

Feb. 22, 1944.

G. KINER

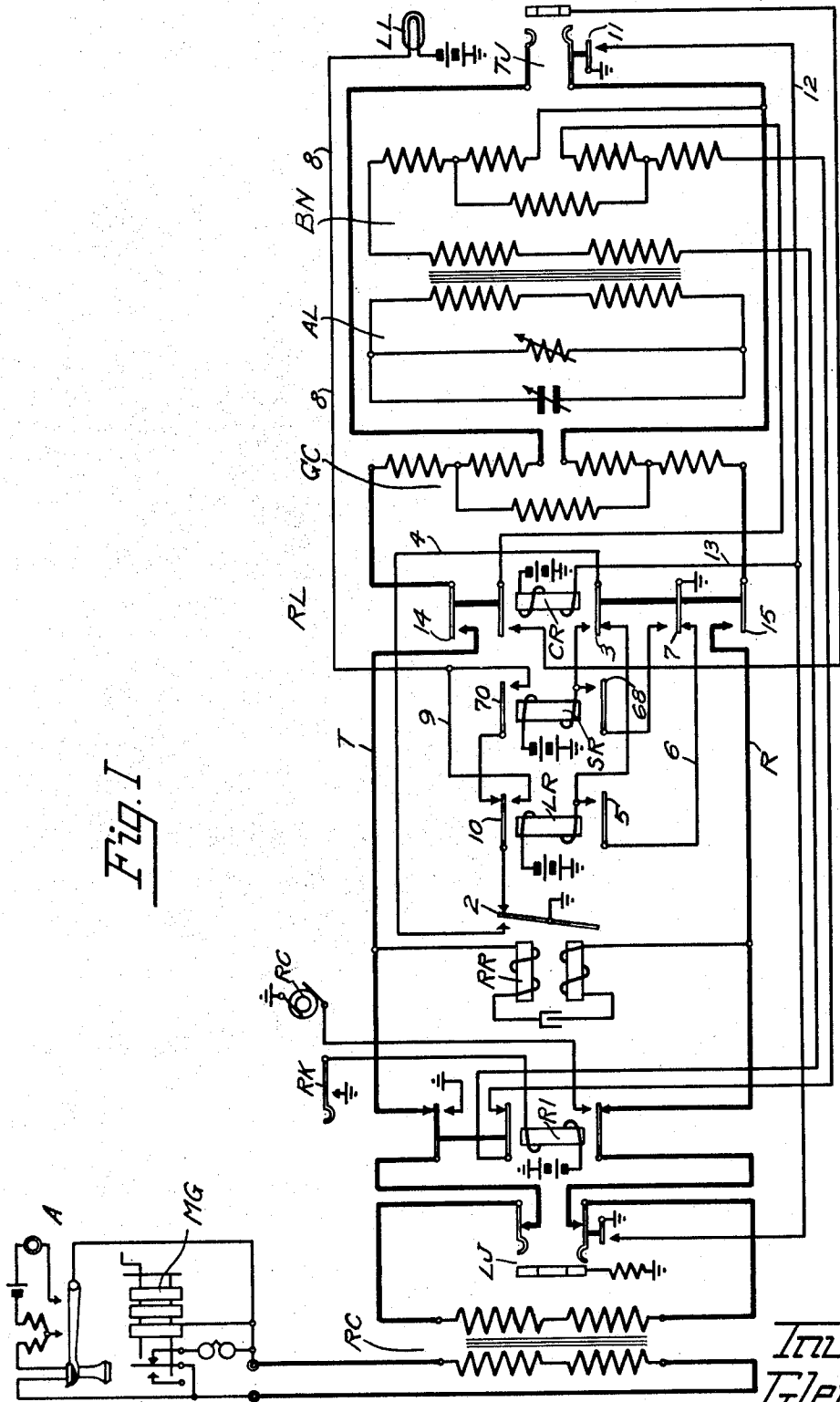
2,342,586

REPEATER SYSTEM

Filed May 5, 1941

3 Sheets-Sheet 1

Fig. 1



Inventor:
Glenn Kiner.
By C. P. Soper
Att'y

Feb. 22, 1944.

