June 8, 1937. G. N. SAUL 2,083,404

TELEPHONE SYSTEM

Filed Feb. 28, 1935 4 Sheets-Sheet 1

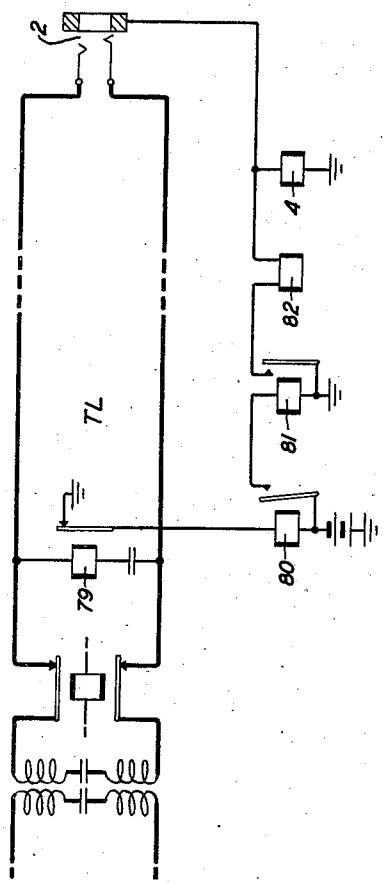

FIG. 1

FIG. 5

FIG. 2	FIG. 3	FIG. 4
FIG. 1		

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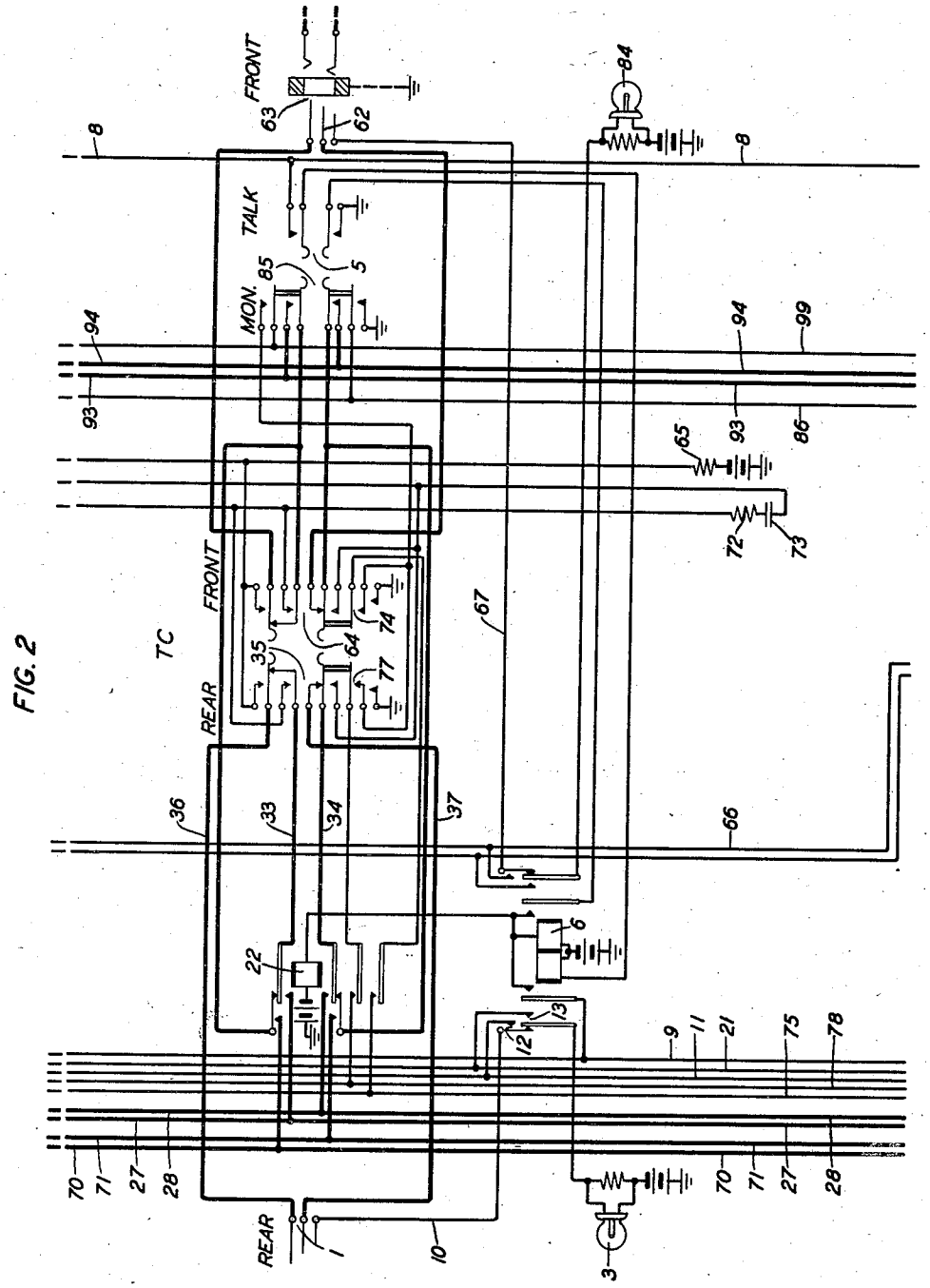

