Jan. 22, 1929. 1,699,774

J. I. BELLAMY

RINGING CURRENT REPEATER

Filed Dec. 9, 1926 2 Sheets-Sheet 1

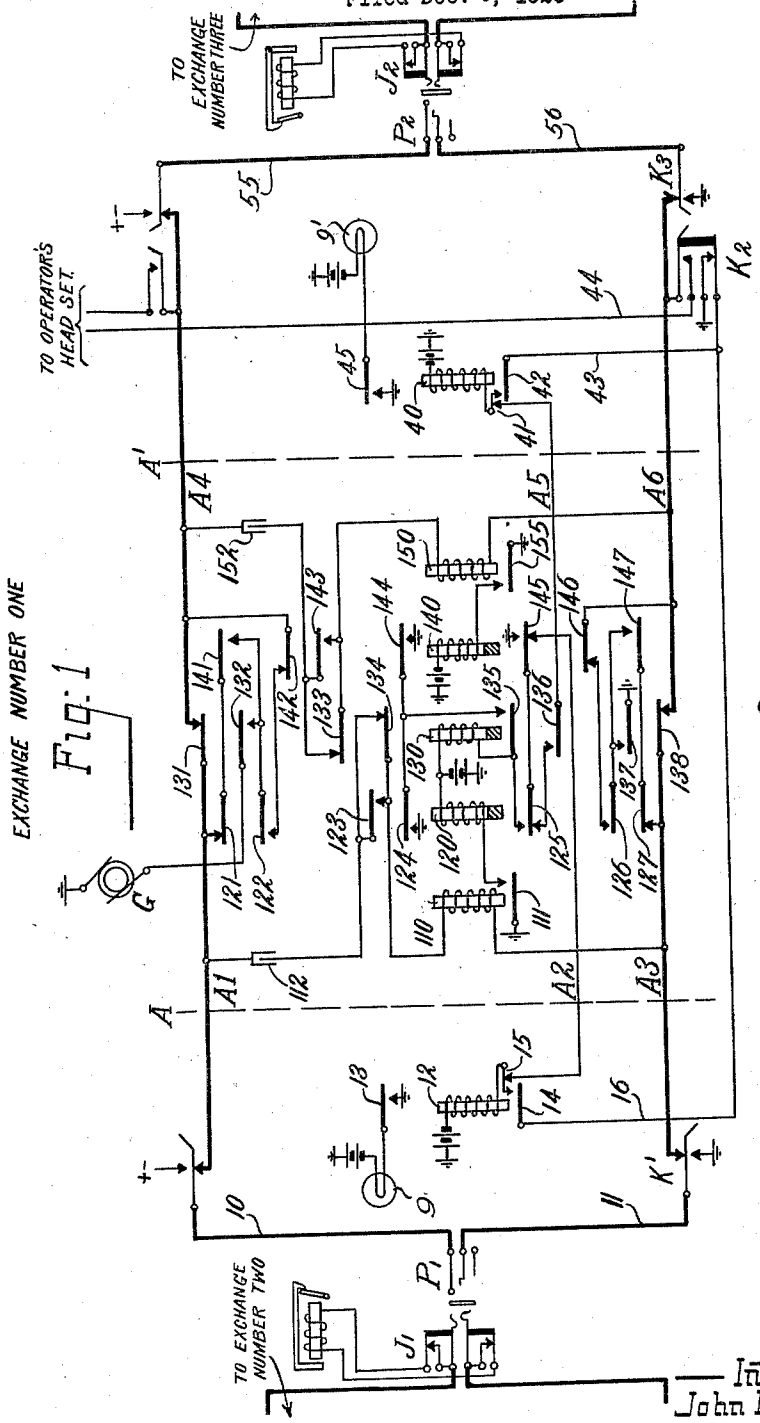


Fig. 1

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Fig: 2

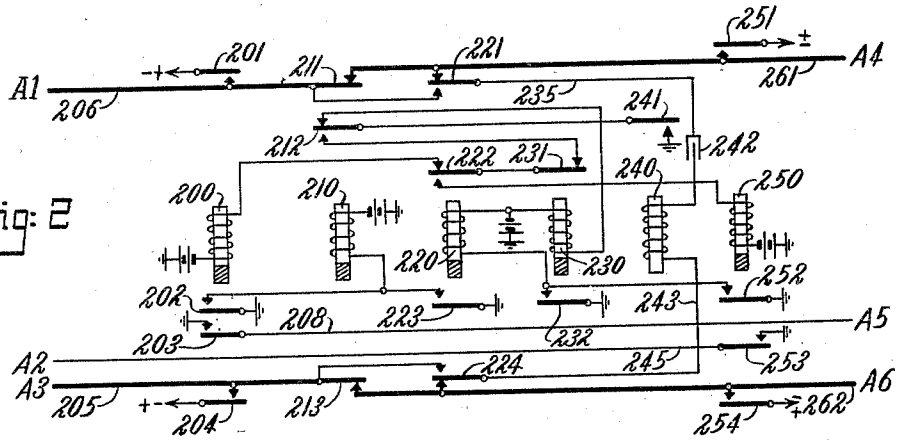


Fig: 3

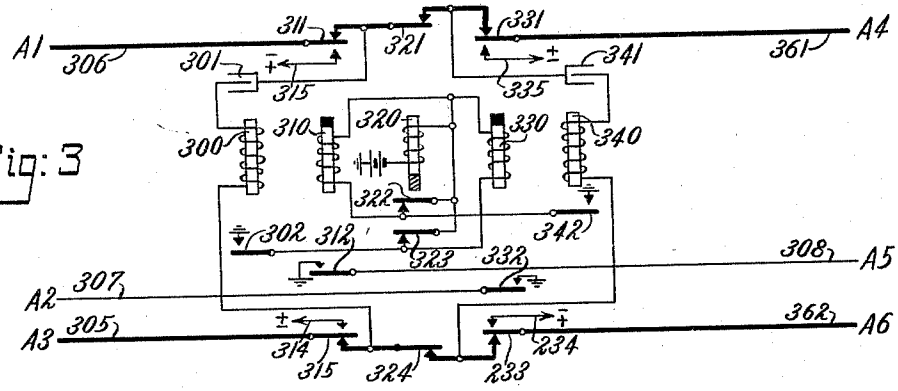
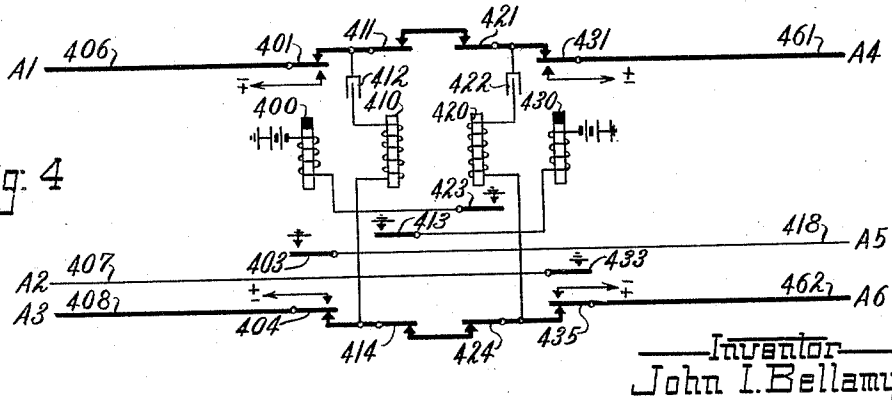


Fig: 4



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UNITED STATES PATENT OFFICE.

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RINGING-CURRENT REPEATER.

Application filed December 9, 1926. Serial No. 153,481.

This invention relates to ringing current repeaters used in long distance telephone work.

In making long distance calls it sometimes happens that the ringing current must be sent over so great a distance that it cannot effectively actuate the ringing apparatus of the called party. Under such conditions it is customary to provide a repeater in the toll line, this repeater being so arranged that ringing current impulses actuate certain mechanism therein, which mechanism connects a source of ringing current at the repeater to the called line. Such ringing current repeaters are generally uni-directional, that is the current must always come in at the same end of the repeater and is always sent out through the other end. It is an object of this invention to provide a two-way ringing current repeater, that is, a repeater so arranged, that no matter over which terminal of the repeater the current is received, the repeater will always operate to connect a new source of ringing current to the other terminal.