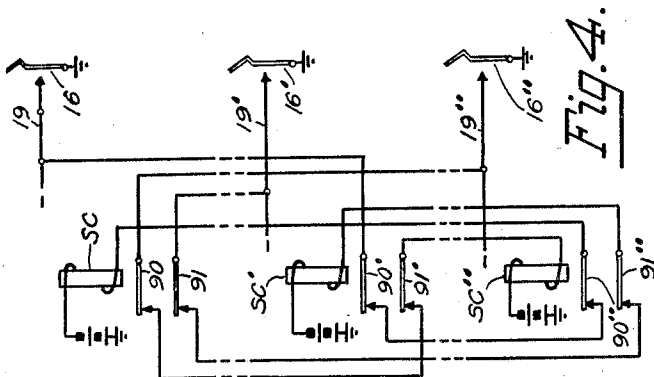
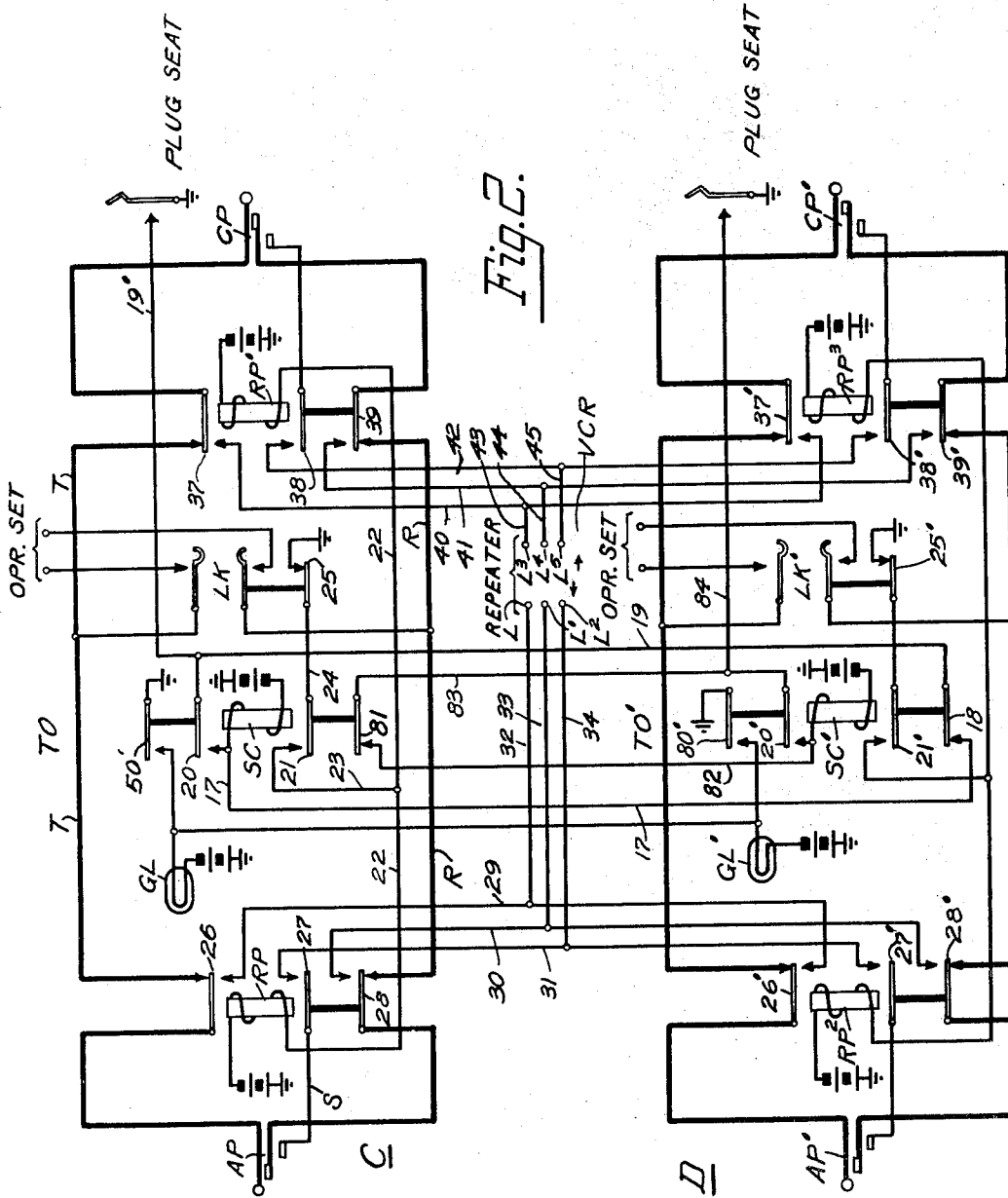
G. KINER