FIG. 2

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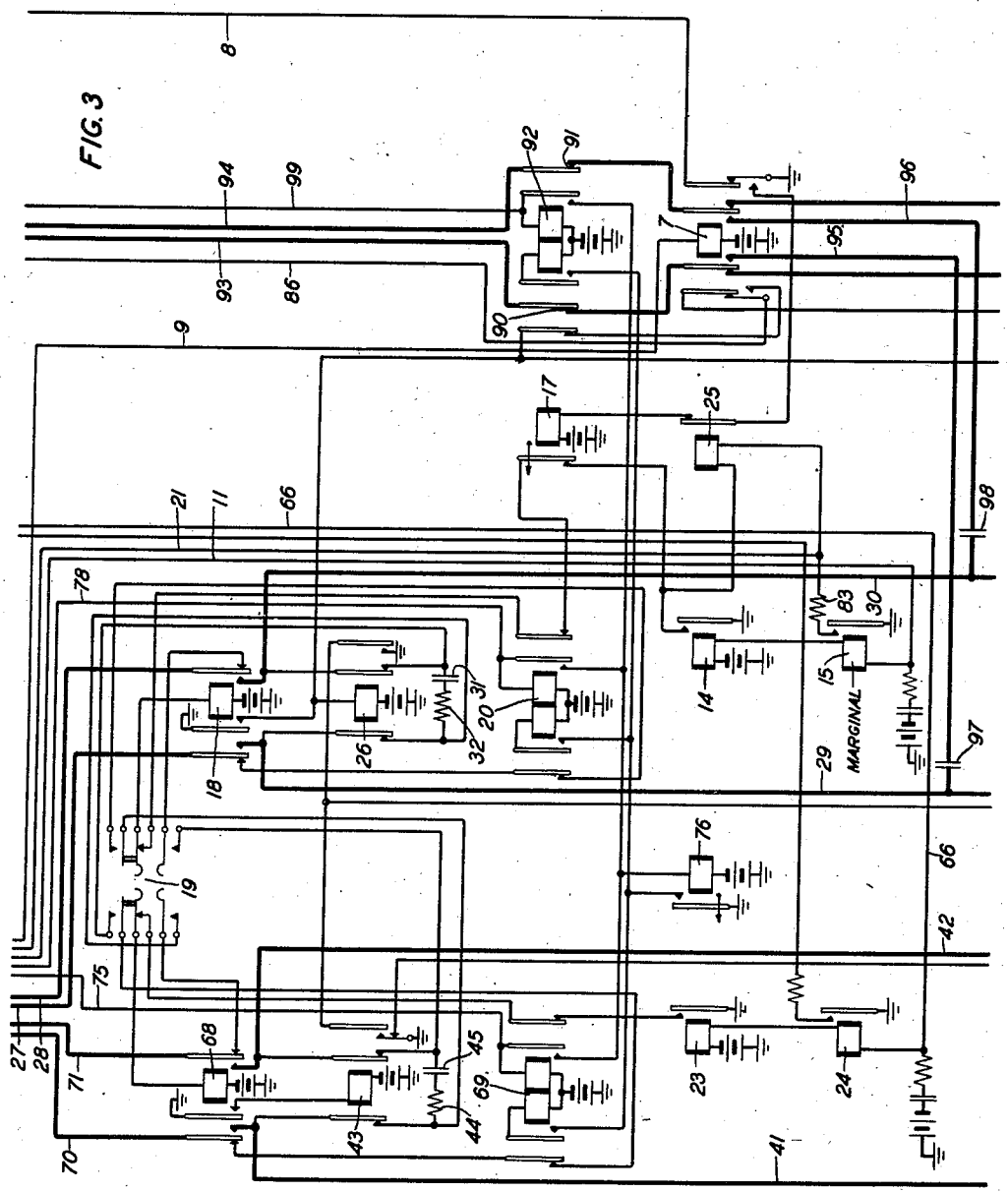
FIG. 3



