

June 21, 1932.

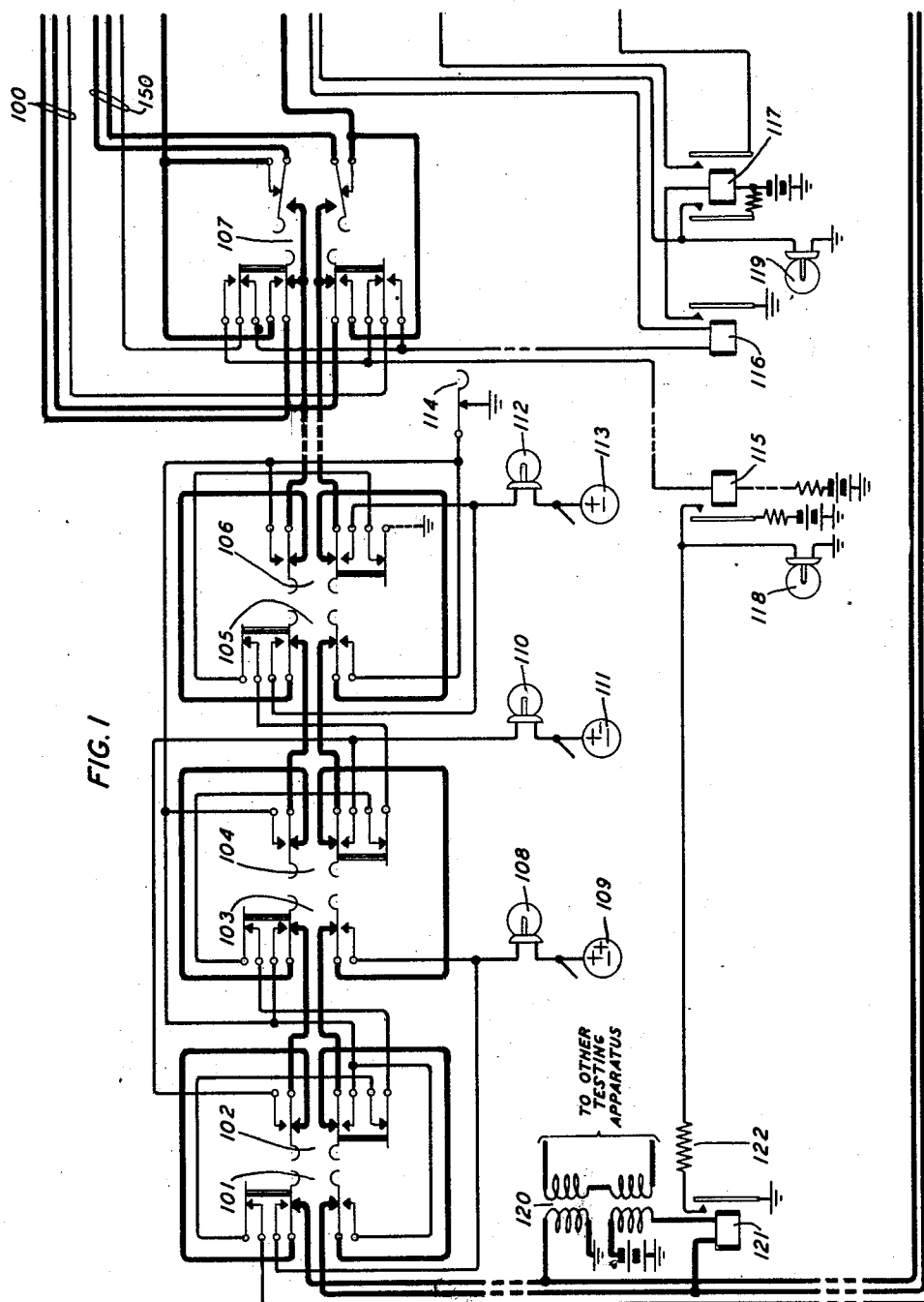
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1,864,061

