high resistance and impedance test-relay or responsive device r^{10} to ground. This test-relay will therefore operate and ground through its armature and front contact one side of the primary of the operator's induction-coil 44, the other side of which is connected by conductor 45, through resistance 46 and conductor 47, to the live pole of the battery B^3 . The completion of the circuit will permit a flow of current there-through, which will induce a current in the secondary of the said induction-coil and produce a click in the receiver 50 of the operator's set. The operator's receiver will respond to this click at all times, even though the order-circuit should be open at the exchange, since the electrostatic capacity of her cir-

cuits and that of the order-circuit is ample for the purpose of producing the click.

In the three-wire systems, where the test-circuits are insulated from the subscribers' lines, there is no danger of varying the current flowing in the line to the annoyance of the subscriber during testing; but in the two-wire systems, where the testing-contacts are connected directly with the talking-circuits, some means is necessary, or at least desirable, to prevent noticeably varying the current upon lines connected for conversation when testing their condition at other sections of the switchboard. This is accomplished in the circuit described by means of the test-relay r^{10} , which is of such high resistance as to vary the current upon the tested line but slightly and which is also of high impedance, so that its current will build up slowly to thereby prevent a sudden variation of current on the line. The subscriber or subscribers whose lines are tested are therefore undisturbed by a sudden or large variation of current through their instruments. It is apparent that any other suitable test responsive device or indicator than the relay 10 can be employed and that the operator's telephone can be used in place of the same or in the circuit with a retardation-coil; but the arrangement described is preferred. This relay is preferably common to all the incoming trunks at the one operator's position, as indicated by the branching lines at 43^a. Upon finding the line idle the plug P^3 is inserted in one of the multiple jacks of the wanted subscriber's line.

The A operator having received the number of the trunk to be used inserts the calling-plug P^2 of her cord-circuit in the jack J^3 at her section of the trunk designated. The insertion of the plug P^2 closes a circuit from the live pole of the battery B^2 at the A office through the conductor 19, sleeve supervisory relay r^5 , sleeve-strand s^2 of the cord-circuit, sleeve-contacts of the plug and jack, and through retardation-coil 34 to ground. This has the effect of positively operating the sleeve supervisory relay r^5 , which attracts its armatures and cuts out the test-relay r^6 and completes the tip-strand of the cord-circuit through armature 20 and its forward contact 21. The closing of this tip-strand permits current to flow from the battery B^2 over the sleeve-strand of the cord-circuit, the sleeve conductor 36 of the trunk-line, through the winding w^2 of the repeating-coil W at the B exchange, through trunk-relay r^7 , and thence through repeating-coil winding w' and over the tip conductor 35 of the trunk back to the A exchange, and thence over tip-strand t^2 of the cord-circuit and through conductor 18, containing the winding of tip supervisory relay r^4 , to the

opposite pole of the battery B^2 . The closing of this circuit operates the trunk-relay r^7 ; but as the resistance of this relay is very high sufficient current does not flow through the tip supervisory relay r^4 at the A exchange to operate the same. The supervisory signal S^3 , associated with the calling-plug P^2 of the A cord-circuit, is therefore lighted by current flowing from the live pole of the battery B^2 , through conductor 26, the signal-lamp S^3 , the armature and forward contact of sleeve supervisory relay r^5 , and thence through the armature and back contact of tip supervisory relay r^4 to ground. This lamp is therefore lighted and remains lighted, as hereinafter explained, until the response of the called subscriber at the B exchange.

The insertion of the incoming trunk-plug into the jack of the wanted line closes a circuit from the live pole of the battery B^3 over conductors 40 and 41, through sleeve-relay r^9 , and thence over the sleeve-strand s^3 of the flexible end of the trunk, through the sleeve-contacts of the plug P^3 and the jack of the called subscriber, and thence to the cut-off relay R of the wanted line to ground, thus operating both the sleeve-relay r^9 and the cut-off relay R , the latter serving to disconnect the line-relay R^2 of the line to render the line-signal inoperative and to connect the normally disconnected jacks with the limbs of the line extending to the substations. The operation of sleeve-relay r^9 disconnects the test-relay r^{10} and closes the tip-strand t^3 through the spring 42 and its forward contact, and thereby establishes the circuit for conversation. It also completes the circuit of the ringing-lamp S^4 from the battery B^3 over conductor 40 to the point 54, thence over conductor 55 and through the lamp S^4 to the back contact of the armature of locking-relay r^{11} , thence through the armature and over conductor 55^a to the point 52^a, over the conductor 52 to the front contact and armature of sleeve-relay r^9 to ground. The completion of this circuit causes the operation of the ringing-lamp S^4 and indicates to the operator that the subscriber has not yet responded. The operation of the trunk-relay r^7 at this time opens through its armature and back contact the circuit of the guard and disconnect-lamp S^5 to thereby prevent its operation.