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REPEATER SYSTEM

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3 Sheets-Sheet 2



INVENTOR:
Glenn Kiner.
By *CPS*
Att'y

Feb. 22, 1944.

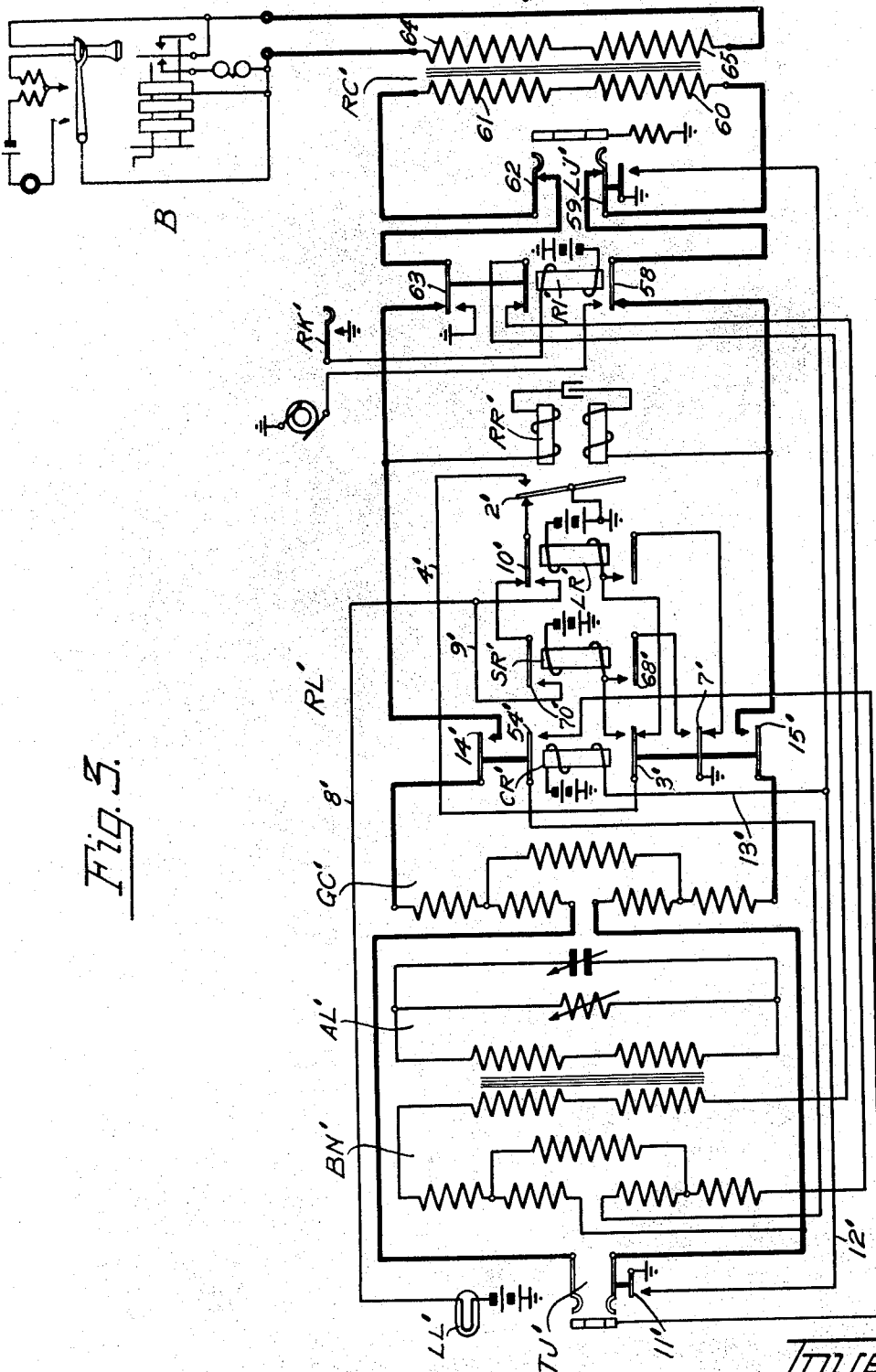
G. KINER

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REPEATER SYSTEM

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3 Sheets-Sheet 3



Inventor:
Glenn Kiner.
By C. S. Soper
Att'y.

UNITED STATES PATENT OFFICE

2,342,586

REPEATER SYSTEM

Glenn Kiner, Markham, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill., a corporation of Illinois

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9 Claims. (Cl. 179-41)

This invention relates in general to telephone systems and more particularly to a voice current repeater system for the interconnection of long distance lines.

One object of this invention is to provide for the more efficient and economical use of voice current repeaters. Specifically the object is to provide means whereby a voice current repeater which is common to a group of link circuits may, if idle, be automatically included in any one of the several link circuits incident to the normal use of the latter, which link circuits may be located at one or different operators' positions; and the further provision of means operative while the said repeater is in use to render it temporarily individual to such link circuit. A further object is to provide a repeater available to several cords which while in use will provide secret service on the connection, but which when released from use, is automatically interposed into another corresponding busy cord connection.

One feature of the invention is the provision of guard signals which are operated at the several positions where the cords are located when the repeater is cut into a toll connection by one operator, to warn the operators at other positions that the common repeater is already in use.

The foregoing features, and others not specifically pointed out, will be better understood from the following description taken in connection with the accompanying drawings wherein

Fig. 1 illustrates a circuit arrangement of a repeater toll line circuit of this invention;

Fig. 2 shows a repeater cord circuit having two connecting cords;

Fig. 3 shows another repeater toll line circuit; and

Fig. 4 shows schematically the application of the invention to three positions, with most of the cord circuit omitted.