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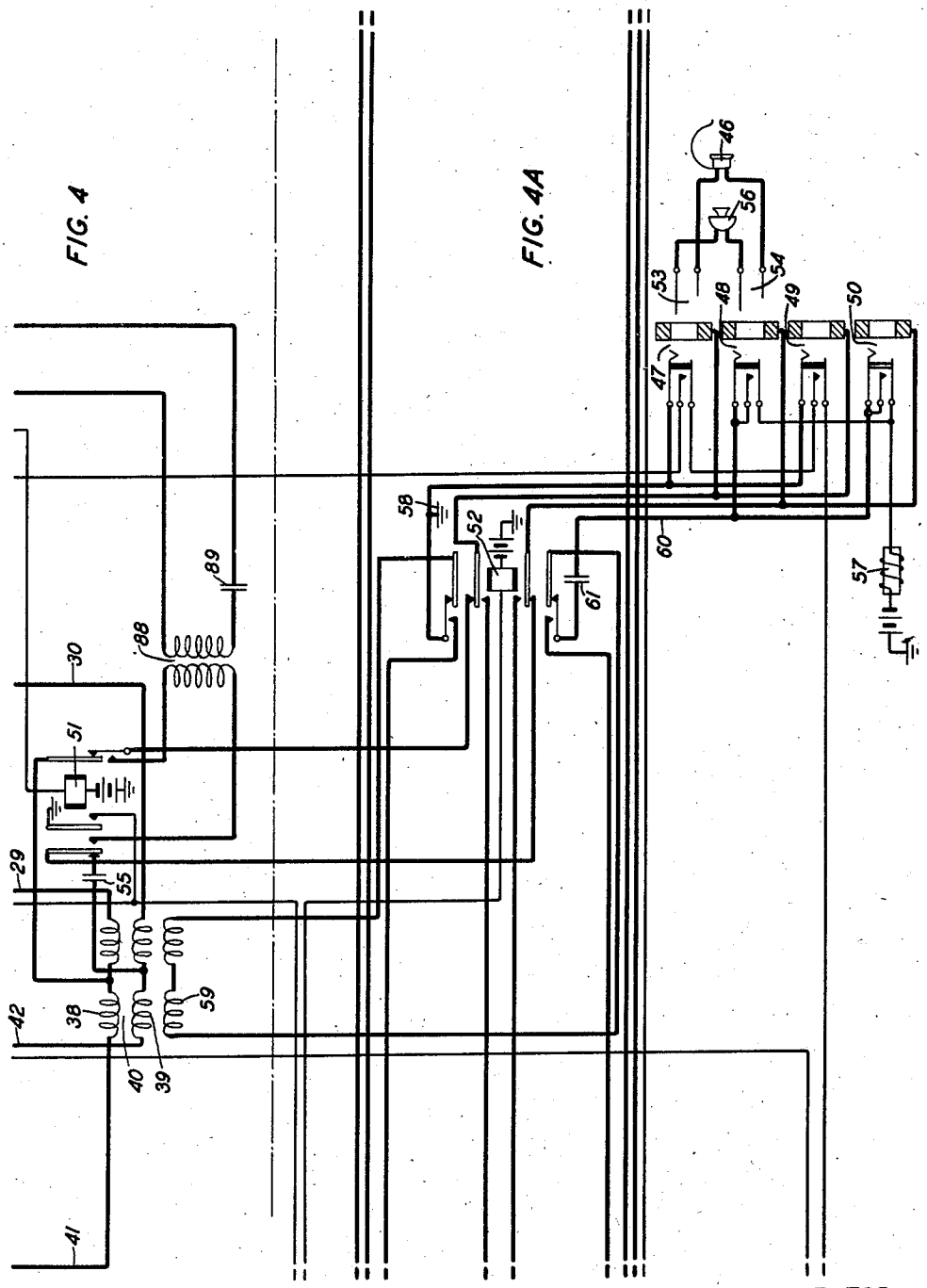
Filed Feb. 28, 1935 4 Sheets-Sheet 4



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Patented June 8, 1937 2,083,404

UNITED STATES PATENT OFFICE

2,083,404

TELEPHONE SYSTEM

George N. Saul, Brooklyn, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application February 28, 1935, Serial No. 8,591

6 Claims. (Cl. 179—43)

This invention relates to telephone systems and more particularly to toll switchboard circuit arrangements. One object of the invention is to prevent annoying clicks in an operator's receiver when she ceases ringing on a called line in case the "talk" key is operated at the time.

Another object is to prevent ringing current incoming over the calling line from entering the answering operator's receiver in case she should insert the answering plug of a cord circuit in the calling line jack while the talking key of that particular cord circuit is operated.

In certain types of switchboard circuits, the operator's telephone set is connected to the cord circuit through what is termed a hybrid repeating coil. Such a hybrid coil arrangement is shown in Fig. 4 of the U. S. patent to Dietze 1,709,900.

