June 1, 1926. 1,586,527

E. E. HINRICHSEN

TELEPHONE SYSTEM

Original Filed July 14, 1920 2 Sheets-Sheet 1

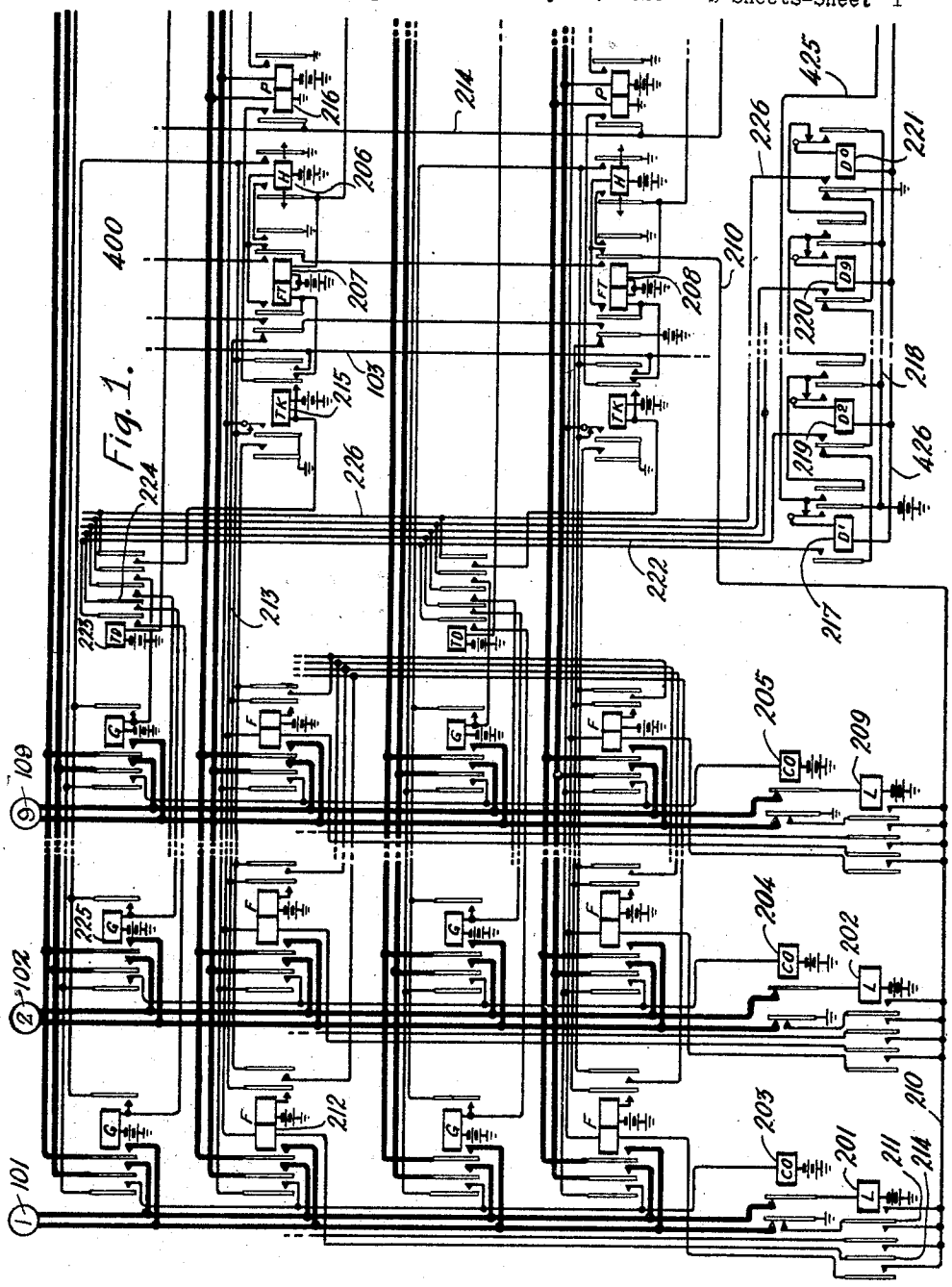


Fig. 1.