Upon the insertion of the trunk-plug P^3 the B operator rings the wanted subscriber. If the subscriber D is the one desired, the ringing-key k^5 is depressed, which throws ringing-current upon the sleeve-strand connected with the plug P^3 and operates the subscriber's bell over the following path: from ground at the generator g^2 , brush 61, armature 50 of the generator, brush 64 through resistance-lamp 65, key k^5 , thence over the sleeve-strand of the cord to the plug P^3 , over the sleeve-limb 3 of the telephone-line to the

station D, and thence through condenser 7 and bell 6 to ground, the receiver 5 being at this time upon the hook 8, and therefore completing the circuit between the condenser 7 and bell 6.

It will be noticed that just previous to the depression of the ringing-key k^5 the cut-off relay R was receiving a negative current through its coils from the battery B^3 . At the instant the ringing-key k^5 is depressed this path of current from the battery B^3 is broken; but a new path is immediately established through the relay R from the negative source of pulsating ringing-current. The relay R is so constructed as to be maintained in continuous operation when this negative pulsating current is passing through its winding, and as pulsations are used of the same direction as the current furnished by the battery B^3 the relay R is prevented from even momentarily releasing its armatures at the moment the ringing-key was depressed.

The bell 6 at the subscriber's station may be of the ordinary polarized type, as the presence of the condenser 7, which is connected directly in the ringing-circuit, permits the operation of such a bell from the pulsating source of ringing-current. The tip-spring of ringing-key k^5 is grounded at this time to provide a path to ground for the return-current if the subscriber should respond during ringing. Should the subscriber D^2 be the one desired, the ringing-key k^4 is depressed, which serves to connect the generator g^2 with the tip-strand of the cord-circuit to operate the bell at the station D^2 .

The ringing-circuit may be traced as follows: from ground at the generator g^2 , brush 61, armature-winding 60 of the generator, brush 62, through resistance-lamp 63, spring k^4 in the tip-strand of the cord-circuit, thence over the tip-strand and tip-conductor 2 of the line to the station D^2 , and thence through condenser 7 and normally closed contacts of the hook 8 and through bell 6 to ground. The bell is thus operated: To maintain the cut-off relay R operated during ringing, the inner contact of the sleeve-spring k^4 is connected through a resistance-coil with the battery-lead 47, extending to the live pole of the battery B^3 . This prevents the deenergization of cut-off relay R while ringing.

Since the ringing-key springs k^4 would most often be used for ordinary metallic ringing, the return-path for current from the subscriber's station is back over the sleeve side of the line and through the battery B^3 . Unless, therefore, the sleeve-strand is severed at the time of ringing the said return-current will pass through the sleeve supervisory relay r^9 and cause the same to chatter, which is not desirable. Hence the sleeve-spring k^4 is arranged to complete a by-path

for current around said supervisory relay when ringing. It will be understood that a single key-lever is preferably used in the ordinary manner to simultaneously operate both tip and sleeve springs.

It is apparent that the arrangement of the ringing-keys is such that either key may be used to call a subscriber at whose station the apparatus is connected in the manner shown at A, which shows the arrangement which I preferably use where but one subscriber is placed upon the line. In this case the ringing-circuit would be complete over the subscriber's metallic circuit, the current returning to the grounded side of the ringing-generator by means of the grounded key k^5 or battery-contact of the ringing-key k^4 .