In the arrangement embodying the present invention the networks or impedance N_1 and N_2 of Fig. 4 of the above noted Dietze patent are normally connected across the respective ends of the coil and are removed only when the respective ends of the cord circuit are connected to line jacks and the talk key is operated.

With this arrangement it will be evident that when the talk key is normal the repeating coil, with respect to the connected transmitter, is balanced and is what is known as in an "anti-sidetone" condition, i. e. a condition such that sounds affecting the transmitter will cause no corresponding effect in the receiver. At such times it is frequently necessary that a supervising operator, who may have her telephone connected in multiple with the switchboard operator, be able to converse with that operator, which under the condition above described would be impossible.

Another object of the invention therefore is to enable a supervisor to talk with the operator at such times, in systems arranged as above described.

A feature of the invention whereby the first object is attained resides in disconnecting the operator's induction coil from the conductor of the cord over which ringing current is being transmitted, when the ringing key is operated, and delay the reconnection of the cord in that direction for an interval sufficient to allow any remaining charge in the line to dissipate.

Another feature whereby the second object is attained resides in a switching arrangement whereby in case the cord circuit talk key is operated at the time the answering plug of the cord circuit is inserted in the jack of the line over which ringing current is incoming the connection of the operator's induction coil to the cord circuit will be delayed until the incoming ringing current ceases.

Still another feature whereby the last object is attained resides in a switching arrangement whereby when the supervisor connects her telephone set in parallel with the set of the regular operator in case no talk key at the position is operated, a circuit will be established to disconnect one of the bridged networks from across the operator's induction coil, thereby unbalancing the coil and permitting conversation between the two telephone sets.

The invention will be understood from the following description of a toll switchboard in accordance therewith and illustrated by the accompanying drawings Figs. 1 to 4, arranged in accordance with Fig. 5. Fig. 1 shows a portion of an incoming toll line essential to an understanding of the invention; Fig. 2 shows a toll cord circuit TC of the so-called sleeve or third wire control type; Fig. 3 is a so-called position circuit. The cord circuit of Fig. 2 and all other cord circuits of the position are arranged to be connected with Fig. 3. Fig. 4 is an operator's telephone circuit cooperating with the aforesaid cord and position circuits.

Figs. 1, 2 and 3 correspond to and are identical with similarly numbered figures forming a part of the disclosure of a copending application filed in the names of Messrs. G. N. Saul and J. B. Shiel, Serial No. 759,672, filed Dec. 29, 1934, and Fig. 4 corresponds to and is identical with Fig. 5 of the same copending application.

The eleven conductors extending to the left and the five conductors extending to the right of Fig. 4 are not essential to an understanding of the present invention and may be disregarded in the consideration of this application, they being shown for convenience only as they are necessary for an understanding of the before mentioned Saul-Shiel application.

A description of the operation of the switchboard circuits embodying the present invention will now be given. It will be understood that a distant operator has initiated a call on the toll line TL of Fig. 1, which call has been brought to the attention of the toll operator having control of the cord circuit of Fig. 2 by the lighting of the usual line lamp, not shown. The operator now inserts the rear or answering plug 1 of the cord circuit (Fig. 2) into jack 2 of the calling line. The supervisory lamp 3, however, does not light at this time due to the high resistance to ground through sleeve relay 4 of the calling line.

The operator now actuates talking key 5, thereby closing a circuit to operate relay 6 which can be traced from ground at the right-hand outer back contacts of relay 7, over conductor 8, through right-hand upper operated contacts of key 5, and left-hand winding of relay 6 to battery. Relay 6 in operating effects the transfer of certain functional conductors from cord circuit TC to the common position circuit, Fig. 3, by which circuit they are controlled. The control of the before mentioned conductors will be described hereinafter in detail.

When relay 6 operated it closed a circuit for operating relay 7 of Fig. 3, which may be traced from battery through the winding of relay 7, over conductor 9, through left- and right-hand inner operated make contacts of relay 6 to ground on the lower contacts of key 5. Relay 7 in operating removes ground on its right-hand outer back contacts from conductor 8, thereby preventing the operation, in another cord circuit of the position, of another relay corresponding to relay 6, if a talk key 5 of another cord circuit should be operated while key 5 of the cord circuit TC of Fig. 2 is operated. This arrangement is to prevent interference between the various cord circuits due to their use of the common position circuit illustrated by Fig. 3. Relay 6 is held operated through its right-hand winding and right-hand inner contacts to ground on the lower contacts of key 5, after its original operating circuit through its left-hand winding is opened by the operation of relay 7, as hereinbefore described. Relay 6 in operating a disconnects lamp 3, at its left-hand outer back contacts from sleeve conductor 10 and connects said conductor 10 to conductor 11 at its contacts 12, thereby completing a circuit from battery (Fig. 3) through the windings of relays 14 and 15 over conductor 11 to sleeve conductors 10, and thence through sleeve contacts of plug 1 and jack 2 and winding of relay 4 to ground. Relay 14 operates in this circuit, but relay 15 which is marginal does not operate at this time. Relay 14 in operating operates relay 18 through a circuit traceable from battery through the winding of relay 18, right-hand break contacts of splitting key 19 and relay 20, break contacts of relay 17 to ground on the operated contacts of relay 14. Relay 14 in operating also closes a circuit from ground through the winding of relay 25, over conductor 21, through operated contacts 13 of relay 6 to lamp 3 and battery. Lamp 3, however, does not light due to the high resistance of relay 25. Relay 18 in operating operates relay 26 through an obvious circuit, and connects rear tip and ring conductors, 27 and 28, with its operated front contacts to conductors 29 and 30 leading to the operator's telephone circuit of Fig. 4. Relay 26 in operating disconnects conductors 29 and 30 from a balancing termination consisting of the series combination of condenser 31 and resistance 32, the functioning of which termination being hereinafter described.