Inventor:
Edward E. Hinrichsen
by R. C. Hopgood
Att'y.

June 1, 1926.

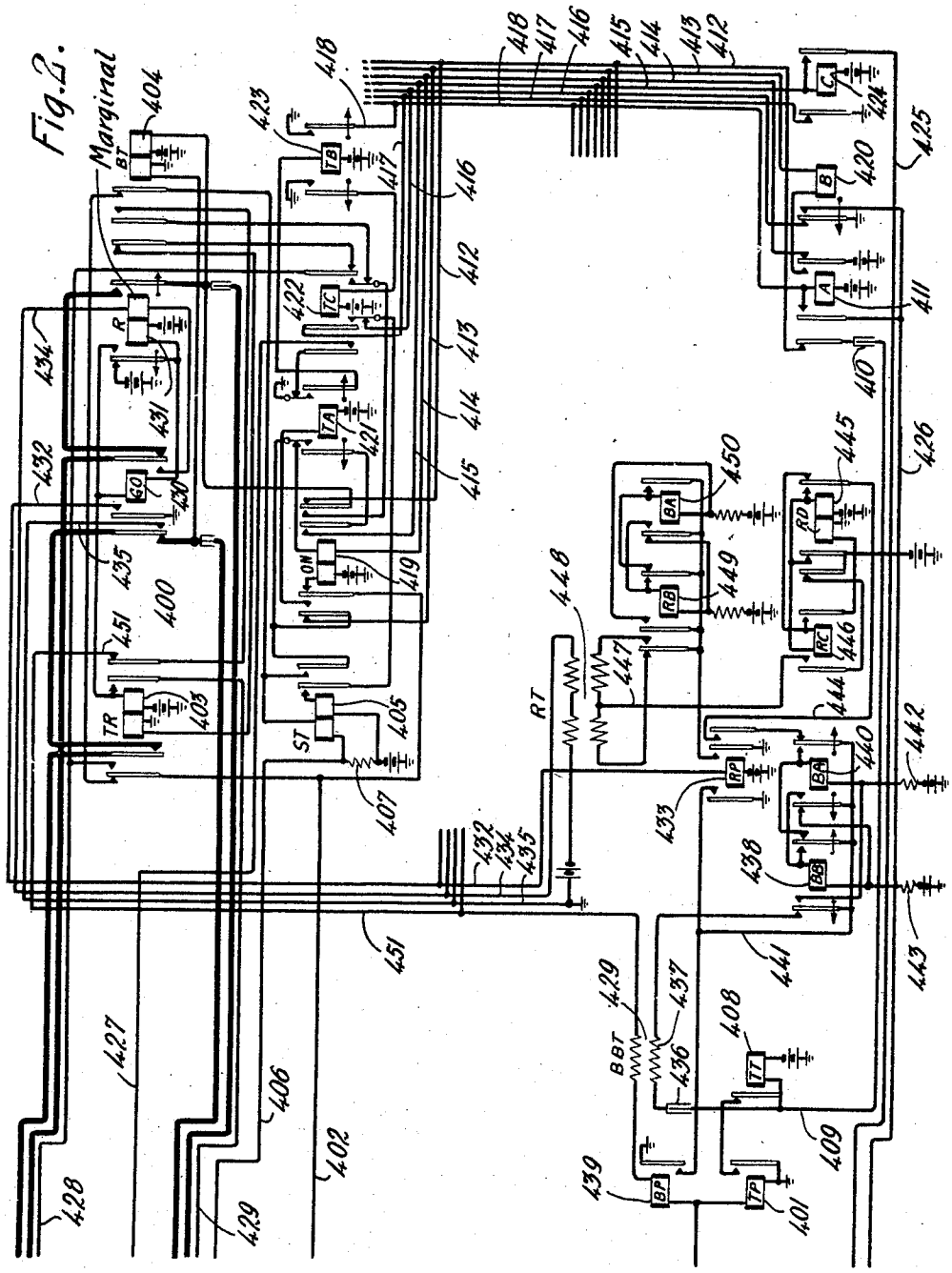
1,586,527

E. E. HINRICHSEN

TELEPHONE SYSTEM

Original Filed July 14, 1920 2 Sheets-Sheet 2

Fig. 2.