The subscriber having been called responds by taking up his receiver, and thereby closes a path for current between the limbs of his line from the main battery B^3 over conductors 40 and 41, sleeve-strand s^3 of the incoming end of the trunk-line 3 of the telephone-line, thence through retardation-coil 9 and transmitter 4 at the substation, thence over limb 2 of the telephone-line back to the central office, and over tip-strand t^3 of the incoming end of the trunk, including spring 42 and its forward contact of sleeve-relay r^9 , through conductor 36^a and tip-relay r^8 to ground. This relay responds to this current and closes through its armature 37 and forward contact the short circuit of the trunk-relay r^7 . The resistance of the trunk-relay r^7 being now removed from the path of current flowing in the trunk-circuit, the tip-relay r^4 of the A cord receives sufficient current from the battery B^2 to operate the same to thereby open the circuit of supervisory signal-lamp S^3 , thus indicating to the A operator that the wanted subscriber has responded to his call and that the parties are in condition to converse. Although the trunk-relay r^7 is now deenergized and its armature engages its back contact, the guard-lamp S^5 is not operated, because its circuit is opened at the back contact and spring 57 of tip-relay r^8 . The closing of spring 57 of the tip-relay r^8 and its forward contact completes the circuit of the locking-relay r^{11} as follows: from the live pole of the battery B^3 over conductor 40 to the point 54, thence through the locking-relay r^{11} , over conductor 56 to the forward contact and spring 57 of the relay r^8 , thence over conductor 52 through the forward contact and spring 51 of sleeve-relay r^9 to ground. The locking-relay r^{11} is therefore operated and opens through its armature and back contact the circuit of the ringing-lamp S^4 , which is extinguished and indicates to the operator that the called subscriber has responded to his ring. The closing of the armature of the locking-relay upon its forward contact completes a locking-circuit for said relay from the point 59^a through conductor

58, the forward contact and the armature of the relay, conductor 55^a to point 52^a, and thence over conductor 52 and the forward contact and spring 51 of sleeve-relay r^9 to ground. This circuit and the relay r^{11} are therefore locked, and the ringing-lamp S^4 is also locked out during the remainder of the connection and can only be released when the sleeve-relay r^9 is deenergized, which occurs when the plug P is pulled out.

Should the tip and sleeve contacts of the plug be crossed when the plug is inserted in a jack and the locking and other relays operated, they will be immediately released by the opening of the sleeve-strand in ringing, and no confusion would result therefrom. The subscribers are now connected together for conversation and the supervisory signals at both exchanges are extinguished. The battery B' is furnishing current over the answering end of the A cord-circuit to the A subscriber's line for talking purposes and for the operation of the supervisory relays, the battery B^2 is furnishing current over the trunk-line for the operation of the supervisory relays associated with the answering end of the A cord-circuit, and the battery B^3 is sending current over the incoming end of the trunk and to the substation D to furnish current for talking and for the operation of the several relays. The voice-currents are transmitted inductively from the subscriber's line L to the trunk-circuit through the condensers c and c^2 in the A cord-circuit and from the trunk-circuit to the incoming end thereof and the subscriber's line connected therewith through the medium of the repeating-coil W. The condenser c^5 between the windings w^3 and w^4 of the repeating-coil at the incoming end of the trunk prevents the flow of steady current therethrough, but permits a free passage of the voice-currents.

At the termination of the conversation the subscribers return their receivers to their hooks, with the result, in the case of subscriber A, that the tip supervisory relay r^2 , connected with the A cord-circuit, is deenergized and closes, through its armature and back contact, the circuit of the supervisory signal S^2 , thus indicating to the operator that subscriber A has returned his receiver to the hook.

When the subscriber D hangs up his telephone, current is cut off from the metallic line in the same way, and the tip-relay r^8 is therefore deenergized. This serves to open the short circuit about the trunk-relay r^7 . The current must now flow through the trunk-relay r^7 , thus actuating it, but is insufficient to maintain the tip-relay r^4 in the A cord-circuit in an operated condition, which therefore allows its armature to fall back, closing the circuit of supervisory signal S^3 , which becomes lighted and shows to the A operator that the subscriber D has hung up

his receiver. The spring 57 of the tip-relay r^8 at the incoming end of the trunk is now closed to conductor 59; but the trunk-relay r^7 having operated, the circuit of the disconnecting-lamp S^5 is again opened. The A operator seeing both signals in her cord-circuit exposed withdraws both plugs, thus restoring all parts at her office to normal position.

10 The withdrawal of the plug P^2 at the A exchange deprives the relay r^7 at the incoming end of the trunk of operating-current, which is therefore deenergized and permits its armature to close upon its back contact 15 the circuit of the disconnecting-lamp S^5 and the pilot-relay r^{12} , said circuit being traced from the live pole of the battery B^3 to conductor 47, through the winding of the pilot-relay r^{12} , and through lamp S^5 , thence over 20 conductor 53, the armature and back contact of trunk-relay r^7 , conductor 59, the back contact and armature 57 of tip-relay r^8 , thence over conductor 52 to the front contact and armature 51 of the sleeve-relay r^9 to 25 ground.