It is a further object of this invention to provide the repeater with signalling means to indicate to the operator from which end the ringing current originated, in case the invention is used in an operator's cord circuit.

These and further objects will be apparent from the accompanying specification taken in conjunction with the drawings forming a part thereof.

In the drawings, Fig. 1, diagramatically illustrates one embodiment of the invention, applied to a toll operator's cord circuit. Figs. 2, 3, and 4 each show a modification of that part of Fig. 1 that extends between the dotted lines A—A'.

Referring to Fig. 1, O represents a toll operator's cord terminating in two plugs P1 and P2. J1 and J2 are two of the many jacks in the operator's switchboard. The trunk from the jack J1 may lead to a toll operator's position in a second exchange which will hereinafter be referred to as exchange two, and that from jack J2 may lead to a toll operator's position in a third exchange which will be referred to as exchange number three. The particular circuits connected to J1 and J2 do not form a part of this invention, hence are not shown.

The operation and function of the various parts will now be briefly described without detailing the specific circuits. Assuming that the operator at O has placed the plug P1 into jack J1 in response to a call, she then operates the key K2 thereby connecting her headset to the cord circuit. Upon ascertaining the number wanted, the plug P2 is inserted into the proper jack, such as J2, and the key K3 is operated to apply ringing current to the talking conductors. The call is then extended to the desired party in the usual manner. Upon the termination of the call one of the parties will replace the receiver upon the hook, thereby giving the usual signal to his toll operator. Assuming that it is the called party who has terminated the call, the operator at exchange number three will thereupon send ringing current over the talking conductors to the repeater at O. Responsive to the application of ringing current, to the talking conductors at the plug P2, the relays 110 and 150 operate, causing the operation of the relay 130, which relay breaks the circuit for the relay 110 since the ringing current is assumed to be coming by way of the plug P2. The dropping back of relay 110 releases relay 120 which has previously operated, thereby connecting the ringing current generator G to the talking conductors, to signal the operator at the second exchange. If the calling party had been the one to terminate the call, then his toll operator would have projected ringing current by way of the jack J1 and plug P1 to the repeater at O in the same manner as was done by the other toll operator, and in this case the relays 110, 130, and 150, would have operated in the same manner as above explained, but the operation of relay 130 would have caused the release of relays 150 and 140, instead of 110 and 120 as before. In this case the lamp 9 would have been lit and ringing current from the generator G would have been projected over the cord circuit to the talking conductor at the plug P2, thereby signalling the operator at exchange three. In either case the operator at O is also signalled by the lamps 9 or 9'. When the two called operators manipulate their listening keys all three operators may converse and determine whether it is proper to take down the connection. If the connection may not be taken down, the toll operator at

the station of the party who has terminated the call recalls the party. If, however, the connections may be severed they are severed.

A detailed description of the circuit arrangement whereby the above operations are obtained will now be given.