Inventor:
Edward E. Hinrichsen
by R. C. Hopgood
Att'y.

Patented June 1, 1926. 1,586,527

UNITED STATES PATENT OFFICE.

EDWARD E. HINRICHSEN, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE SYSTEM.

Original application filed July 14, 1920, Serial No. 396,143. Divided and this application filed September 28, 1923. Serial No. 665,280.

This invention relates to telephone systems and particularly to subscriber-operated switching means for private branch exchange working. This application is a division of application Serial No. 396,143 filed July 14, 1920, which has been issued as Patent No. 1,507,116 on September 2, 1924 to E. E. Hinrichsen.

The object of the invention is to provide an all relay system of small capacity embodying all the conveniences of a modern automatic telephone system suitable for use in a private residence or small business establishment where the number of stations is so small that the regular employment of an operator is unwarranted.

A feature of the present invention resides in the busy tone and ringing circuits wherein busy tone and ringing currents are generated and controlled entirely by relays. Two relays each with means for making and breaking the circuit of the other are employed as an interrupter for alternately applying a source of direct current to different primary windings of a transformer. Application of direct current in this manner produces in the secondary winding an alternating current of the proper characteristics for use as ringing current. Another pair of relays of the slow releasing type in a similar circuit are employed to slowly interrupt a circuit at a uniform rate. These slow interruptions are utilized to control a busy tone circuit so that characteristic interrupted busy tone may be supplied to a distributing point. These slow interruptions are also utilized to control a third pair of relays which are arranged in such a circuit that two complete cycles of said slow interruptions are utilized in energizing said last pair of relays in all their possible combinations. These last relays in turn control a circuit at a periodic but non-uniform rate and this latter circuit is used to control the application of ringing current in what are known as the silent and ringing periods.

Other features including novel circuit details will be more apparent as the description progresses.

In the accompanying drawing one embodiment of this invention is diagrammatically illustrated. Fig. 1 represents a group of subscribers' lines with the means for making incoming and outgoing connections to link circuits. Fig. 2 is a representation of a link circuit.

A station to station call.

In the drawings, three station lines are shown which, in the system, would be stations 1, 2 and 9, here numbered 101, 102 and 109 respectively. Individual to each station line, there is a line relay L, whose function is to respond to outgoing calls from the substation and to initiate circuit movement for connecting the calling line to the first idle link circuit. Also, individual to each line is a cut-off relay CO whose function is to respond to the seizure of a line on an incoming call to cut-off the line relay and prevent the taking of an idle link circuit, as on an outgoing call. This relay also responds to the seizure of an idle link circuit on an outgoing call to cut-off the line relay and remove the calling condition set up by said line relay. Individual to each link circuit there are a number of relays whose functions are as follows:

Relay F operates to join a calling line to a link circuit.

Relay G operates to connect a link circuit to a called line.

Relay TD operates to connect the common numerical leads from the counting relays to the G relays of the link circuit whereby a particular G relay is operated.

Relay P is an impulse-responsive relay and functions in the manner of the well-known line relay, responding to impulses propagated and transmitted from the substation, and supplies, through its windings, talking battery for the calling substation.

Relay H is a holding relay and functions as the first slow relay in the modern step-by-step systems. This relay remains energized during the sending of impulses, although its circuit is continually opened for short intervals during this time.

Relay FT is an allotter relay. When the link circuit is idle, this relay is in normal position and in this condition renders the link circuit selectable. When the link circuit is seized, this relay becomes energized and transfers the selectable condition to the next idle link circuit. It also functions to put relay H under direct control of relay P.

Relay TK is a trunking relay. When a trunk, rather than a local connection, is de-

sired, this relay operates in the same manner as the relay G and acts to cause a direct connection between a calling line and an idle trunk and to then restore the link circuit to normal.

Relay ST is a stepping relay controlled by relay P to transmit the dial impulses to the counting relays.