The operation of the pilot-relay r^{12} lights the pilot-signal S^6 , which attracts the operator's attention and who upon observing the lighted lamp S^5 is thus informed that the A 30 operator has taken down the connection at that exchange, and she accordingly withdraws the plug P^3 from the jack of the subscriber's line. Upon the withdrawal of the trunk-plug the sleeve-relay r^9 is deenergized and 35 the circuit of the signal-lamp S^5 , as well as that of the pilot-relay r^{12} , opened at the front contact and armature 51 of the said relay. Both lights S^5 and S^6 are thus extinguished, and at the same time the circuit of the locking-relay 40 r^{11} is broken at the same point, which relay is therefore deenergized and permits its armature to return to normal position.

The disconnecting-signal S^5 serves also as a guard-lamp in case the A operator inserts the 45 calling-plug P^2 into a wrong trunk-jack, for the reason that the trunk-relay of that trunk will be operated, while the sleeve-relay r^9 is not operated. A circuit will therefore be completed from the live pole of the battery 50 B^3 over conductor 47, through pilot-relay r^{12} , and disconnecting-lamp S^5 , through conductor 53, the armature and front contact of trunk-relay r^7 , conductor 52^b, to the back contact of spring 51 of sleeve-relay r^9 , thence 55 through the armature or spring 51 to ground. The disconnecting-lamp S^5 , as well as the pilot-lamp S^6 , will therefore be lighted and will indicate to the operator that a mistake has been made.

60 At the same time both ringing-lamp S^4 and guard-lamp S^5 of the trunk whose plug is inserted will operate, thus apprising the operator that the trunk has not been connected with at its opposite end. It will be noticed 65 that the sleeve-relay spring 51 controls,

through its forward contact, a ground branch from point 52^a and that from said point two parallel paths are normally completed to the live pole of the battery, one including conductor 55^a, the normal contacts of locking-relay r^{11} , ringing-lamp S^4 , conductors 55 and 40, while the other includes conductor 52, the normal contacts of tip-relay r^8 , conductor 59, the normal contacts of trunk-relay r^7 , conductor 53, including lamp S^5 and pilot-relay 75 r^{12} , and conductor 47 to the battery. When ground is thrown upon these parallel paths, as by the closing of the sleeve-relay r^9 , which is the condition when the plug P^3 of an idle trunk is inserted in a line, both lamps are 80 operated. This can only occur under these circumstances, for the reason that in normal working before the subscriber responds both the trunk-relay and the sleeve-relay are operated, the former serving to open one parallel path, which permits only the ringing-lamp to operate. 85

As soon as the subscriber responds the locking-relay operates and holds open the parallel path through its contacts during the 90 remainder of the connection. At the same time, although the trunk-relay is no longer operated, the tip-relay is operated, which again opens the first path, so that lamp S^5 cannot glow. Now when the A operator takes 95 down the connection, lamp S^5 operates; but the other parallel path remains open through locking-relay r^{11} .

In case the wanted-subscriber's line is found busy or in case the subscriber having 100 been called does not respond the plug P^3 is inserted in one of the jacks J^5 or J^6 and the corresponding signal is transmitted to the waiting subscriber.

Upon inserting the plug P^3 in one of the 105 "busy back" or "don't-answer" jacks—for example, one of the jacks J^5 —a path for current is provided from the battery B^3 through the sleeve-strand of the trunk-cord, sleeve-contacts of the plug and jack, and over conductor 75 to ground. This will serve to 110 operate the sleeve-relay r^9 to complete the continuity of the tip-strand t^3 of the trunk-cord through its spring 42 and the front contact. Upon the completion of the strand at 115 this point the tip-relay r^8 is provided with current from the live pole of the generator B^4 through the secondary winding of the induction-coil 67, through circuit-breaker 69, and thence over conductor 71, through resistance 72 and the tip-contacts of the jack and plug, and over the tip-strand and 120 through the relay r^8 to ground. This circuit is interrupted at the breaker 69, so that the relay r^8 is alternately energized and deenergized to correspondingly make and break the short circuit of the trunk-relay r^7 , which is therefore simultaneously removed from and inserted in the circuit of the outgoing end of the trunk. This causes the intermittent 130

operation of the tip-relay r^4 in the A cord-circuit to effect the flashing of the supervisory signal S^3 , whereby the A operator is notified that the called-subscriber's line is busy.