When relay 6 operated it closed a circuit for operating relay 22, which may be traced from battery through the winding of relay 22, right-hand operated inner make contacts of relay 6 to ground on the lower contacts of talk key 5. Relay 22 in operating connects with its upper and lower inner make contacts talking conductors 27 and 28 to conductors 33 and 34, which connect through the normally closed contacts of ringing key 35 to cord circuit conductors 36 and 37. The toll operator may now converge over the calling line through the tip and ring contacts of plug 1 and jack 2. The aforesaid conductors 29 and 30 connect to the right-hand terminals of winding 38 and 39 of induction coil 40. The left-hand terminals of said windings connect over conductors 31 and 42 through left-hand and right-hand inner break contacts of relay 43 to another balancing termination, consisting of a resistance 44 in series with a condenser 45, and balancing the impedance of the toll line connected to the right-hand terminals of windings 38 and 39. The operator's receiver 46 is connected for conversation to induction coil 40 through a circuit traceable from the middle point of winding 38, right-hand break contacts of relay 51, upper inner break contacts of relay 52, sleeve contacts of jack 47 and plug 53, receiver 46, sleeve contacts of plug 54 and jack 48, lower inner break contacts of relay 52, left-hand outer break contacts of relay 51, condenser 55 to middle of winding 39. The operator's transmitter 56 is energized through a circuit traced from battery through retardation coil 57, operated local contacts and tip contacts of jack 48, tip contacts of plug 54, transmitter 56, tip contacts of plug 53 and jack 47 to ground 58. The voice currents generated by transmitter 56 are conducted to winding 59 of induction coil 40 through a circuit in multiple with the transmitter. This circuit may be followed from conductor 60, through condenser 61, lower outer break contacts of relay 52, winding 59 of induction coil 40, upper outer break contacts of relay 52 to ground 58. The operator's telephone arrangement just described is that of the aforesaid Dietze Patent 1,709,900 and it functions as described in said patent.

The operator having received instructions for completing the call inserts plug 62 of the front cord into jack 63 of the called line. This causes the operation of relay 23 through a circuit that may be traced from battery through the windings of relays 23 and 24, over conductor 66, right-hand outer operated make contacts of relay 6, sleeve conductor 67 and sleeve contacts of plug 62 and jack 63. Relay 24 is marginal and does not operate at this time. The operation of relay 23 operates relay 68, through a circuit traceable from battery through the winding of relay 68, left-hand break contacts of splitting key 19, right-hand outer break contacts of relay 69 to ground on the contacts of relay 23. Relay 68 in operating operates relay 43 through an obvious circuit and connects talking conductors 70 and 71, to conductors 41 and 42, which connect to the induction coil 40 of the operator's telephone circuit, as hereinbefore traced. The aforesaid operation of relay 43 disconnects the hereinbefore mentioned balancing termination consisting of resistance 44 and condenser 45. The operator now actuates front ringing key 64, which connects battery through resistance 65 to the tip conductor of the calling cord through the upper outer make contacts of key 64. This causes an associated ringing circuit, not shown, to function in a well-known manner to connect ringing current to the conductors of the called line.

When ringing key 64 was actuated a circuit was closed for operating relay 69 which may be traced from ground through springs 74 of key 64, lower outer operated contacts of relay 22, over conductor 75, and through right-hand winding of relay 69 to battery. Relay 69 in operating operates slow releasing relay 76 from ground on conductor 75, through right-hand operated inner

contacts of relay 69 and winding of relay 76 to battery. Relay 76 in operating closes a circuit through the left-hand winding of relay 69, left-hand inner operated contacts of relay 69 to ground on the contacts of relay 76.