Relay ON is a test relay and, depending on the busy or idle condition of the counting relays will either remain deenergized or become energized, thereby causing the operation of a relay A associated with the counting relays to remove the condition which marks the counting relays as idle. When the counting relays are in use, relay ON fails to operate thereby preventing relay ST from locking and performing its proper functions.

Relay TA is a slow-to-release relay effectively responsive to the train of impulses transmitted from the substation. At the end of the last impulse, relay TA deenergizes and extends a ground through the contacts of relay TC to energize relay TD which, in turn, causes the energization of a particular relay G.

Relay TC is a fast relay indirectly controlled by relay TA. Its function is to connect ground from the contacts of relay TA after it has been deenergized to the winding of relay TD. It also acts to transfer a locking ground from the back contact of a relay B associated with the counting relays to the back contact of a relay C also associated with the counting relays. The function of relays A, B and C will be brought out hereinafter.

Relay TB is directly responsive to relay TA and is of the slow-to-release type whereby after the relay TA is deenergized, relay TB still maintains its armatures in its attracted position for an interval long enough to cause the proper energization of the relay TD.

Relay BT is a busy test relay. It operates when the called line is busy, cuts off the sleeve of the called line from relay TR and transmits busy tone to the calling line. It opens the circuit of relay ST to prevent any displacement of the apparatus, should the calling subscriber attempt to dial again. Relay BT also acts as the battery feed supply coils for the called line.

Relay TR is a relay responsive to the idle condition of the called line. When BT fails to operate TR becomes energized and opens the circuit of relay ST, in this way performing the same function as that pointed out for relay BT. Upon operation it marks the called line as busy.

Relay GO starts the ringing interrupters and connects the called line to the ringing leads. This relay is short-circuited by the relay R when it in turn operates.

Relay R is the ringing relay. Upon the operation of relay GO, ringing current is supplied through one of its windings to the called line and, being a marginal relay, will not attract its armatures until the subscriber by taking his receiver off the hook, so reduces the resistance of the substation loop that sufficient current will flow to cause the energization of this relay. Thereupon, relay R short circuits the windings of relay GO and locks itself in a local circuit to maintain the conversational circuit closed.

Relays A, B and C, which are common to the link circuits, have the following functions:

Relay A acts to supply dial tone to the link circuits to indicate the idle condition of the counting relays. When the subscriber removes his receiver from the hook and relay F functions, if the counting relays are idle and he may therefore operate his dial sender, dial tone will be transmitted from a back contact of relay A to the calling subscriber. Relay A therefore also acts to cut off the dial tone and the operating battery from the link circuits when the counting relays are in use.

Relay B is a slow-to-release relay whose function is to prevent the locking of relays ST should a called subscriber fail to notice the absence of dial tone.

Relay C cooperates with relay ST. It cuts off the holding ground from relay ST so that upon the end of the impulse, relay ST will be deenergized. Relay C functions to operate the counting relays.

The actions and interactions of these relays will be more apparent from a description of the establishment of a station to station call.

When the subscriber at substation 101 removes his receiver from its switchhook, line relay 201 becomes energized through a circuit including battery, winding of relay 201, inner armature and back contact of relay 203, the loop of substation 101, back contact and outer armature of relay 203 to ground. Relay 201 attracts its armatures and extends a circuit from battery, winding of relay 206, back contact and inner right-hand armature of relay 207, front contact and inner right-hand armature of relay 208 (assuming the first link circuit to be in use), conductor 210, contact and armature 211 of relay 201, back contact and outer left-hand armature of relay 203 to ground. Relay 206 is energized in this circuit.

The energization of relay 201 also closes a circuit from ground, outer left-hand armature and back contact of relay 203, armature 211 and its associated contact of relay 201, contact and armature 214 of relay 201, left-hand winding of relay 212, conductor 213, back contact and outer left-hand armature of relay 207, front contact and outer left-