General operation

Considering the drawings generally, in Fig. 1 a toll substation A is connected through a repeating coil RC to a repeater line circuit RL which latter terminates at a toll operator's position at a distant exchange, in a local jack LJ, and a repeater jack TJ. The local jack permits the operator to answer a call signal, and the repeater jack permits a voice current repeater connection between lines. The toll line circuit also includes a ringing relay RI which, when operated by the actuation of the ringing key RK, connects ringing current from a suitable ringing current source RC, to the lines of station A to call the latter.

When station A is calling, a ring-up relay RR is operated by the ringing current and operates the line relay LR. The line relay, in turn, closes a circuit to actuate the line signal LL, and lock up. A supervisory relay SR controls the signal LL to give the operator a disconnect or recall signal. A connecting relay CR is provided which controls the effacement of the line lamp signal LL, completes the continuity of the tip and ring conductors T and R, and also connects the attenuation control pad GC, and the artificial line AL of the balance network BN into the circuit.

In Fig. 2, a repeater cord circuit is illustrated having a common two-way voice current repeater VCR, and at least two cords TO and TO' at the same or different toll operators' positions. The cords TO and TO' comprise, respectively, answering plugs and calling plugs AP and CP, at position C, and AP' and CP' at position D, repeater connecting control relays SC and SC', and repeater connecting relays RP and RP', and RP² and RP³. Plug seat switches PS and PS' associated with the calling plugs CP and CP' of the cords are included in the circuits, respectively, of the repeater connecting control relays SC and SC'. Guard lamps GL and GL' of the cords give visual indication to the operators when the two-way voice current repeater VCR having the terminals L, L', L² and L³, L⁴, L⁵ is being used in a connection between a calling and a called toll line. The voice current repeaters and the repeater line circuits, may be of any well-known type as, for example, those shown in U. S. Patent No. 2,050,292, issued to George R. Eaton. Listening keys LK and LK', associated with the respective cords, when actuated, connect the operators' sets to the cord conductors, and remove ground from the circuit of the respective repeater connecting relays.