TELEPHONE RINGING SYSTEM

Filed Sept. 12, 1931

4 Sheets-Sheet 1



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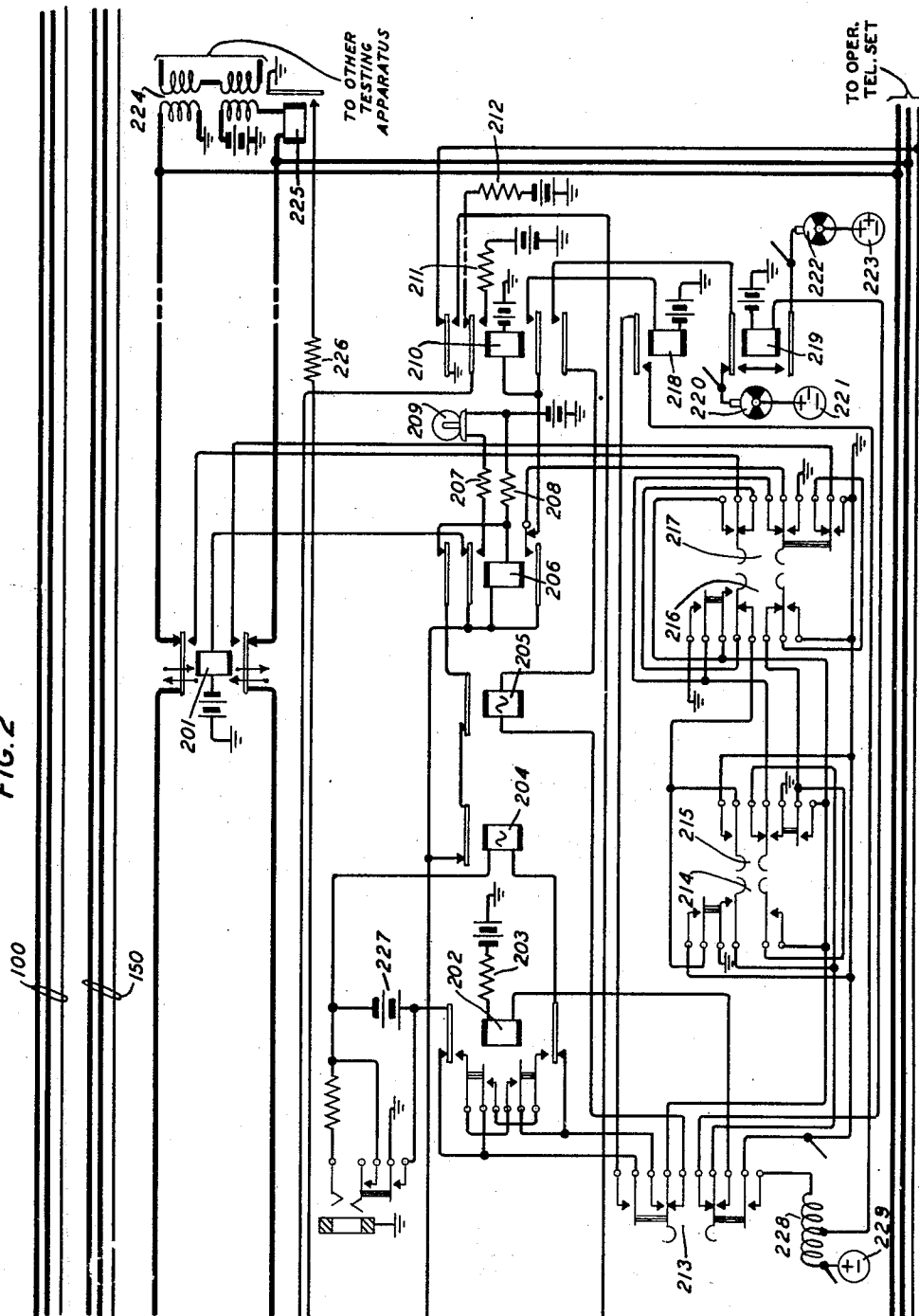
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FIG. 2



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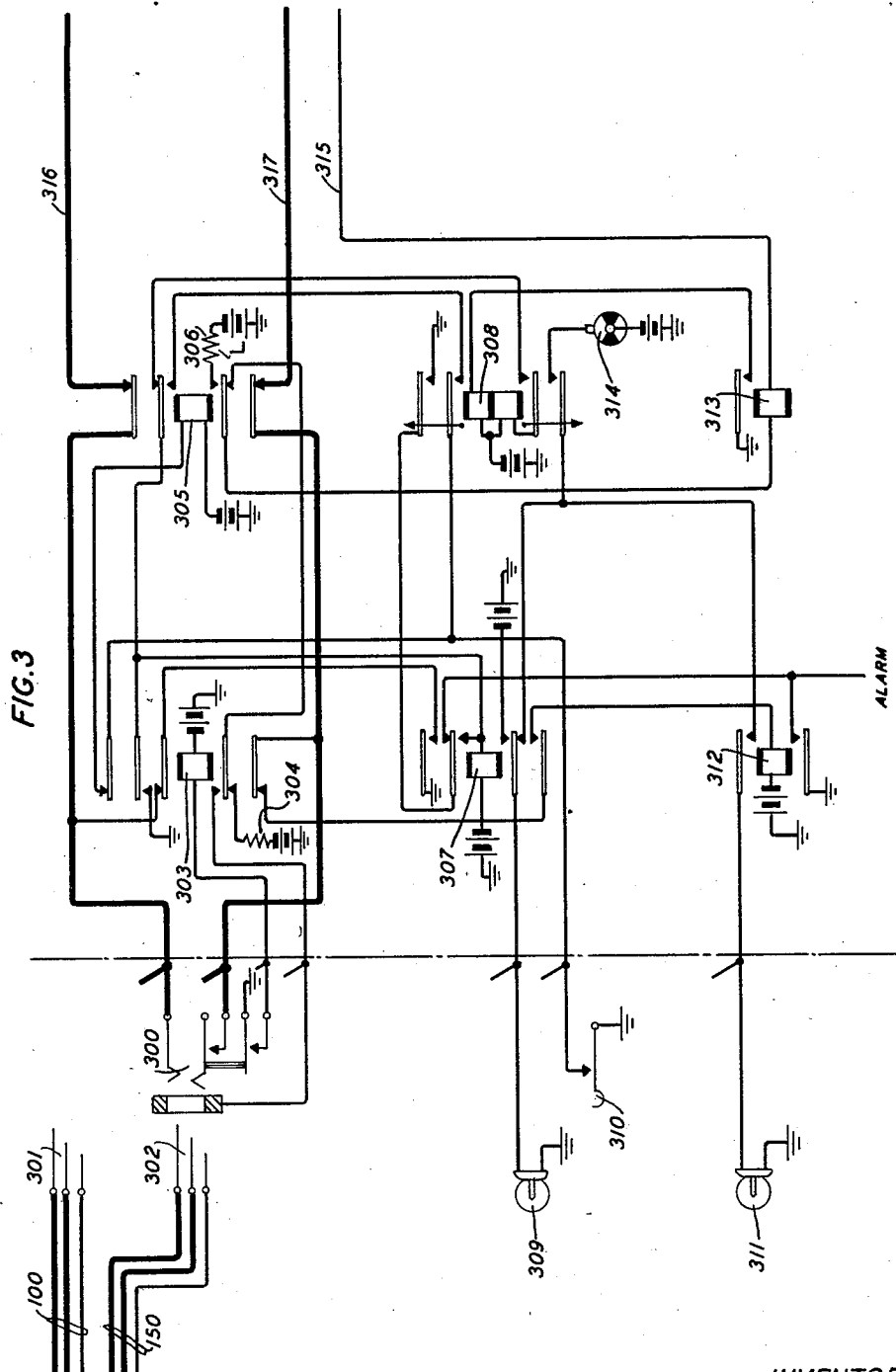
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4 Sheets-Sheet 3