hand armature of relay 208 to battery. Relay 212 is energized in this circuit and through its three left-hand armatures, connects the calling line 101 to the link circuit 400. As soon as relay 212 is energized a ground is extended from the right-hand armature of relay 206, normal contacts of the inner left-hand armature of relay 215, outer left-hand armature and front contact of relay 212 winding of cut off relay 203 to battery. Relay 203 becomes energized and cuts off the line relay 201 which in turn becomes deenergized. The loop of the calling substation now causes the energization of relay 216 whereupon a circuit is extended from ground, winding of relay 401, conductor 214, left-hand armature and contact of relay 216, inner right-hand armature and back contact of relay 215, left-hand winding of relay 207 to battery. Relay 207 is energized in this circuit and through its inner right-hand armature and its outer left-hand armature, extends the starting wires to the next idle link circuit in the same manner as relay 208 which through its energization extended the starting wires to the link circuit 400. The ground for operating relay 207 is extended through the inner left-hand armature and front contact of relay 207 to the winding of relay 206 whereby relay 206 is put under the direct control of relay 216. Relays 206 and 207 being now energized, a circuit is extended from ground, the outer right-hand armature and front contact of relay 207, left-hand armature and front contact of relay 206 to the right-hand winding of relay 207 so that relay 207 remains energized as long as the holding relay 206 is energized. Through the outer right-hand armature of relay 207 and the left-hand armature of relay 206, ground is placed on conductor 402 thence through the outer left-hand armature and back contact of relay 403, the back contact and inner left-hand armature of relay 404, to the left-hand winding of relay 405. The left-hand winding of relay 405, however, is short-circuited at this time due to a connection from ground, the right-hand armature and front contact of relay 216, conductor 406 to the winding of relay 405. The resistance 407 prevents the short-circuiting of the battery.

Since the left-hand winding of relay 207 and the winding of relay 206 are supplied with current flowing through the winding of relay 401, this latter relay is energized and, through its armature, causes the energization of relay 408 which, because its circuit is made through its back contact and armature, is alternately energized and deenergized so that it buzzes and sets up on the conductor 409, a tone. This tone is used as a dial tone and extends over the conductor 409, through the condenser 410, the outer left-hand armature and back contact of relay 411, conductor 412, back contact and outer right-hand armature of relay 419, the right-hand winding of relay 404 to battery. By the inductive relation of the two windings of relay 404 and their connection to the main conductors of link circuit 400, this dial tone is transmitted to the calling substation 101. The connection is now in a stable condition awaiting the sending of a series of impulses from the calling substation.

Let it be assumed that the subscriber at substation 101 wishes to establish a connection to substation 102. He thereupon manipulates his dial to send a series of two impulses which are in the form of two short interruptions of his line circuit. Relay 216 responds to this by retracting its armatures twice in quick succession and finally moving them to the attracted position where they remain until the end of the conversation. Upon the first retraction of the armatures of relay 216, the ground is removed from the conductor 406 whereupon relay 405 becomes energized and attracts its armatures. Relay 405 locks up in a circuit including battery, the right-hand winding of relay 405 front contact and inner right-hand armature of relay 405, normal contacts of the inner left-hand armature of relay 422, conductor 416 back contact and left-hand armature of relay 420. Immediately a circuit is established from battery, the right-hand armature and back contact of relay 411, conductor 414, right-hand winding of relay 419, normal contacts of the left-hand armature of relay 421, outer right-hand armature and front contact of relay 405 to the ground on conductor 402. Relay 419 becomes energized, and through its left-hand winding, front contact and inner left-hand armature of relay 419 locks to the ground on conductor 402. A circuit is now established from the ground on the left-hand winding of relay 405 through the front contact and outer right-hand armature of relay 405, outer left-hand armature and front contact of relay 419, winding of relay 421 to battery and ground. Relay 421 becomes energized in this circuit and attracts its armatures. Thereupon a circuit is established from ground, the alternate contact and right-hand armature of relay 421 to the winding of relay 423. Relay 423 is energized in this circuit. Through its right-hand armature it places a ground on conductor 418 thence to the winding of relay 411 to battery, whereby relay 411 is energized. The energization of relay 411 through the movement of its right-hand armature cuts off the operating battery through the conductor 414 whereby relays ON of other link circuits may not be energized until the counting relays have become idle.