It will be assumed that the connections between J1 and J2 have already been set up, since that is done in the usual manner and is well known in the art, and it will be further assumed that the subscriber at exchange three has already replaced his receiver and that the toll operator at that exchange has connected a source of ringing current to the talking conductors leading to jack J2 in order to inform the toll operator at exchange number two of that fact. The ringing current is now projected through the tip and ring conductors of jack J2, and plug P2, the talking conductors 55 and 56 to the points A4 and A6. A circuit is completed for the relays 110 and 150, the circuit for the relay 110 extending from A4 through the back contact 131 of relay 130, condenser 112, back contact 134 of relay 130, relay 110, back contact 138 of relay 130 to the point A6. The circuit for the relay 150 extends from A4 to the condenser 152, back contact 133 of relay 130, relay 150 to the point A6. Relay 110 at its contact 111 establishes a circuit for the relay 120, while a circuit for the relay 140 is established at the contact 155 of relay 150. When relays 120 and 140 have both operated, a circuit for the relay 130 is established, said circuit extending from battery through the relay 130, from contact 125 of relay 120 to ground at the front contact 145 of relay 140. Relay 130 at its contact 135 establishes a holding circuit for itself, said circuit extending to ground at either the contact 124 of relay 120, or 144 of relay 140, the two last mentioned contacts being connected in parallel. At contacts 131 and 138 the relay 130 opens the circuit for the relay 110 which thereupon falls back. The opening of contact 133 is of no effect at this time since the circuit for the relay 150 is maintained closed at the contact 143 of relay 140. Relay 110 upon falling back releases the relay 120 which thereupon falls back, and at its contacts 121 and 127 connects the ringing current generator G to the tip and ring side of the plug P1, the circuit being as follows: From the grounded generator G, through the front contacts 132 and 141 of the relays 130 and 140, respectively, contact 121 of relay 120, the upper talking conductor, to the tip side of the plug P1, ground being fed through the front contacts 137 and 147 of the relays 130 and 140, respectively, thence through the back contact 127 of the relay 120, and from there by way of the lower talking conductor to the ring side of the plug P1. The ringing current can not feed back to the ring and tip conductors of the plug P2 because of the open contacts 131 and 138. The frequency of the current generated at G is the same as that received, although a different frequency may be used. At the back contact 125, relay 120 further establishes a circuit for the relay 40, this circuit extending from the grounded battery at relay 40 through the front contact 145. Relay 40 at its back contact 42 establishes a locking circuit for itself, ground being received by way of the key K2. At the contact 45, relay 40 establishes a circuit for the signal lamp 9′. Thus it is seen that in response to the application of ringing current through the tip and ring conductors of the jack J2 the generator G is connected to transmit ringing current through the tip and ring conductors of the plug P2, and also a signal is operated to indicate to the operator from which end of the cord circuit the ringing current is being applied. The operator at exchange three applies the signalling current only momentarily. Upon removal of the signalling current from the tip and ring conductors of J2 the relay 150 falls back and at its contact 155 opens the circuit for the relay 140, which a moment later likewise releases. At contacts 141 and 147 relay 140 disconnects the generator G from the talking conductors. At contact 145 the original operating circuit for the relay 40 is opened at another point, which however is of no effect since that circuit was already opened at the contact 41, and further a locking circuit for the relay 40 has already been established as pointed out above. At contact 144 relay 140 opens the circuit for the relay 130 which relay thereupon falls back after a slight delay and reconditions the repeater for subsequent use. The ringing current applied to the tip and ring conductors of jack J1 operates a drop in the toll operator's switchboard in the usual manner. The toll operator at exchange number two now connects her headset across the talking conductors as does also the operator at O. All three toll operators may now converse and determine whether the connection may be taken down. Upon the operation of the key K2 the circuit for the relay 40 is opened and that relay drops back extinguishing the signal lamp 9′. The apparatus is now ready for further use.

For the sake of further illustration, an explanation will now be given of the manner of operation of the apparatus when the call is terminated by a party at exchange number two. The toll operator at exchange number two, observing the usual signal operates her key to apply ringing current to the talking conductors terminating in the jack J1. The ringing current is projected over the tip and ring conductors of the plug P1 through the key K1 to the points A1 and A3. A circuit is now established for the relays 110 and 150, the circuit for the relay 110 extending from A1 through the condenser 112, back contact

134 of relay 130, relay 110 to the point A3. The circuit for the relay 150 extends from A1 through the back contact 131 of relay 130, condenser 152, back contact 133 of relay 130, relay 150, lower talking conductor, back contact 138 of relay 130 to the point A3. The relays 110 and 150 upon operating establish a circuit for the relays 120 and 140 which latter relays establish an operating circuit for the relay 130, in the manner previously set forth. The relay 130 upon operating its contacts 131 and 138 breaks the circuit for the relay 150 which relay thereupon falls back and opens the circuit for the relay 140. A moment later relay 140 upon falling back connects the ringing current generator to the tip and ring conductors of the plug P2, the circuit extending from the generator G through the front contacts 132 and 122 of relay 130 and 120 respectively, back contact 142 of relay 140, the upper talking conductor, to the tip of the plug P2, ground being connected through the front contacts 137 and 126 of the relays 130 and 120, respectively, back contact 146 of the relay 140, key K3 to the ring conductor of the plug P2. At contact 145, relay 140 completes a circuit for the signalling relay 12, said circuit extending from battery at the relay 12, through said relay, back contact 145, front contacts 125 and 135 of relay 120 and 130, respectively, to ground at the front contact 124 of relay 120. Relay 12 upon operating completes a holding circuit for itself at contact 14, said holding circuit extending through the key K2. The subsequent procedure on the part of the toll operators and also the release of the apparatus takes place in the manner previously explained.