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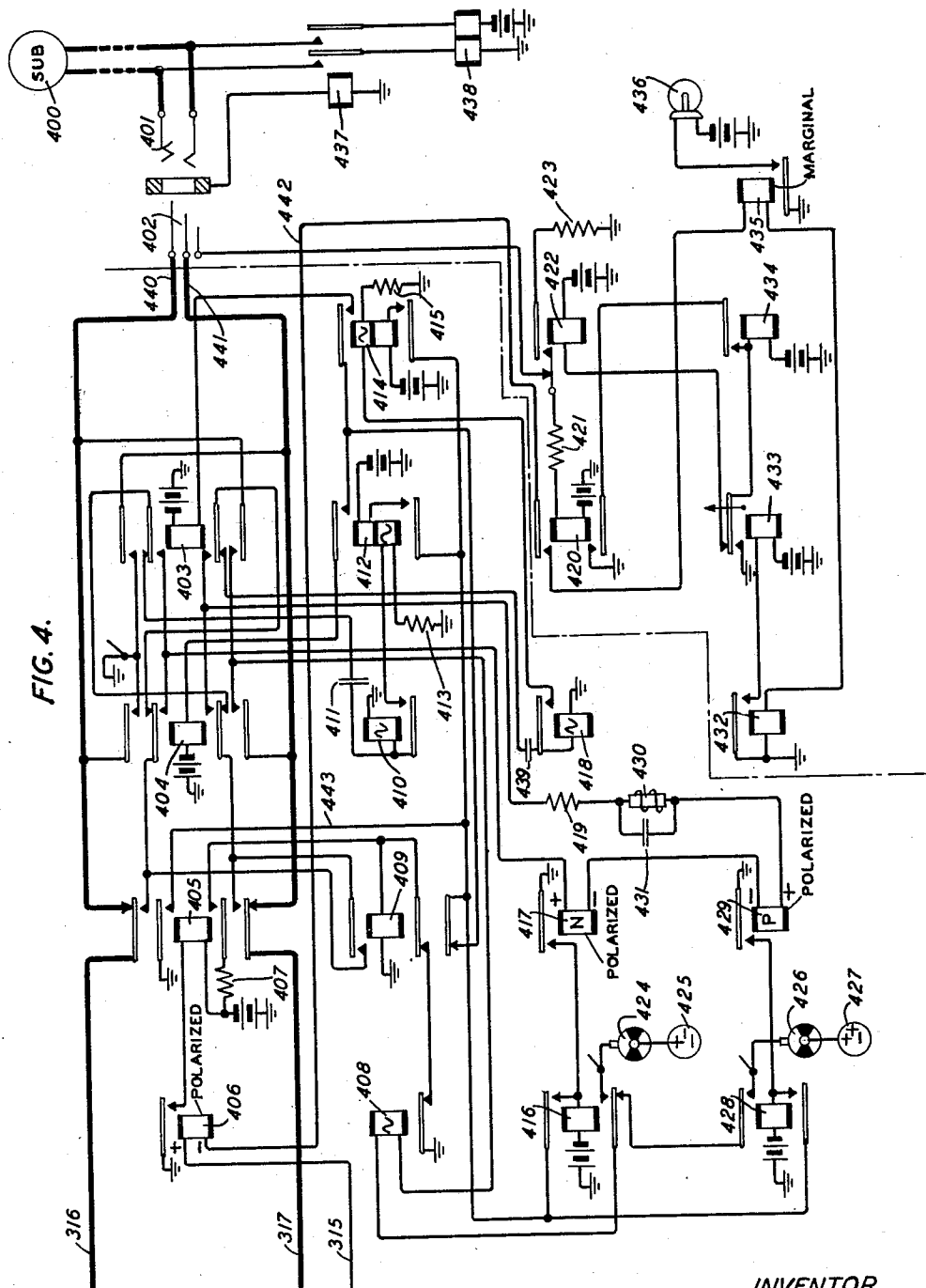
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TELEPHONE RINGING SYSTEM