By its left-hand armature, relay 423 places a ground on the winding of relay 422 which operates, whereby the circuit previously described for the locking of relay 405 is now replaced by a circuit extending from ground, the left-hand armature and back contact of relay 424, conductor 417, inner left-hand armature and alternate contact of relay 422, inner right-hand armature and front contact of relay 405, and right-hand winding of relay 405 to battery. A circuit is now established from battery, the winding of relay 424, conductor 415, front contact and inner right-hand armature of relay 419, left-hand armature and alternate contact of relay 421, outer right-hand armature and front contact of relay 405 to the ground supplied over conductor 402 for the left-hand winding of relay 405. This causes the energization of relay 424 whereby the locking ground for the right-hand winding of relay 405 is removed.

Through its right-hand armature, relay 424 places a ground on conductor 425 which extends through the normal contacts of the inner right-hand armature of relay 217 to the winding of relay 217. However, through the energization of relay 411 and the attraction of its inner left-hand armature, a ground is placed on the conductor 426 and thence to the other side of the winding of relay 217. Hence relay 217 is short-circuited at this time.

Relay 216 now attracts its armatures and through its right-hand armature and front contact again short-circuits the left-hand winding of relay 405 and since the right-hand winding no longer has a holding ground, relay 405 retracts its armatures. Thereupon the ground for energizing relay 424 is removed and a circuit is established from battery, the winding of relay 424, the front contact and right-hand armature of relay 424, conductor 425, normal contact of the inner right-hand armature of relay 217, winding of relay 217, conductor 426, inner left-hand armature and front contact of relay 411, conductor 418, right-hand armature and front contact of relay 423 to ground. Relay 217 attracts its armatures and through its inner right-hand armature and alternate contact locks up to the battery connected to conductor 218. The movement of the armatures of relay 217 opens the circuit just described for relay 424 whereby it becomes deenergized. The retraction of its armatures by relay 405, opens a circuit for relay 421 but since this is a slow-to-release relay, it does not retract its armatures until after the whole series of impulses have been sent. When relay 216 again retracts its armatures on the second interruption of the line circuit by removing the short-circuit from around the left-hand winding of relay 405, relay 216 again causes the energization of relay 405. Again relay 424 is energized and, in a similar manner, establishes a short-circuit around the winding of relay 219. When relay 216 attracts its armatures at the end of the series of impulses, relay 405 is short-circuited as before and the ground is again removed from conductor 415 by the movement of the outer right-hand armature of relay 405. Counting relay 219 now becomes energized in series with relay 424, and through the movement of its armatures deenergizes relay 424 at the same time locking up to battery and conductor 218.

It will thus be seen that two interruptions representing the digit 2 will cause the energization of the first two counting relays 217 and 219, so that the ground will be extended from the left-hand armature and back contact of the last counting relay 221; the left-hand armature and back contact of the next counting relay 220 and so on until it reaches the left armature and front contact of the last counting relay to be operated, that is, relay 219, where the ground will be extended through the front contact to conductor 222. In a short interval of time, relay 223 will be energized whereupon conductor 222 will be extended through the armature 224 and front contact of relay 223 to the winding of relay 225.

Upon the retraction of its armatures by relay 405, the circuit for relay 421 is permanently opened whereby after a short interval relay 421 becomes deenergized. A circuit is then established from ground, the normal contacts of the right-hand armature of relay 421, the outer left-hand armature and front contact of relay 422, conductor 427, winding of relay 223 to battery, whereby relay 223 is energized with the resultant energization of relay 225 as just described.

Let it be assumed that substation 102 is at this time busy. A ground on the third wire will then be connected through the outer left-hand armature of relay 225 to conductor 428, the right-hand armature and alternate contact of relay 422, the outer right-hand armature and front contact of relay 419, the right-hand winding of relay 404 to battery. Relay 404 becomes energized in this circuit. A short interval after relay 421 has become deenergized, relay 423 retracts its armatures resulting in the deenergization of relay 422 and the deenergization of relay 411 whereby relay 223 and the counting relays are restored to normal, relay 225 having locked up through its right-hand armature and contact to ground at the right-hand armature of relay 206.