5 The flashing of this light of course corresponds to the rapidity of the breaking of the circuit at breaker 67 or 70, which indicates to the operator whether the line is busy or does not answer. The subscriber is also notified
10 by the tone caused in his receiver.

The order-circuit 33, as is indicated by the branching lines 33^a, connects the B operator with several A operators either at the same or at different exchanges. The A operator is
15 also provided with a plurality of keys k^2 to connect herself with the different B operators. The "busy back" or "don't-answer" apparatus is common to the various sections of the incoming trunk-board, as is indicated by
20 the branching lines.

Although I have described the method of making connections through the medium of the order-circuit, I do not wish to so confine the invention, for it is apparent that the A
25 operator is able by means of her testing apparatus to test the condition of the several trunks before her until an idle trunk is found. Upon so testing and finding an idle trunk she may insert the calling-plug P^2 of her cord-
30 circuit, with the result that the trunk-relay r^7 operates and lights the lamp S^5 , which lamp has been previously termed the "guard-lamp," but in this method of operation it would act as a calling-signal from the A oper-
35 ator to the B operator. The B operator upon seeing the signal S^5 would depress her listening-key k^6 k^6 , which would connect her receiver in series with the repeating-coil windings w^3 and w^4 , these receiver connec-
40 tions being indicated in dotted lines in Fig. 1. She is therefore able to communicate with the A operator. The presence of the condenser c^8 (shown in dotted lines in parallel with the trunk-relay r^7) permits conversa-
45 tion between the operators at this time. Upon learning the desired connection the B operator completes the same, as before described. It will also be understood that had the subscriber A called for a connection with
50 another subscriber in the same exchange the line of that subscriber would have been tested in the ordinary manner by means of the cord-plug P^2 and the subscriber would have been called by the ringing-generator g .

55 Fig. 2 shows a modification of the trunking-circuit in which the trunk-relay r^7 is shunted when the tip relay operates by means of a branch containing the repeating-coil windings w' and w^2 , closed through the
60 armature 37 and front contact of the said tip-relay. It is therefore evident that when the tip-relay is operated the trunk-relay r^7 is deprived of operating-current and is thus deenergized, and its resistance is removed
65 from the metallic trunk-circuit whereby the

tip-relay in the A cord-circuit operates, as described in connection with Fig. 1. Otherwise the construction and arrangement is the same in this figure as in that previously described, and the operation is the same
70 throughout. A more detailed description of the same is therefore considered unnecessary.

Fig. 3 shows my improvements applied to a trunk in which the trunk-relay r^7 is of low
75 resistance and is normally connected between the sleeve side 36 of the trunk-line and the ground through the repeating-coil winding w^2 , and thence through conductor 39 to the armature 37 and back contact to a tip-relay.
80 It will be seen by reference to Fig. 1 that the battery B^2 is grounded at one pole and connected at the other pole with the sleeve-strand of the cord-circuit through conductor 19. This trunk-relay will therefore be oper-
85 ated by current from the live pole of the battery B^2 at the A exchange over conductor 19, sleeve-strand of the cord-circuit and sleeve-conductor of the trunk, and through the trunk-relay to ground. When the called
90 subscriber responds and the tip-relay operates, as before described, a strand 37 closes on its front contact which is connected with the tip-conductor 35 of the trunk-line and therefore completes the metallic circuit of the
95 outgoing end of the trunk. The trunk-relay is therefore included in this metallic portion of the circuit; but as it is of low resistance it does not prevent the tip-relay in the A cord-
100 circuit from operating. The operation differs from that described heretofore in that the trunk-relay is first operated over ground and remains operated during conversation of the connected subscribers when the outgoing
105 end of the trunk is closed. The operation of a disconnecting-lamp in this form of the invention does not depend upon the completion of the circuit through the back contact of the tip-relay armature, but is completed directly through the armatures of the trunk-
110 relay and of the sleeve-relay, as shown, a conductor 59^b leading directly from the back contact of the armature of the trunk-relay to the conductor 52, extending between the spring 57 of tip-relay and the forward con-
115 tact of spring 51 of the sleeve-relay. Otherwise the operation is the same as previously described and will be understood without further description.