In Fig. 3, is shown another repeater line circuit RL', for the called toll substation B, extending through repeating coil RC' to a toll position at an exchange and terminates in a local jack LJ', and a repeater jack TJ'. This line circuit is similar to that in Fig. 1. Further description is not believed necessary. Like apparatus in the two figures are indicated by corresponding reference characters.

Detail operation

Having described, in general, the apparatus of this invention, a more detailed description of operation will now be given by tracing the operation of the circuits in establishing a connection

between a calling toll substation A and a called toll substation B.

The subscriber at the toll substation A, initiates a call by operating the hand generator MG and ringing current therefrom flows through the repeating coil RC of the line circuit to temporarily operate the ring-up relay RR. The closing of the front contact by armature 2 of this relay completes an operating circuit for line relay LR. The line relay circuit extends from grounded battery through the winding of relay LR, back contact and armature 3 of connecting relay CR, conductor 4, to ground at front contact and armature 2 of relay RR. Upon the termination of ringing current, relay RR restores and opens the energizing circuit of the line relay. In restoring, its armature 2 completes a circuit for the line signal LL through armature 10 and front contact of the line relay LR, and over conductors 9 and 8. The line relay LR operates and locks through its front contact and armature 5 over conductor 6, to ground through back contact and armature 7 of the relay CR.

The line lamp LL is lighted at toll position C in the exchange, and the toll operator noting the display on indicator LL, inserts an answering plug of an ordinary cord (not shown) into the calling line local jack LJ. Upon being informed that the called party is located at the toll substation B, the operator withdraws the plug from the local jack LJ and inserts the answering plug AP of a repeater cord circuit TO into the repeater jack TJ. The insertion of the plug AP into the jack TJ closes the normally open contact 11 of the latter which completes a circuit for the connect relay CR over conductors 12 and 13. The operation of relay CR moves its armature 3 to break the locking circuit of line relay LR, and prepares a circuit for relay SR. The line relay restores its armature 10 and effaces the line signal LL.

The operator may now actuate the listening key LK to connect the operator's set to the tip and ring conductors T and R of the cord TO and converse with the subscriber at A. The closure of front contact and armature 14 and the closure of front contact and armature 15 of relay CR completed the continuity of the tip and ring conductors T and R. Relay CR also connects the gain control pad GC and the balance network BN into the circuit. Assuming that the wanted party is the toll subscriber at the substation B (Fig. 3), the operator now releases listening key LK and inserts the calling plug CP of repeater cord circuit TO into the repeater jack TJ' of the called line.

The plug seat switch PS (associated with the calling plug CP) is operated by removal of the plug from its seat and permits the normally open spring contact 16 to close and establish a circuit for the repeater switching control relay SC, from battery through its own winding, conductor 17, back contact and armature 18 of the repeater switching control relay SC' (of the cord circuit TO' at position D), conductors 19 and 19', to ground at closed contact 16 of the plug switch. Relay SC operates and locks through its front contact and armature 20, over conductor 19', to ground at the closed contact 16 of the plug switch PS. The circuits of the repeater connecting relays RP and RP' are in parallel and traced from battery through their respective windings, conductors 22 and 23, front contact and armature 21 of the relay SC, conductor 24,

to ground at normally closed contact 25 of the operator's listening key LK. The relays RP and RP' operate. The closing by armatures 26, 27 and 28 of the front contacts of relay RP connects the tip, ring, and sleeve conductors T, R, and S of the answering end of the cord or link circuit TO by way of conductors 29, 30, 31; and 32, 33, and 34 to the repeater terminals L, L', and L². The closing by armatures 37, 38, and 39 of the front contacts of relay RP', (associated with the calling end of the cord TO) connects the respective tip, ring, and sleeve conductors T, R, and S at the calling end of the cord TO over conductors 40, 41, 42; and 43, 44, and 45 to the terminals L³, L⁴, and L⁵ at the other side of the voice current repeater.