The modification shown in Figs. 2, 3, and 4 will now be explained.

In the modifications shown in Fig. 2, if ringing current is applied to the talking conductors at the points A1 and A3, relay 240 operates over a circuit extending from the point A1 through the talking conductor 206, back contacts 211 and 221 of relays 210 and 220, respectively, condenser 242, relay 240, back contacts 224 and 213 of relays 220 and 210, respectively, conductor 205 to the point A3. Relay 240 at its contact 241 establishes an operating circuit for the relay 230, said circuit extending through the back contact 212 of the relay 210. At the contact 232 relay 230 establishes a circuit for the relay 220, which latter relay at its contact 223 establishes an operating circuit for the relay 210. The opening of the contacts 211 and 213 of the relay 210 is now of no effect since they are shunted by the now closed contacts 221 and 224 of the relay 220. At the contacts 212, the relay 210 breaks the operating circuit for the relay 230 and at the same contacts prepares a circuit for the relay 250. An instant later when the relay 230 falls back, the circuit for the relay 250 is completed. It is to be noted at this point that when the relay 230 falls back it breaks, at the contact 232, the circuit for the relay 220, which relay, however, being slow-acting, remains operated for a moment, during which time the relay 250 operates over a circuit extending from ground at the front contact 241, front contact 212, contact 231, front contact 222, thence through the relay 250 to battery and ground. The relay 250 at its armature 252 reestablishes a circuit for the relay 220 before said relay has had time to fall back, and at its contact 253 connects ground to the point A2, said ground extending by way of the conductor 245. Ground at A2 causes a signal to light, thereby indicating to the operator the source of the ringing current, in a manner explained in connection with Fig. 1. At the contacts 251 and 254 the relay 250 applies ringing current to the talking conductors 261 and 262. It being noted at this time that the talking conductors between points A1—A4 and between points A3—A6 are broken at the armatures 211 and 213, respectively, and since contacts 221 and 224 are now in their operated position the ringing current applied at the contacts 251—254 can not possibly extend back to the conductors 205—206, nor affect any of the relays 200—250. Upon the removal of ringing current from the conductors 205—206 the relay 240 drops back, and at its contact 241 opens the circuit for the relay 250 which relay releases and removes the ringing current from the conductors 261—262, and at its contact 252 opens the circuit for the relay 220. An instant later the relay 220 falls back and at armature 223 opens the circuit for the relay 210 which relay thereupon falls back. At contacts 211 and 213 the relay 210 reestablishes connections between A1—A4, and A3—A6. The return to normal of the contact 212 is at this time of no effect since the contacts 241 are already open. All the relays are now back in their normal positions, the signals have been operated, and the operators may proceed in the manner explained in connection with Fig. 1.

For the sake of further explaining the manner of operation of the modification shown in Fig. 2 it will be assumed now that the ringing current is applied to the repeater at A4—A6 instead of at A1—A3 as was previously assumed. In this case as before, the relay 240 operates, its circuit extending over the conductor 261, back contact 221 of the relay 220, condenser 242, relay 240, back contact 224 of the relay 220, through the conductor 262 to A6. The relay 240 at the contact 241 establishes a circuit for the relay 230 as previously traced, which latter relay at its contact 232 establishes a circuit for the relay 220. The relay 220 at its contacts 221—224 extends the circuit for the relay 240 through the back contacts 211—213, and at its contact 223 establishes