Fig. 4 shows still another modification in
120 which the trunk-relay instead of being short-circuited absolutely, as in Fig. 1, when the tip-relay r^8 operates in response to the answer of the called subscriber is short-circuited through the extra low wound relay r^{13} , which
125 has one side permanently connected with the forward contact and armature 37 of the tip-relay r^8 and its other side permanently connected upon the sleeve side of the winding of the trunk-relay r^7 . This relay r^{13} is of suffi-
130

ciently low resistance to permit the operation of the tip-relay of the A cords and the operation of the supervisory signal connected therewith. When this auxiliary relay r^{13} operates, it cuts into circuit a low-resistance winding placed upon the trunk-relay, said winding being in a ground branch containing the tip-relay r^8 when the relays are operated. The ground branch of the tip-relay r^8 is normally completed through the back contact of the armature of the auxiliary magnet r^{13} . The further operation of the system is apparent from the drawings and is the same as that heretofore described. The pilot-relay and the other testing-signal operate in the same manner as in the previous figures.

Fig. 5 shows a trunk differing slightly from Fig. 4, in which the auxiliary low-resistance relay is omitted and the low-resistance winding upon the trunk-relay is connected in the short circuit of the high resistance when the tip-relay operates. The operation of the system is thought also to be apparent and is not specifically described. The pilot-relay and the disconnecting-lamp, as well as the ringing-lamp, operate over circuits corresponding to those of Fig. 1.

The ground connections heretofore referred to, it will be understood, may and in practice usually are one and the same, or they may be the common office return, although it is found by experience that it is necessary to place a dead ground upon one side of the common battery. This ground connection may be placed at the opposite pole of the several batteries instead of as shown in the diagrams, all of which is apparent to those skilled in the art.

The pilot-relay may have one and one-half ohms resistance and the other parts may be of the desired or usual dimensions.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The combination with a trunk-circuit adapted to be united to a calling-telephone line at its outgoing end and a called-telephone line at its incoming end, of a plurality of relays at the latter end of the trunk, a signaling-circuit controlled by said relays, a source of current and a signaling device in said circuit, means whereby said circuit may be void of current when no signal is displayed, a portion of the said signaling-circuit on one side of the said source being used only for signaling purposes whereby it and the said source may be common to a plurality of such trunk signaling-circuits, and a pilot signaling device in said portion, substantially as described.

2. The combination with a trunk-circuit adapted to be united to a calling-telephone line at its outgoing end and a called-telephone line at its incoming end; of a plurality of relays at the latter end of the trunk, one adapt-

ed to be actuated by current over the outgoing end of the trunk and another over the incoming end; a signaling-circuit for the trunk having alternate branches controlled by said relays and closed thereby whenever the first or second named relay is energized alone, a source of current included in said circuit, a signal actuated whenever the circuit is closed over either branch, a portion of the said signaling-circuit on one side of the source of current being used in said circuit only whereby said portion and said source may be common to a plurality of such trunks, and a pilot signaling device located in such portion, substantially as described.

3. The combination with a trunk-line, of a cord-circuit to connect with its outgoing end, and a called-subscriber's line having only two wires extending throughout the multiple switchboard with which its incoming end may be connected, a disconnect-signal for said incoming end, means operated by current flowing over a portion of the talking-circuit when connection is made with the called line for closing the circuit of said signal at one point, and further means operated by and during the connection of said cord-circuit with the trunk for opening the circuit of said signal at another point, one terminal of said signal being free under said latter condition, substantially as described.

4. The combination with a trunk-line, of a cord-circuit to connect with its outgoing end, and a called-subscriber's line having only two wires extending throughout the multiple switchboard with which its incoming end may be connected, a disconnect-signal for said incoming end, means operated by current flowing over a portion of the talking-circuit when connection is made with the called line for closing the circuit of said signal at one point, and further means controlled by current sent over the trunk-circuit when the cord is connected therewith for opening the circuit of said signal at another point, whereby said signal can only be operated when the cord-circuit is disconnected from the trunk, one terminal of said signal being free in said latter position, substantially as described.