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4 Sheets-Sheet 4



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TELEPHONE RINGING SYSTEM

Application filed September 12, 1931. Serial No. 562,446.

This invention relates to signaling arrangements for use in telephone systems and has for its object to increase the range over which signaling may take place.

In the establishment of ordinary interoffice connections it is customary to apply ringing current to the called subscriber's line from equipment located in the office at which the line is located. However, together with the centralization of the information and toll offices has arisen the centralization of the work of the test man. Some of the tests of a subscriber's line are performed with the receiver on the switchhook while others require removal of the receiver. It is, therefore, necessary that the control of the application of the ringing current remain with the test man. Where a considerable distance separates the office at which the test desk is located from the office serving the subscriber's line the ringing current as received at that office may not have sufficient strength to operate the ringer properly.

In accordance with the present invention, the application of ringing current to a trunk outgoing from an operator's desk causes the association of the trunk at the distant office with means for testing for the nature of the applied ringing current and the response of the testing means causes the application of the same type of ringing current to the outgoing end of the trunk and thence to the subscriber's line. The removal of the receiver causes the disconnection of the ringing current from both ends of the trunk line.

The invention has been disclosed in connection with a skeletonized showing of a test circuit similar to that shown and described in detail in Patent 1,632,902 to L. H. Johnson, June 21, 1927. The drawings include the following figures:

Fig. 1 which shows a set of manual ringing keys and a transfer key;

Fig. 2 which shows a set of machine ringing keys;

Fig. 3 which shows the end of a trunk circuit at the test desk; and

Fig. 4 which shows the terminating plug of the trunk, and a subscriber's line at the right of the dotted line, and the remote con-

trol ringing equipment at the left of that line.

The test circuit includes a primary test cord and a secondary test cord. Associated with each test cord are a number of testing arrangements by which tests may be made on a subscriber's line and the equipment associated therewith. The tests normally made with the primary cord require the constant attention of the test man and are performed more or less rapidly. The tests normally performed with the secondary test cord require a longer time and may require the attention of the test man only intermittently, after the connection has been established. For a description of this test equipment, reference may be made to the above identified Johnson patent.

The primary test cord has accordingly been equipped with keys for manual ringing which are non-locking and apply ringing current only while held operated. The secondary test cord is equipped with keys for machine ringing, that is, keys which lock when operated and control the application of interrupted ringing current from the ringing machine. A key is provided by which the primary and secondary test cords may be reversed, that is, connected to the equipment normally associated with the other cord. By the use of this key, therefore, it is possible to signal a subscriber with either type of ringing current and then to make such tests as are necessary.

The manual ringing keys would ordinarily be used in signaling a subscriber located in a nearby office, or for signaling operating desks in a more distant office, since they have no effect on the remote control equipment of Fig. 4, as will be shown hereinafter. For signaling subscribers associated with distant offices, the machine ringing would ordinarily be used so that it may be relayed to the subscriber's substation by the remote control equipment. In signaling nearby offices, the remote control equipment would not be necessary and trunks appearing at those offices would include the equipment of Fig. 3 connected directly to the incoming plug and asso-

ciated equipment at the right of the dotted line in Fig. 4.

Assuming first that substation 400, which is to be tested, is in a nearby office and ringing need not be relayed, the test man will insert plug 301, attached to cord 100 associated with the manual ringing circuit, into jack 300. The insertion of the plug in the jack closes an obvious circuit for relay 303 which in turn operates relay 307. Relay 307 closes a circuit for lamps such as lamp 309 at each position at which the trunk appears, to mark the trunk busy. The identity of the substation is passed by means of a call wire or talking trunk (not shown) to the operator at whose position the trunk appears in plug 402. Plug 402 is then inserted into jack 401. A circuit is then closed from ground through the winding of cut-off relay 437 sleeves of jack 401 and plug 402, normal contact of relay 422, resistance 421, winding of relay 420 to battery. With relay 420 operated, a circuit is closed from ground through the windings of relays 432 and 435, front contact of relay 420, conductor 442 to conductor 315, winding of relay 313, inner lower back contact of relay 305, lower front contact of relay 303, sleeves of jack 300, plug 301, and cord 100, outer lower normal contact of key 107, winding of relay 115 to battery. Relay 115 operates, lighting lamp 118 as an indication that the line has been connected with the test circuit. Relay 432 operates, closing an obvious circuit for relay 433 which in turn operates relay 434. Relay 434 locks under the control of relay 420. Relay 435 does not operate in this circuit, being marginal. Relay 313 also operates in this circuit, closing a circuit for relay 308 which closes a locking circuit for itself from battery through its lower winding and inner lower contact, inner upper back contact of relay 305, inner upper front contact of relay 307 to ground at the outer upper front contact of relay 308. Relay 307 is also held operated in this circuit.