According to a particular feature of this invention the arrangement described in the preceding paragraph avoids the possibility of the operator receiving disturbing clicks in her receiver from line discharges after the ringing key is restored to normal after ringing. This is accomplished by the slow release characteristics of relay 76, which remains operated for an interval after ground is removed from conductor 75 due to said restoration of ringing key 64. Relay 76 holds relay 69 through its left-hand winding until it finally releases, thereby preventing the immediate reoperation of relay 68 and the consequent immediate reconnection of conductors 70 and 71 to the operator's telephone circuit of Fig. 4. This delay is sufficient to allow the calling line to dissipate the charge due to the ringing current, and disturbing clicks in the operator's receiver are accordingly avoided.

Let it be assumed now that the operator desires to ring on the rear or answering cord. The invention now functions in a manner similar to that described for ringing on the front cord. Ringing key 35 is accordingly actuated and battery through resistance 65 is connected by the upper outer make contacts of key 35 to the tip conductor 36 of toll line TL through the tip contacts of plug 1 and jack 2. This causes the associated ringing circuit, not shown, to function. At the same time key 35 also connects ground through its springs 77, lower middle make contacts of relay 22, over conductor 78 through the right-hand winding of relay 20 to battery. Relay 20 operates and opens the operating circuit of relay 18, which releases. Relay 26 also releases and connects the balancing termination consisting of condenser 31 and resistance 32 to conductors 29 and 30, thereby maintaining the balanced condition of the operator's telephone circuit.

When relay 20 operated it closed a circuit from ground on conductor 78, through its right-hand inner contacts and winding of slow releasing relay 76 to battery. Relay 76 now functions in connection with relay 20 in the same manner as hereinbefore described in connection with ringing on the front or calling cord, so that the line is discharged before the operator's telephone is reconnected following the restoration to normal of the ringing key. Objectionable clicks due to ringing are accordingly avoided.

Let it be assumed now that the distant operator at the end of toll line TL desires to recall the operator having control of cord circuit TC. Ringing current will be transmitted over the line and will operate relay 79, removing ground from its back contacts and causing the release of normally operated relay 80. Relay 80 in releasing operates relay 81 which connects the winding of low resistance relay 82 in multiple with that of high resistance relay 4. This reduces the resistance of the circuit hereinbefore traced through the windings of relays 14 and 15, and marginal relay 15 now operates and connects ground through resistance 83 to conductor 21, shunting the winding of relay 25 thereby causing the lighting of lamp 3 over the circuit before traced. If the distant operator on the called line also desires to signal, a similar reduction in the resistance of the sleeve circuit of jack 63 is effected by circuit arrangements not shown causing the operation of relay 24 and the lighting of lamp 84.

Let it be assumed now that, the conversational connection being established, and all cord circuit keys being normal the operator desires to monitor on the connection. Monitor key 85 will accordingly be actuated and will connect ground through its lower outer make contacts to conductor 86, thence through the left-hand outer break contacts of relay 7 and winding of relay 51 to battery. Relay 51 operates and transfers with its transfer contacts the circuit of the winding of receiver 46 from induction coil 40 to the left-hand winding of monitoring coil 88. The right-hand windings of coil 88 are connected in series with condenser 89, through inner break contacts of relay 7, break contacts 90 and 91 of relay 92, over conductors 93 and 94, and the inner make contacts of monitor key 85 to the talking conductors of the cord circuit. The operator may now listen in on the connection.

If one of the talk keys of a cord circuit are operated, the operator may operate a monitoring key of another cord circuit and monitor on that cord circuit. To describe this condition let it be assumed that the cord circuit whose talk key has been operated has only its front cord plugged up. Under this condition relay 7 is operated, due to the operation of talking key 5, as hereinbefore described. The operation of relay 7 transfers with its transfer contacts, monitoring leads 93 and 94 (connected to the cord circuit of which the monitoring key is operated) to leads 95 and 96, which connect to leads 29 and 30 through condensers 97 and 98. Leads 29 and 30 connect to the right-hand terminals of windings 38 and 39 of induction coil 40. Conductor 86 leading to the winding of monitoring relay 51 is also transferred by the left-hand outer contacts of relay 7 through the left-hand outer break contacts of relay 92 to the winding of relay 26, which operates from ground on said lead 86. The operation of relay 26 disconnects the balancing termination consisting of resistance 32 and condenser 31 from leads 29 and 30. The left-hand terminals of induction coil windings 38 and 39 are connected over leads 41 and 42 and through operated contacts of relay 68 to leads 70 and 71, which connect to the talking conductors of the front cord through the operated contacts of relay 22. The toll operator may now converse and listen on both cord circuits simultaneously. If the rear cord of the cord circuit having the operated talk key 5 is plugged up, relay 26 is already operated when ground is connected to its winding by the operation of the monitoring key 85 of the other cord circuit. The operator may monitor simultaneously on both cords as described before.