The insertion of the calling plug CP into the trunk jack TJ' of the repeater line circuit RL', (Fig. 3) closes an energizing circuit for the connect relay CR' which operates from battery through its own winding, conductors 13' and 12', to ground at the now-closed contact 11' of the jack TJ'. The closing of front contacts on relay CR', by armatures 14', 15' and 54', connects the attenuation control pad GC' and the balance network BN' into the talking circuit of the repeater line of station B. The closing by armatures 3' of front contact on relay CR' prepares a circuit for the supervisory relay SR' which will be operated, when a disconnect or recall signal is received from the called toll line B.

The operator now signals the called station B by operating the ringing key RK' associated with the line circuit RL'. The closing of its normally open contact completes a circuit for the ringing relay RI'. Ringing current from ringing source RG' flows through front contact and armature 58 of relay RI', normal contact 59 of the local jack LJ', windings 60 and 61 of the repeating coil RC', normal contact 62 of the local jack, to ground at front contact and armature 63 of the relay RI'. Ringing current induced in the windings 64 and 65 of the repeating coil RC' actuates the signal at the called substation B. The operator may monitor the call in the usual manner. The talking circuit, when the subscriber at B answers, is traced over the T and R conductors which include the connected voice current repeater.

Upon conclusion of conversation, the subscriber at the calling toll substation A restores the receiver and actuates the hand generator MG to again operate the ring-up relay RR of the line circuit RL. The closing of its front contact by armature 2 of relay RR completes a circuit for the supervisory relay SR through front contact and armature 3 of relay CR. The relay SR operates and locks from battery through its own winding, its front contact and armature 68, to ground at front contact and armature 7 of relay CR. At the conclusion of signal current, relay RR restores, closing at its back contact by armature 2 a circuit for the combined disconnect and line signal means LL, from battery through LL, conductor 8, front contact and armature 70 of relay SR, back contact and armature 10 of relay LR, to ground at back contact and armature 2 of relay RR. The signal LL indicates that conversation is terminated.

The party at the called toll substation B, upon completion of conversation, operates hand generator MG' to actuate the ring-up relay RR' of the repeater line circuit RL'. The closing of its front contact by armature 2' closes the circuit for the supervisory relay SR' from battery through winding of relay SR' front contact and armature 3'

of relay CR', conductor 4', to ground at front contact and armature 2' of relay RR'. Relay SR' operates and locks through its front contact and armature 68', to ground, at front contact and armature 1' of relay CR'. The cessation of ringing current from the toll substation B releases relay RR' which restores, and again closes its back contact by armature 2'. It thereupon lights the disconnect signal LL' of the line circuit RL', from battery through the lamp LL', conductors 8' and 9', front contact and armature 10' of relay SR', back contact and armature 10' of relay LR', to ground, at back contact and restored armature 2' of the relay RR'.

The operator noting the disconnect signals LL and LL', removes the plugs AP and CP from the respective jacks TJ and TJ'. The restoration of the plug CP upon its plug switch PS again opens contact 16 to interrupt the locking circuit of the relay SC of the cord TO. Relay SC restores and releases armature 21 from its front contact which restores relays RP and RP'. The opening of armatures 26, 27, and 28 from their front contacts, and armatures 37, 38, and 39 from the front contacts of the respective relays RP and RP', disconnects the two-way voice current repeater from the cord TO and permits its use for establishing other repeater connections.

Whenever the repeater is in use, suitable guard lamps GL and GL' warn the operators that it is not available for use. The energization, as before described, of the repeater switching control relay SC of the toll operator's cord TO, closed its front contact by armature 50 and connected ground to the guard lamp circuit.

Assuming now, however, that the toll operator at the position D ignores the lighted lamp GL' at her position and attempts to establish a connection with the repeater, the removal of the calling plug CP' from its plug seat brings about the closing of the normally open contact 16' of plug switch PS', but this ground does not complete an energizing circuit for the relay SC' (of the cord TO' of the toll position D) because the initial energizing circuit of this relay is interrupted at the back contact and armature 81 of the relay SC (of the cord TO at the position C). Relay SC' does not operate and front contact and armature 21' remain open. Relays RP² and RP³ of the cord TO consequently cannot operate to close the circuits to the respective repeater terminals L, L', L², and L³, L⁴, L⁵.