After such tests have been made as are made with the receiver on the switchhook, if the test man wishes the receiver removed, he will operate one of the ringing keys 101 to 104 if the substation is one on a four-party line, one of keys 105 and 106 if the substation is one on a two-party line, or key 106 if it is an individual line. Assuming that key 101 is the proper key to use for this substation, the operation of the key closes a circuit from ringing source 109, ballast lamp 108, upper operated contact of key 101, upper normal contacts of keys 102 to 107, tips of cord 100, plug 301 and jack 300, outer upper back contact of relay 305, conductors 316 and 440, tips of plug 402 and jack 401, through the ringer at substation 400, back over the rings of jack 401 and plug 402, conductors 441, and 317, outer lower back contact of relay 305, rings of jack 300, plug 301 and cord 100,

lower normal contacts of keys 107, 106, 105, 104, 103 and 102, lower operated contact of key 101, key 114 to ground. When the receiver is removed from the switchhook at substation 400 and the ringing key is normal, a direct current circuit is closed through the substation and extending over the inner upper normal contact of key 101 to the upper left winding of repeating coil 120 and ground, and over the lower normal contact of key 101, winding of relay 121, lower left winding of repeating coil 120 to battery. Relay 120 when it operates in this circuit connects ground through resistance 122, in shunt of lamp 118, extinguishing that lamp as an indication to the test man that the receiver has been removed.

If the test man wishes to hold the line while he makes other tests with the test cord, he may remove the plug 301 from jack 300 without releasing the attached line. The removal of the plug releases relay 303 which connects battery through resistance 304 over its inner lower back contact, and the inner lower back contact of relay 305 to the winding of relay 313 holding relays 313 and 432 operated. Relays 308 and 307 also remain locked as above described. With relay 303 released and relay 307 operated, battery through the winding of relay 312 is connected over the outer lower front contact of relay 307, outer lower back contact of relay 303, to the ring side of the trunk and ground is connected over the outer upper front contact of relay 307 and the inner upper back contact of relay 303 to the tip side of the trunk. If the receiver is removed from the switchhook under these conditions, or the ring side of the line is grounded, or a field test man connects his telephone across the line, relay 312 operates closing an alarm circuit. It also completes a circuit from battery through interrupter 314, outer lower front contact of relay 308, upper front contact of relay 312, to lamp 311 at each position at which the trunk appears to attract the attention of an operator or test man.

In order to release the trunk it is necessary for the test man to operate key 310 with plug 301 removed from the jack 300. As above described, the removal of the plug releases relay 303, while relays 313, 307 and 308 remain operated. The closure of key 310 connects ground over the contact of the key, back contact of relay 303 to the winding of relay 305 and battery. Relay 305 disconnects the tip and ring conductors of the trunk from the jack, connects battery through low resistance 306 in series with the windings of relays 313, 435 and 432 and opens the locking circuit for relay 308. However, relay 308 is held operated from the front contact of relay 313. Relay 305 also closes a locking circuit for itself extending through its winding over the outer upper back con-

tact of relay 303, inner upper front contact of relay 308, upper front contact of relay 305, inner upper front contact of relay 307, to ground at the outer upper front contact of relay 308. This prevents the release of relay 305 until the connection has been released at the distant end. Relay 435 operates in series with the low resistance 306 and lights lamp 436. In response to the lighting of lamp 436, plug 402 is withdrawn from jack 401, releasing relay 420 and opening the circuit of relays 432, 435 and 313 which release. Relay 432 in turn releases relays 433 and 434. The release of relay 313 opens the energizing circuit of relay 308 and that relay releases in turn releasing relays 307 and 305. With relay 307 released, lamp 309 is extinguished to indicate that the trunk has been restored to normal.

If the manual ringing keys are used for signaling over a trunk which includes remote control ringing equipment, the circuits will include all of the equipment shown in Fig. 4, and conductor 315 will be connected to conductor 442 through the winding of polarized relay 406, conductor 316 will be connected to conductor 440 over the upper back contact of relay 405 and conductor 317 will be connected to conductor 441 over the lower back contact of relay 405. Since relay 406 is polarized, so as to be unresponsive to the current in the sleeve circuit over cord 100, ringing takes place exactly as above described.