an operating circuit for the relay 210, which relay upon operating, opens the circuit for relay 240 at the contacts 211—213. Relay 240 now releases its contact 241, thereby opening the circuit for the relay 230 at another point, the original circuit for relay 230 having been opened at the contact 212 upon the operation of the relay 210. An instant later the relay 230 falls back and closes the contact 231 and opens the contact 232. The circuit for the relay 220 is now open at the contact 232 and a moment later it also falls back, whereupon the original operating circuit for the relay 240 is again closed at contacts 221 and 224. At its contact 223, the relay 220 breaks the circuit for the relay 210 but this latter relay being slow to release remains operated for a moment. In the meantime the relay 240 operates and at its contact 241 establishes an operating circuit for the relay 200, said circuit extending from ground at the front contact 241 of relay 240, through the front contact 212 of the relay 210 which has not yet fallen back, the back contact 231 of the relay 230, and the back contact 222 of the relay 220 to the winding of the relay 200 thence to the battery and ground. Relay 200 operates, and at its contact 202 establishes a new circuit for the relay 210 before said relay has had time to fall back, at its contact 203, it connects ground to the point A5, through the conductor 208, thus operating the relay 40 shown in Fig. 1, to light the lamp 9'. At its contacts 201 and 204 relay 200 applies ringing current to the talking conductors 206 and 205, the ringing current being applied as long as ringing current is maintained at the points A4—A6. When the ringing current is removed from the conductors 261 and 262 the relay 240 drops back and at contact 241 opens the circuit for the relay 200 which relay therefore also falls back. At its contacts 201 and 204 relay 200 removes the ringing current from the conductors 206—205, and at its contact 202 the relay 200 opens the circuit for the relay 210, which latter relay an instant later falls back. Upon falling back, the relay 210 at its contacts 211 and 213 reconnects the talking conductors, and at its contact 212 prepares the apparatus so that it may again operate in the manner described should ringing current again be applied from either direction.

The manner of operation of the modification shown in Fig. 3 will now be explained, it being understood that structure is illustrated for use in a cord circuit such as shown in Fig. 1. When ringing current is applied to the talking conductors at the points A1—A3 or A4—A6 the relays 300 and 340 both operate, the circuit for said relays being apparent. Upon the operation of either of said relays, a circuit is established for the relay 320, said circuit extending from battery, through the relay 320, thence to either the back contact 322 of relay 320 and the front contact 342 of the relay 340, or through the back contact 323 of relay 320 and front contact 302 of the relay 300, both branches being connected in parallel. At its contacts 322 and 323 the relay 320 removes the short circuit from the winding of relays 310 and 330 and opens its own original operating circuit. The relay 320 is however maintained operated over a circuit extending from battery at the relay 320, through the relay, thence through relays 310 and 330 connected in parallel, the branch extending through relay 310 receiving ground at the front contact of relay 340, and the branch extending through the relay 330 receiving ground at the front contact of relay 300. The relays 310 and 330 are therefore both momentarily energized in series with the relay 320. At its contacts 321 and 324 the relay 320 opens the talking conductors. At this time either the relay 300 or the relay 340 will drop back depending upon over which side, the ringing current is coming. If the ringing current is applied at the conductors 306 and 305 then the relay 300 will be maintained and the relay 340 will drop back, its circuit being broken at the contacts 321 and 324. If however, the ringing current is applied at the conductors 361 and 362, then the circuit for the relay 340 is maintained while that of relay 300 is broken. At this point it will be assumed that the ringing current is applied to the conductors 306 and 305. The relay 340 dropping back at this time breaks the circuit for the relay 310 before said relay has operated, whereas the contact 302 being maintained closed, the relay 330 finally operates. The relay 330 at its contacts 331 and 333 connects a source of ringing current to the talking conductors 361 and 362, and at its contacts 332 connects ground by way of conductors 307 to the point A2, thereby operating a signal to indicate to the operator, in the manner previously explained, over which side the ringing current is coming. The relays operated, will remain so until such time as the ringing current is removed from the conductors 306 and 305 and when that happens the circuit for the relay 300 is broken and it falls back thereby breaking at the contact 302 the circuit for the relays 320 and 330 which were connected in series. The relay 330 falls back and removes the source of ringing current from the conductors 361 and 362, and the relay 320 falls back and reconnects the talking conductors.

In the above description it was assumed that the ringing current originated over the conductors 306—305. If however the ringing current originated over the conductors 361 and 362 it is obvious that the relay 300 would have fallen back upon the operation of the relay 320, and the relay 340 would have been maintained operated, and the circuit extending through relay 320 would include the relay 310 in series instead of the relay 330. Ring-

ing current would then have been applied through the contacts 311 and 313 of the relay 310 to the conductors 306—305 and would have been maintained as long as the relay 304 remained operated, this circuit being closed so long as ringing current is being applied to the conductors 361—362. Relay 310 in addition, at its contacts 312, connects ground to the point A5 through the conductor 308, thereby operating the signal lamp as explained in connection with Fig. 1, to notify the operator that the signalling current is being applied from that end. Upon the release of relay 340, the relays 310 and 320 each drop back and the operators proceed as explained in connection with Fig. 1.