The invention was described hereinbefore for the conditions existing when the operator actuated the ringing key 35 or 64 on a cord circuit with the talk key 5 of that cord circuit operated. It will now be described for ringing with only a monitoring key 85 operated. Relay 92 is now operated in a circuit from battery through the right-hand winding of relay 92, over conductor 99, through upper outer contacts of key 85 to ground on the lower, outside operated contacts of front cord ringing key 64, or rear cord key 35. Relay 92 in operating extends through its right-hand, inner operated contacts the ground on conductor 99 to the winding of slow releasing relay 76, which operates and holds relay 92 through its left-hand inner contacts and

winding. Relay 92 in operating opens its break contacts 90 and 91, thereby disconnecting monitoring leads 93 and 94 during ringing. The actuation of either of the aforesaid ringing keys 35 or 64 causes the associated ringing circuit (not shown) to ring on the toll line, and to connect to the line not being called a balancing termination consisting of resistance 72 and condenser 73. After the restoration of the ringing key, relay 92 is held operated for a moment until relay 76 releases, thereby allowing the charge on the line to be dissipated before the monitoring leads 93 and 94 are reconnected to the cord circuit conductors by the release of relay 92.

In the preceding paragraph the ringing function was described with a monitoring key operated on one cord circuit, and no keys operated on any other cord circuit. Let it be assumed now that it is required to ring on a cord circuit whose monitor key is operated, while a talk key of another cord circuit is operated. Under this condition relay 7 is operated as hereinbefore described, and the monitoring leads 93 and 94 are accordingly connected to leads 95 and 96. When relay 92 now operates in response to the actuation of the ringing key 35 or 64, the disconnection of leads 93 and 94 is from leads 95 and 96. In other respects the operation is as described in the preceding paragraph.

If it is desired to ring on a cord circuit with no talk or monitoring keys operated, the actuation of ringing 35 or 64 connects the balancing termination consisting of resistance 72 and condenser 73 to the line that is not being called.

To enable the toll operator to talk on either toll line separately, without being heard on the other line, a splitting key 19 is provided. When the associated key lever is operated to the left, so as to talk on the rear cord exclusively, the operating circuit for relay 68 is opened. Relay 68 in releasing disconnects front cord conductors 70 and 71 from leads 41 and 42 to the operator's telephone circuit, and when relay 43 also obviously releases, the front balancing termination is connected to leads 41 and 42. In order to balance the disconnected line associated with the front cord, the operation of key 19 closes a circuit for connecting the balancing termination consisting of resistance 32 and condenser 31 to the front cord talking conductors 70 and 71. This circuit may be traced from conductor 70, through left-hand outer break contacts of relays 68 and 69, left-hand upper make contacts of key 19, condenser 31, resistance 32, left-hand lower make contacts of key 19, and right-hand break contacts of relay 68, to conductor 71. With this arrangement the operator is enabled to talk on the line associated with the rear cord, without being heard by the line associated with the front cord. In like manner, if splitting key 19 is operated to the right or front position, the operator may converse on the front cord only. In this case relays 18 and 26 release and the termination consisting of resistance 44 and condenser 45 is connected through the contacts of key 19 to the talking conductors 27 and 28 associated with the disconnected rear cord line.

The invention has been described for the usual functions involved in establishing a conversational connection between two toll lines, including ringing, splitting and supervision, and the operation of the operator's telephone circuit for talking and monitoring. It will now be described for certain additional features, to which it is desired that special attention be given.

Let it be assumed now that the toll operator in control of cord circuit TC (Fig. 2) has observed the actuation of the line signal (not shown) associated with toll line TL (Fig. 1) and operates her talk key 5 before inserting plug 1 into jack 2. Without the particular features of this invention, which will now be described, it is to be expected that the operator will frequently hear in her receiver disturbing clicks due to the ringing current still connected to the toll line at the time of plugging in. Due to the operation of talk key 5 relay 7 is operated as before described. Slow release relay 17 operates through a circuit traceable from battery through the winding of relay 17, break contacts of relay 25 to ground on the right-hand outer operated contacts of relay 7. Relay 17 in operating opens with its break contacts the operating circuit for relay 18. When plug 1 is inserted into jack 2, if ringing relay 79 is operated the sleeve resistance of jack 2 will be low and both relays 14 and 15 will operate. Under this condition relay 25 cannot operate due to the shunting effect of resistance 83 connected to ground to the contacts of relay 15. Relay 17 accordingly remains operated and keeps open the operating circuit of relay 18, which in not operating does not connect talking conductors 27 and 28 to the operator's telephone circuit. Accordingly ringing current is kept out of the operator's receiver. When, however, ringing current ceases, relay 15 releases, removing shunt 83 and relay 25 operates, through a circuit from battery through lamp 3, operated contacts 13 of relay 6, over conductor 21, through winding of relay 25 to ground on the operated contacts of relay 14. Relay 25 in operating releases relay 17, which closes the circuit of relay 18 which operates, and connects leads 27 and 28 to the operator's telephone circuit, thereby enabling the operator to converse on the calling line.