The cord, however, at this time may be used to complete a non-repeater type connection if traffic requires its use even though the repeater is not immediately available. In such a case, the connection is directly through the T, R, and S conductors of the cord. The operation of plug switch 16', however, prepared a circuit for the repeater switching relay SC' so that if the repeater is released at position C, upon termination of a call thereat, it will be automatically connected into the cord circuit at position D to improve the conversational characteristics of the latter circuit, provided, of course, that the connection is continuing. As soon as armature 81 closes its back contact, the circuit of relay SC' is completed. It then operates and in turn completes the circuits of relays RP² and RP³. These relays automatically connect the repeater to the circuit at their front contacts by respective armatures 26', 27' and 28', and also armatures 37', 38', and 39'.

Now, if the operator at the toll position D had established the first connection, i. e., between the

calling toll substation A and the called toll substation B, then the energizing circuit of relay SC' (of the cord TO') extended from battery through the winding of relay SC', conductor 82, back contact and armature 81 of relay SC (of cord CO at position C), conductors 83 and 84, to ground at the closed contact 16' of the actuated plug switch PS'. Relay SC' would operate and lock to ground at closed plug switch contact 16', by armature 20' engaging its front contact. Relay SC' also completes energizing circuits for the relays RP² and RP³ from the ground at back contact and armature 25' of the operator's key LK', through front contact and armature 21'. The closing by armatures 26', 27', and 28' of front contacts of relay RP² and by armatures 37', 38', 39' of front contacts of relay RP³ connects the tip, ring, and sleeve conductors of the cord TO' to the respective terminals L, L', L², and L³, L⁴, L⁵ of the repeater via conductors 29, 30, 31, 32, 33, 34 and conductors 40, 41, 42, 43, 44, 45. The closing of front contact by armature 80' of relay SC' completes the multiple circuit of the guard lamps GL and GL' for the toll positions C and D.

Now, if the toll operator at position C, attempts to make a connection which would include the repeater, a non-repeater type toll cord connection may be established, but the repeater cannot be included in the circuit. The initial energizing circuit of relay SC (of the cord TO) is held open at back contact 18 of energized relay SC'. Hence, relay SC cannot operate and its open front contact and armature 21 prevents the energizing of relays RP and RP'. Relays RP and RP' remain normal, thus a second toll operator cannot intrude on the established connection. It is, therefore, seen that although the common repeater is available to a group of at least two toll operators' cords for connection in the toll cord circuits, when a connection has been made by the calling plug at one position, all other cords of the common group are precluded from either using the repeater or interfering with its use in an existing connection.

In Fig. 4, a schematic wiring diagram shows the adaptation of the invention to three cords having a repeater circuit common thereto. Of course, each of the positions may have additional cord circuits, having a common repeater available for connection. Although each repeater can only be used in only one cord connection at a time, it may automatically be placed in another busy cord when released from a prior connection.

Where more than two cords are common to a repeater, additional contacts are needed on the SC relays, so that the energizing circuit of each relay is under the control of contacts on each of the others of the common group of cord circuits. For example, relay SC in Fig. 4 has its energizing circuit extending through back contact and armature 90'' of relay SC''; back contact and armature 90' of relay SC'; and conductor 19; to ground through normally open contact 16 of plug switch E. Similarly, relay SC' has its winding in series with back contact and armature 91'' of relay SC''; back contact and armature 91' of relay SC; conductor 19', normally open contact 16' of relay switch F, to ground. Relay SC'' has its winding in the circuit of back contact and armature 91' of relay SC'; back contact and armature 90 of relay SC; conductor 19'', to ground through normally open contact 16'' of plug switch G. The operation of the cord circuit in other respects is the same as previously described.