If machine ringing is to be used on a direct trunk, that is, one without the remote control ringing equipment, plug 302 is inserted in jack 300. Relays 303 and 307 are operated as previously described. The sleeve circuit, which is completed when plug 402 is inserted in jack 401 of the line under test, may be traced as before through the windings of relays 432, 435 and 313 to the sleeves of jack 300, plug 302 and cord 150, outer upper left normal contacts of key 107, winding of relay 116, inner upper back contact of relay 210, resistance 212 to battery. Relays 432 and 313 function as previously described, relay 435 being unoperated. Relay 116 operates relay 117 which in turn lights lamps 119 as an indication that the line has been connected to the test circuit. Keys 214, 215, 216 and 217 correspond in the type of ringing applied to keys 103, 104, 101 and 102 respectively. To signal subscriber 400 then, key 216 will be operated. The operation of key 216 closes a circuit from ground at its outer upper operated contact over the lower normal contacts of keys 215 and 213, through the winding of relay 219 to battery. Relay 219 transfers the ringing circuit from negative source 221 to positive source 223. Key 216 also closes a circuit from ground over the outer upper contact of key 216, over the lower normal con-

tact of key 217, lower normal contacts of relay 206, winding of relay 210 to battery. Relay 210 in operating disconnects negative battery through resistance 212 from the sleeve circuit and connects positive battery through resistance 211 thereto, but since the remote control ringing circuit is not included in the outgoing trunk this operation is ineffective. It also connects ground over its upper front contact, front contact of relay 117, through the winding of relay 206, and resistance 208 to battery. However, a circuit is also closed over the back contacts of relays 204, 205 and 206, to resistance 208 in shunt of the winding relay 206 preventing its operation at this time. Another branch of this circuit extends over the inner upper back contact of relay 206 to the winding of relay 201 and battery. Relay 201 disconnects the talking conductors from the repeating coil 224 and connects them to the ringing keys, preparing the ringing circuit. Relay 210 also extends its operating circuit to the winding of relay 218 which also operates but is ineffective. Relay 210 completes the ringing circuit which may be traced from positive superimposed source 223 through ringing interrupter 222, front contacts of relay 219, outer lower front contact of relay 210, winding of relay 205, upper normal contact of key 213, inner upper operated contact of key 216, upper normal contact of key 217, upper normal contact of relay 201, upper right contact of key 107, tips of cord 150, plug 302 and jack 300, over the upper back contact of relay 305, conductors 316 and 440, tips of plug 402 and jack 401, through the ringer at substation 400, rings of jack 401 and plug 402, conductors 441 and 317, outer lower back contact of relay 305, rings of jack 300, plug 302 and cord 150, lower right contact of key 107, lower front contact of relay 201, outer lower normal contact of key 217, lower operated contact of key 216, ground. Relay 205 does not operate in this circuit, but when the receiver is removed at the substation 400, the circuit is altered so that relay 205 does operate. The operation of relay 205 opens the shunt around the winding of relay 206 which now operates, opening the shunt at its own contact so that the release of relay 205 cannot reclose it and locks over its lower alternate contact, inner lower normal contact of key 217 to ground at the outer upper operated contact of key 216. It also opens the circuit of relay 210 which releases in turn releasing relay 218, opening the ringing circuit, withdrawing the connection of negative battery from the sleeve circuit and reconnecting ground to the operator's telephone set to permit the connection of the telephone with the trunk. Relay 206 lights lamp 209 as a signal that the call has been answered and opens the circuit of relay 201 to connect the line

through to the testing apparatus. The test man can now release the ringing key in turn releasing relay 206, extinguishing lamp 209. The release of relay 201 also extends the line to the repeating coil 224 and relay 225. Relay 225 in operating connects ground through resistance 226 in shunt of lamp 119 extinguishing that lamp as a signal that the receiver is off the switchhook at the line under test.

Assuming now that the line 400 to be tested lies in a distant office, and that the secondary cord 150 has been inserted in a trunk including the remote control ringing equipment of Fig. 4, the action of the machine ringing key circuit will be the same as previously described. However, under these circumstances polarized relay 406 is connected in the sleeve circuit. When relay 210 operates connecting positive battery to the sleeve circuit, relay 406 operates, in turn operating relay 405. Relay 405 opens the trunk, connecting the incoming end to the means for identifying the nature of the ringing current. Relay 405 also prepares a circuit for relay 409 from battery through resistance 407, inner lower contact of relay 405, winding of relay 409 to ground, but ground is connected over the back contact of relay 408 and the back contact of relay 409 in shunt of the winding of relay 409 to prevent its operation at this time. Relay 405 also connects ground to conductor 443. The ringing circuit is first extended to means for identifying the side of the line to which ringing current has been applied. Assuming that key 216 has been operated as before described, the ringing circuit extends from source 223 as previously traced to conductor 316, outer upper front contact of relay 405, upper back contact of relay 404, lower back contact of relay 403, condenser 439, winding of relay 418 to ground and from ground over the lower operated contact of key 217 to conductor 317 as above described, outer lower front contact of relay 405, lower back contact of relay 404, upper back contact of relay 403, condenser 411, winding of relay 410 to ground. Relay 418 responds to ringing current applied to the tip conductor, but relay 410 cannot operate in series with ground. Relay 418 in operating extends the ringing circuit over its front contact, to the upper winding of relay 414, resistance 415 and ground. Relays 410 and 418 and 414 together present a combination which will not operate falsely on currents due to capacities in the trunk, etc. Relay 414 in operating locks from battery through its lower winding to grounded conductor 443. It also closes a circuit from battery through the winding of relay 403, upper contact of relay 414, outer lower contact of relay 409 to grounded conductor 443.