Another feature of the invention will now be described whereby an arrangement is provided to enable a supervisor to communicate with the toll operator by plugging in her telephone set in multiple with that of the operator when the cord circuit talk keys are normal. As hereinbefore described, the operator's telephone circuit, when no talk key is operated, is balanced by the connection of a termination consisting of resistance 44 and condenser 45 to the left-hand terminals of windings 38 and 39 of induction coil 40, and of a termination consisting of resistance 32 and condenser 31 to the corresponding right-hand terminals of said winding. Under this balanced condition a telephone set in multiple with that of the toll operator would be ineffective due to the anti-sidetone condition. When however, a supervisor plugs into jacks 49 and 50 with a telephone set, not shown, but identical with that consisting of receiver 46 and transmitter 56 this invention provides an arrangement whereby the aforementioned balanced condition is removed, enabling supervisor and operator to converse. When plugs are inserted into jacks 47 and 49 a circuit is closed for operating relay 26, which may be traced from battery through the winding of relay 26, operated local contacts of jacks 47 and 49, over normally closed contacts of a grouping key shown in Fig. 5 of the before-mentioned copending application of Saul and Shiel, Serial No. 759,672, filed December 29, 1934, and designated by the reference numeral 1, to ground on the right-hand outer back contacts of relay 43. Relay 26 in operating disconnects the aforementioned balancing termination consisting of re-

sistance **32** and condenser **31**, and accordingly, due to the unbalance resulting, the anti-side condition is removed and supervisor and operator may converse. If the operator should now operate the talk key **5** of a cord circuit and insert plug **62** into jack **63**, relay **43** would operate as before described, releasing relay **26**, which would reconnect the rear termination consisting of said resistance **32** and condenser **31**, reestablishing the normal anti-sidetone condition.

What is claimed is:

1. In a telephone system, a link circuit, an operator's telephone circuit including a transformer having two windings, means for serially connecting each winding in a different conductor of said link, an impedance network normally connected across both corresponding ends of the two windings, an operator's receiver connected between intermediate points of the two windings, a second receiver, means for connecting the second receiver in multiple with the operator's receiver, and means responsive to the connection of said receivers in multiples to disconnect one of said networks from the transformer.

2. In an operator's telephone circuit, a hybrid induction coil, a transmitter and receiver connected thereto, said coil being normally so balanced with respect to the connected transmitter and receiver that sounds affecting the transmitter cause no corresponding effect in the receiver, a second transmitter and receiver, means for connecting the second transmitter and receiver to the induction coil in multiple with the first transmitter and receiver, and means responsive to said multiple connection to unbalance said coil.

3. In a telephone system, an operator's cord circuit, a line connected thereto, an operator's telephone circuit connected to the cord circuit, a source of ringing current, ringing means for connecting said source to the cord and then to the line, means responsive to the actuation of said ringing means for disconnecting said operator's telephone circuit from the cord, and other means for delaying the reconnection of said telephone circuit to the cord for a predetermined interval after said ringing current has been disconnected.

4. In a telephone system, an operator's cord circuit, a line connected thereto, an operator's telephone circuit connected to the cord circuit, a source of ringing current, ringing means for connecting said ringing current to said cord and then to said line, means actuated when said ringing current is connected to the cord to disconnect said operator's telephone circuit from the cord, and means for delaying the reconnection of said telephone circuit to the cord for a predetermined interval after said ringing current has been disconnected.

5. In a telephone system, an operator's cord circuit, a line connected thereto, an operator's telephone circuit connected to the cord circuit, a source of ringing current, means associated with the cord circuit for causing said source of ringing current to be connected to the line, means responsive to the actuation of said ringing means for disconnecting said operator's telephone circuit from the cord, and other means for delaying the reconnection of said telephone circuit to the cord for a predetermined interval after said ringing current has been disconnected.

6. In an operator's telephone circuit, a hybrid induction coil, a transmitter and receiver connected thereto, a balancing impedance connected to one terminal end of said induction coil, a balancing impedance connected to the other terminal end of said induction coil, the connection of said balancing impedances causing said induction coil to be so balanced that sounds affecting the transmitter cause no corresponding effect in the receiver, a second transmitter and receiver, means for connecting the second transmitter and receiver to the induction coil in multiple with the first transmitter and receiver, and means responsive to said multiple connection for disconnecting one of said balancing impedances so that said induction coil is thereby unbalanced and sounds affecting either or both of said transmitters are reproduced in both of said receivers.

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