5. The combination with a trunk-line, of a cord-circuit to connect with its outgoing end, and a called-subscriber's line having only two wires extending throughout the multiple switchboard with which its incoming end may be connected, a disconnect-signal for said incoming end, means actuated by current flowing over a part of the talking-circuit when connection is established with the called line for closing the circuit of said signal at one point to place it in condition to operate, and further means operated by the connection of said cord-circuit with the trunk for opening the circuit of said signal at another point, rendering the same inoperative with-

out placing a shunt about said signal, substantially as described.

6. The combination with a trunk-line, of a cord-circuit to connect with its outgoing end, and a called-subscriber's line having only two wires extending throughout the multiple switchboard with which its incoming end may be connected, a disconnect-signal for said incoming end, a relay actuated by current flowing over a portion of the talking-circuit for closing the circuit of said signal at one point and placing it in condition to operate, and a trunk-relay at the incoming end of the trunk adapted to be actuated when a connection is established between the cord-circuit and the trunk to open the circuit of said signal at a second point, rendering the same inoperative without placing a shunt about said signal, substantially as described.

7. The combination with a trunk-line, of a cord-circuit to connect with its outgoing end and a called-subscriber's line having only two wires extending throughout the multiple switchboard with which its incoming end may be connected, a disconnect-signal for said incoming end, a relay actuated over a portion of the talking-circuit when connection is made with the called line for closing the circuit of said signal at one point, and a trunk-relay at the incoming end of the trunk actuated by current from the cord-circuit when the cord is connected with the trunk to open the circuit of said signal at another point, one terminal of said signal being left free under said latter condition, and a pilot-relay adapted to be actuated in series with said signal, substantially as described.

8. The combination with a trunk-line, of a cord-circuit to connect with its outgoing end, and a called-subscriber's line having only two wires extending throughout the multiple switchboard with which its incoming end may be connected, a disconnect-signal for said incoming end having its circuit closed by current flowing over a portion of the talking-circuit when a trunk is connected with the called line, and means depending upon the connection of the cord with the trunk to again open the circuit of said signal at another point, the contacts in the circuit of said signal being both on the same side of the signal, and a pilot-relay connected in series with a plurality of said signals, substantially as described.

9. The combination with a trunk-line, of a cord-circuit to connect with its outgoing end, and a called-subscriber's line having only two wires extending throughout the multiple switchboard with which its incoming end is connected, a disconnect-signal for the incoming end of the trunk, and a pilot-relay in series with said disconnect-signal, means op-

erated over one side of the talking-circuit to close the circuit of said signal when the trunk is connected with the called line, a trunk-relay also at the incoming end of the trunk actuated when the cord-circuit is connected with the trunk, the said trunk-relay serving to open the circuit of said signal at a second point when the cord is connected with the trunk, and to close the same when the cord-circuit is disconnected therefrom, the contacts of said signal-circuit being both on the same side of the signal, whereby a plurality of said signals associated with different trunk-circuits may be connected in series with said pilot-relay, substantially as described.

10. The combination with a trunk-line, of a cord-circuit to connect with its outgoing end, and a called-subscriber's line with which its incoming end is adapted to be connected, a guard-signal for the incoming end of the trunk, means to close the circuit of said signal by current flowing over the two limbs of the trunk-line in series when the cord-circuit is connected with the trunk, and further means actuated by current sent over a portion of the talking-circuit when the trunk is connected with a called line for opening the circuit of said signal at another point, the said points being located in the signal-circuit on the same side of said signal, and a pilot-relay permanently connected in series with said signal, substantially as described.

11. The combination with a trunk-line, of a cord-circuit to connect with its outgoing end, and a called-subscriber's line with which its incoming end is adapted to be connected, a guard-signal for the incoming end of the trunk, a relay adapted to close the circuit of said signal at one point, and adapted to be actuated over a portion of the talking-circuit when the incoming end of the trunk is connected with the called-subscriber's line, said relay having its coil out of the path of voice-currents, a trunk-relay connected with the outgoing end of the trunk and adapted to be actuated by current flowing over the two limbs of the trunk-line in series when the cord-circuit is connected with the trunk, and adapted to close the circuit of said signal at a second point, and means for actuating said signal when the first-named relay is deenergized and the trunk-relay is energized, the contacts in the circuit of said signal being both on the same side of the signal, and a pilot-relay permanently connected in series with said signal, substantially as described.

Signed by me at Chicago, county of Cook, State of Illinois, this 1st day of July, 1902.

H. G. WEBSTER.

Witnesses:

WM. W. DEAN,
G. BEDER.