Relay 403 in operating transfers the ring-

ing circuit from relays 418 and 410 to polarized relays 417 and 429 which test for the polarity of the superimposed ringing current. The circuit extends from the upper front contact of relay 405 over the upper back contact of relay 404, inner lower front contact of relay 403, through the impedance network including retard coil 430, condenser 431 and resistance 419, windings of relays 429 and 417, inner upper front contact of relay 403, lower back contact of relay 404, to the outer lower front contact of relay 405. Since it was assumed that positive superposed ringing current was used, relay 429 will operate, in turn operating relay 428 which locks to grounded conductor 443. With relay 428 operated the outgoing ringing circuit is established from positive superimposed ringing source 427, ringing interrupter 426, front contact of relay 428, back contact of relay 416, winding of relay 408, outer lower front contact of relay 403 over the tip conductor 440, tips of plug 402 and jack 401, through the substation ringer to the rings of jack 401 and plug 402, ring conductor 441, outer upper front contact of relay 403 to ground. The subscriber is, therefore, signaled with the proper kind of ringing current applied to the proper side of the line.

Relay 408 cannot operate in series with the substation ringer, but when the receiver is removed, it does operate. The operation of relay 408 removes the shunt from the winding of relay 409 which now operates, further opening the shunt around its winding. It also opens the circuit of relay 403 to disconnect the outgoing ringing current from the line. In addition it connects the outer upper and outer lower front contacts of relay 405 together at its upper contact, completing a circuit for relay 205 in which that relay can operate. The effect of the operation of relay 205 is the same as previously described. The release of relay 210 restores the connection of negative battery to the sleeve circuit causing the release of relay 406 which in turn releases relays 405, 414 and 428 restoring the remote control ringing circuit to normal. The remaining functions of the equipment are the same as previously described. Relays 412, 416 and 404 perform the same functions for ringing current connected to the ring side of the line as relays 414, 428 and 403 performed when the ringing current was connected to the tip side of the line.

Key 213, in combination with keys 214 to 217, provides a low voltage ringing current for the adjustment of ringers without excessive noise. The operation of key 213 connects continuous ringing current source 225 over the outer lower operated contact of key 213 to ground. Assuming that the ringer of substation 400 is to be adjusted, key 216 will also be operated and a circuit is closed from ground over the outer upper operated contact

of key 216, lower normal contact of key 215, inner lower operated contact of key 213, winding of relay 202, resistance 203 to battery. Relays 210 and 218 are also operated over
 5 key 216 as previously described. The ringing circuit extends from source 229 through potentiometer coil 228 to its middle tap, front contact of relay 218, outer upper operated contact of key 213, inner upper and outer
 10 lower front contacts of relay 202, winding of relay 204, through battery 227 which supplies the superimposed positive potential, outer upper and inner lower front contacts of relay 202, inner upper operated contacts of keys
 15 213 and 216, upper normal contact of key 217, upper front contact of relay 201 over the ringing circuit as previously traced back to the lower front contact of relay 201, outer lower normal contact of key 217, lower operated
 20 contact of key 216 to ground. The location of the tap on the potentiometer 228 is so arranged that approximately sixty volts of the continuous ringing current is used. This arrangement would, of course, be used only
 25 where the substation can be rung directly.

From the foregoing description and a consideration of the drawings, it will be clear how the circuits function when ringing over the tip conductor or when using negative superimposed ringing current.
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What is claimed is:

1. In a telephone system, a first office, a plurality of sources of ringing current at said first office, a second office, a similar plurality of sources of ringing current at said second office, a trunk circuit connecting said offices, a telephone circuit outgoing from said second office, means to apply ringing current from one of said sources at said first office to said trunk circuit, means associated with said trunk circuit at said second office for determining the nature of incoming ringing current, and means responsive to the operation of said determining means to apply ringing
 40 current from the corresponding one of said plurality of sources at said second office to said outgoing telephone circuit.

2. In a telephone system, a plurality of sources of ringing current differing in polarity at a first office, a similar plurality of sources of ringing current at a second office, a trunk circuit connecting said offices, a telephone circuit outgoing from said second office, means to apply ringing current from
 50 either one of said sources of ringing current at said first office to either side of said trunk circuit, means associated with said trunk circuit at said second office for testing the conductors of said trunk for said ringing current, means thereupon effective for testing the polarity of the incoming ringing current, and means responsive to the operation of said testing means to cause the application of ringing current of the same polarity to the
 60 same side of said outgoing telephone circuit.

3. In a telephone system, a plurality of sources of ringing current differing in polarity at a first office, a similar plurality of sources of ringing current at a second office, a trunk circuit connecting said offices, a telephone circuit outgoing from said second office, means to apply ringing current from
 70 either one of said sources of ringing current at said first office to either side of said trunk circuit, a pair of alternating current relays at said second office, means to associate said relays with the two sides of said trunk to test for the presence of ringing current, a pair of polarized relays, means responsive to the operation of either alternating current relay to connect said polarized relays in series to said incoming trunk to determine the polarity of said ringing current, and means responsive to the joint operation of one alternating current relay and one polarized relay
 75 for connecting ringing current of the same polarity to the corresponding conductor of the outgoing line.