Let us assume that we have three toll operators' positions, three repeater cords at each position and three repeaters, each of which may be employed with any one of three cords, one at each position. In such an arrangement, all three repeaters could be employed with the three cords at any one of the positions, or two of the repeaters could be employed with two cords at one position and the other repeater with a cord at either of the other positions. In other words, the repeaters may be used at whichever positions the varying traffic requirements dictate.

A system of the type herein described is useful for private telephone systems such as used by oil companies, railroads, etc., where the normal traffic does not warrant the cost of many expensive repeaters, but where occasional emergency traffic conditions may warrant conversational connections omitting a repeater; or at least temporarily omitting the repeater for a part of a conversation.

Although a preferred embodiment of this invention is illustrated and described, variations in the details are contemplated and the invention should be limited only by the scope of the appended claims.

What is claimed is:

1. In a telephone system, a repeater circuit comprising a voice current repeater, two or more cords arranged to separately include said repeater serially in their respective circuits, and relay means actuated by setting up a connection with one of said cords to seize said repeater, if idle, and connect it into the used cord, and means to prevent disturbing the connection by the use of another of said cords.

2. In a telephone system, a plurality of connecting links, a two-way repeater, means for connecting said repeater, if idle, to any one of said links taken for use, means permitting the use of a second one of said links in establishing a connection exclusive of said repeater, and means for automatically connecting said repeater to said second one of said links incident to disestablishing the connection through the first-mentioned link.

3. A telephone system including two or more cords, a voice current repeater common to said cords and adapted to be connected in any one of said cords one at a time, a switching control relay for each cord, a plug seat switch at the calling end of each cord, an energizing circuit for each control relay extending through the plug switch of its respective cord and through normal contacts on the control relays of all other of said cords, repeater connecting relays for each cord arranged to connect said repeater therein, the operation of each control relay being arranged to energize the repeater connecting relays of its cord, to lock itself through said plug switch, and to open the energizing circuit of the control relays of each of the other cords.

4. In a telephone system, a plurality of connecting links, a two-way repeater arranged for use individually with any of said links, means for automatically including said repeater in the first established link connection and to render said repeater individual to said connection dur-

ing the continuance thereof, means whereby other links may be employed to establish connections, exclusive of said repeater, during the continuance of the connection first established, and means whereby, upon the termination of a connection in which said repeater is included, said repeater will be automatically transferred into another one of said existing connections one at a time, so long as any of said links continue in use.

5. In a telephone system, a plurality of links, a two-way repeater common to said links, means for automatically including said repeater in a link connection and for rendering it individual to said connection, means for establishing non-repeater type connections through any or all of the other links, and means to automatically transfer said repeater from a terminated link connection to another continuing link connection until all of the link connections have been terminated.

6. In a telephone system, links, switching means enabling talking connections to be set up through said links respectively, a voice current repeater common to said links, the terminal conductors of said repeater being multiplied to open contacts at each of said links, relay means in each link operable incidental to the setting up of a connection therethrough for splitting the link and for closing said open contacts to insert said repeater into the link, and interlocking circuit connections between the relay means of the links effective to prevent the insertion of said repeater into more than one link at a time.

7. In a telephone system, links, switching means enabling talking connections to be set up through said links respectively, a voice current repeater common to said links, the terminal conductors of said repeater being multiplied to open contacts at each of said links, and means in each link operable incidental to the setting up of a connection therethrough for splitting the link and for closing said open contacts to insert said repeater into the link.

8. In a telephone system, links, switching means enabling talking connections to be set up through said links respectively, a voice current repeater common to said links, the terminal conductors of said repeater being multiplied to open contacts at each of said links, and means in each link for splitting the link and for closing said open contacts to insert said repeater into the link, whereby the repeater may be used in a connection set up through any one of said links.

9. In a telephone system, links, switching means enabling talking connections to be set up through said links respectively, a voice current repeater common to said links, the terminal conductors of said repeater being multiplied to open contacts at each of said links, means in each link for splitting the link and for closing said open contacts to insert said repeater into the link, whereby the repeater may be used in a connection set up through any one of said links, and interlocking means effective to prevent said repeater from being inserted into more than one of said links at a time.

GLENN KINER.