At this stage, the operation of the modification shown in Fig. 4, will be apparent. Ringing current coming in over the talking conductors will cause the operation of relays 410 and 420, the circuit for said relays being obvious from the drawings. It is apparent that if the ringing current is coming from the left hand side, relay 410 will be maintained operated and will break the circuit for the relay 420 at the contacts 411 and 414, whereas, if the ringing current is coming from the right-hand side, relay 420 will be maintained and will at its contacts 421 and 424 break the operating circuit for the relay 410. The relay 420 at its contact 423 closes an operating circuit for the relay 400, whereas, the relay 410 at its contact 413 closes an operating circuit for the relay 430. The relays 400 and 430 are each slow to pull up and do not operate until the relay 410 or the relay 420 has had time to fall back. If the relay 410 is maintained operated, the relay 430 at its contacts 431—435 applies ringing current to the outgoing conductors 461—462, and at its contact 433 applies ground to A2 through the conductor 407. If the relay 420 is maintained operated, the relay 400 at its contacts 401—405 applies ringing current to the outgoing conductors 406—408, and at its contact 403 applies ground to A5 through the conductor 418.

From the above disclosure it may be seen that the repeater is not limited to use in a cord circuit, but may be used as a link in any toll line over which it may be necessary to transmit ringing current from either end to the other, and wherein the distance is so great that the ringing current cannot be efficiently transmitted the entire distance.

In compliance with the requirements of the patent statutes I have herein described certain preferred embodiments of my invention. It is however to be understood that the same is shown for illustrative purposes only, and I do not wish to be limited to the precise structure shown. What I consider new and desire to procure by Letters Patent is:

1. In combination, a conductor, two ringing current responsive relays connected to two points on the conductor and operable by ringing current received over either end of said conductor, means for opening said conductor between said two points, and connections effective responsive to the operation of said relays for operating said means.

2. In combination, an electro responsive device including two relays, means for applying ringing current to both of said relays over either of two paths, means in said device controlled by said relays for indicating over which path the ringing current is applied and for transmitting ringing current over the other path.

3. In combination with two relays, connections for operating both of said relays over either of two paths, connections effective responsive to the operation of the first of said relays for disconnecting the second relay from one of said paths and connections effective responsive to the operation of the second relay for disconnecting the first relay from the other of said paths.

4. In combination, two relays, connections for operating both of said relays over either of two paths, connections controlled by the first of said relays for disconnecting the second relay from the first of said paths, connections controlled by the second relay for disconnecting the first relay from the second path, means controlled by the first of said relays for transmitting ringing current over the second path and means controlled by the second relay for transmitting ringing current over the other path.

5. In a telephone system, two toll stations, means including a ringing current repeater connecting the stations, means at either station for transmitting ringing current to the repeater, means including locking relays for indicating from which station the ringing current is being transmitted, means operated by the repeater for transmitting ringing current to the other station, and an operator controlled key for releasing said locking relays.

6. In a toll line comprising two sections, a cord circuit for associating said sections, two relays associated with said cord and both initially responsive to ringing current incoming from either section, and means controlled by said relays for rendering one or the other of said relays inoperative according to the direction of the incoming ringing current.

7. In a ringing current repeater, a conductor, two ringing current responsive relays connected to two points on said conductor, a relay initially operated under the joint control of both of said relays and maintained operated under the control of either one of said relays for opening said conductor between said two points, and means under the joint control of all three relays for repeating ringing current.

8. In a ringing current repeater, a con-

ductor, a ringing current responsive relay connected to a point on said conductor and operated responsive to ringing current received over either end of said conductor, means controlled by said relay for opening said conductor at a point between said first mentioned point and one end of the conductor, additional means for disconnecting said relay from the other end of the conductor and additional means for supplying ringing current to said other end of said conductor.

In witness whereof, I hereunto subscribe my name this 6th day of December, A. D. 1926.

JOHN I. BELLAMY.