4. In a telephone system, a first office, a plurality of sources of ringing current at said first office, a second office, a trunk circuit connecting said offices, means to prepare a talking circuit over said trunk circuit, means at said first office to apply ringing current from one of said sources to said trunk circuit, means at said second office for testing the nature of the incoming ringing current, and means responsive to the operation of said applying means to open said talking circuit at said second office and to associate said testing means with said trunk.
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5. In a telephone system, a first plurality of sources of ringing current, a corresponding second plurality of sources of ringing current, a trunk circuit, means to apply ringing current from one of said first plurality of sources to the incoming end of said trunk circuit, testing means for determining the nature of the ringing current applied, means responsive to the operation of said applying means to associate said testing means with said trunk circuit, and means responsive to said testing means to apply ringing current from the corresponding second source to the outgoing end of said trunk circuit.
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6. In a telephone system, a first office, a plurality of sources of ringing current at said first office, a second office, a trunk circuit connecting said offices, means for preparing a talking circuit over said trunk circuit, means at said first office for manually applying ringing current to said trunk circuit from one of said sources, means at said first office for automatically applying ringing current to said trunk circuit from one of said sources, means at said second office for testing the nature of the incoming ringing current, and means responsive only to the operation of said automatic applying means to open said talking connection at said second office and to as-
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sociate said testing means with said trunk.

7. In a telephone system, a first plurality of sources of ringing current, a corresponding second plurality of sources of ringing current, a trunk circuit, means for manually applying ringing current from one of said first plurality of sources to the incoming end of said trunk circuit, means for automatically applying ringing current from one of said first plurality of sources to the incoming end of said trunk circuit, testing means for determining the nature of the ringing current applied, means responsive only to the operation of said automatic applying means to associate said testing means with said trunk circuit, and means responsive to said testing means to apply ringing current from the corresponding second source to the outgoing end of said trunk circuit.

8. In a telephone system, a first office, a plurality of sources of ringing current at said first office, a second office, a corresponding second plurality of sources of ringing current at said second office, a trunk circuit connecting said offices, a subscriber's substation including a switchhook contact, means for connecting said trunk circuit with said substation, means for preparing a talking circuit over said trunk circuit to said substation, means at said first office for applying ringing current from one of said sources to the incoming end of said trunk circuit, testing means for determining the nature of the ringing current applied, means responsive to the operation of said applying means to associate said testing means with said trunk circuit, means responsive to said testing means to connect ringing current from the corresponding second source to the outgoing end of said trunk circuit and said substation, and means associated with said testing means responsive to the closure of said switchhook contact to cause the disconnection of said applying means from said trunk circuit.

9. In a telephone system, a first office, a plurality of sources of ringing current at said first office, a second office, a corresponding second plurality of sources of ringing current at said second office, a trunk circuit connecting said offices, a subscriber's substation including a switchhook contact, means for connecting said trunk circuit with said substation, means to prepare a talking circuit over said trunk circuit to said substation, means at said first office for applying ringing current from one of said sources to the incoming end of said trunk circuit, testing means for determining the nature of the ringing current applied, means responsive to the operation of said applying means for associating said testing means with said trunk circuit, means responsive to said testing means to connect ringing current from the corresponding second source to the outgoing end of said trunk circuit and said substation,

and means associated with said testing means responsive to the closure of said switchhook contact to cause the removal of ringing current from both ends of said trunk circuit.

10. In a telephone system, a first quality of sources of ringing current, a corresponding second plurality of sources of ringing current, a trunk circuit, means for manually applying ringing current from one of said first plurality of sources to the incoming end of said trunk circuit, means for automatically applying ringing current from one of said first plurality of sources to the incoming end of said trunk circuit, testing means for determining the nature of the ringing current applied, means responsive only to the operation of said automatic applying means to associate said testing means with said trunk circuit, means responsive to said testing means to connect ringing current from the corresponding second source to the outgoing end of said trunk circuit, and to said substation, and means associated with said testing means responsive to the closure of said switchhook contact to cause the disconnection of said applying means from said trunk circuit.

11. In a telephone system, a first plurality of sources of ringing current, a corresponding second plurality of sources of ringing current, a trunk circuit, means for manually applying ringing current from one of said first plurality of sources to the incoming end of said trunk circuit, means for automatically applying ringing current from one of said first plurality of sources to the incoming end of said trunk circuit, testing means for determining the nature of the ringing current applied, means responsive only to the operation of said automatic applying means to associate said testing means with said trunk circuit, means responsive to said testing means to connect ringing current from the corresponding second source to the outgoing end of said trunk circuit and said substation, and means associated with said testing means responsive to the closure of said switchhook contact to cause the removal of ringing current from both ends of said trunk circuit.

In witness whereof I hereunto subscribe my name this 1st day of September, 1931.

JOHN W. GOODERHAM.