A source of busy tone 429 is now connected through the back contact and outer right-hand armature of relay 403, the front contact and middle left-hand armature of relay 404, the lower normal contacts of the right-hand armature of relay 422, the front contact and

outer right-hand armature of relay 419 to the winding of relay 404, whereby through the inductive relation of the two windings of relay 404, busy tone is transmitted to the calling subscriber's station.

The calling subscriber now replaces his receiver on its hook whereby relay 216 becomes deenergized. Since this is more than a short interruption, the circuit including the left-hand armature and front contact of relay 216, the inner right-hand armature and back contact of relay 215, the inner left-hand armature and front contact of relay 207, the winding of relay 206, is broken so that relay 206 becomes deenergized. Thus, the ground is removed from the right-hand winding of relay 207 and it becomes deenergized. The ground being removed from conductor 402, relay 419 becomes deenergized and relay 206 by opening its contact at its right-hand armature, removes the ground for holding relays 225, 212 and 203 whereupon the connection is entirely restored to normal.

Let it be assumed that substation 102 is idle. Therefore, as soon as relay 421 becomes deenergized the circuit for the energization of relay 223 which connects the grounded lead 222 to relay 225, is established as before. A circuit will now be established through battery, the winding of relay 204, the outer left-hand armature and front contact of relay 225, conductor 428, right-hand armature and alternate contact of relay 422, outer right-hand armature and front contact of relay 419, right-hand winding of relay 404 to battery, but neither relay 204 nor 404 become energized in this circuit. In a short interval, relay 423 becomes deenergized and in turn relay 422 becomes deenergized. Thereupon this circuit is changed to lead now through the upper normal contact of the right-hand armature of relay 422, the outer left-hand armature and back contact of relay 404, the left-hand winding of relay 403 to ground. This causes the energization of both relays 204 and 403 whereupon relay 204 is energized directly from the ground on conductor 402 through the outer left-hand armature and front contact of relay 403 to conductor 428, relay 403 in the meantime having locked up through its right-hand winding, inner armature and front contact to conductor 429, the normal contact of the inner left-hand armature of relay 215, front contact and right-hand armature of relay 206 to ground. The ground on the right-hand armature of relay 403 is also extended through the winding of relay 430, the left-hand armature and back contact of relay 431 to battery. Relay 430 becomes energized and through its inner left-hand armature and front contact places ground on conductor 432 which extends to the winding of relay 433, and thence to battery whereby relay 433 becomes energized and starts the ringing relays as will be pointed out hereinafter. This places ringing current on conductors 434 and 435. A ringing circuit is now established from ground, conductor 435, front contact and outer left-hand armature of relay 430, front contact and inner left-hand armature of relay 403, through the loop of the called substation, front contact and right-hand armature of relay 430, right-hand winding of relay 431, conductor 434 to the other terminal of the source of ringing current. Ringing current flowing in this circuit is insufficient to cause the energization of relay 431 until the called subscriber removes his receiver from its hook. At that time, relay 431 becomes energized and by moving its left-hand armature, short circuits the winding of relay 430 which becomes deenergized. Relay 431 establishes a locking circuit through the left-hand winding of relay 431, left-hand armature and front contact of relay 431 to the ground on conductor 429. The conversational circuit is now established.

Talking battery is supplied to the calling line through the windings of relay 216 and to the called line through the windings of relay 404. It is immaterial at this time whether relay 404 becomes energized or not as the movement of its armatures is without effect.

At the end of the conversation when the calling subscriber replaces his receiver on its hook, relay 216 becomes deenergized and the connection is restored to normal in the manner described.

Busy tone and ringing circuits.

The operation of the busy tone and ringing circuits will now be described. When relay 401 becomes energized as before described, relay 408 is caused to buzz, placing on conductor 409 a tone which may be transmitted steadily through condenser 410 as a dial tone to the calling subscribers and which may also be transmitted through condenser 436 to the primary winding 437 of the busy tone transformer and thence through the back contact and left-hand armature of relay 438 to a ground on conductor 441 which may be supplied either at the contact and armature of relay 439 or at the contact and left-hand armature of relay 433. Relays 438 and 440 are operated by this ground to alternately open and close the circuit of the primary winding 437 in the following manner: When ground is placed on conductor 441, it is extended through the right-hand armature and back contact of relay 438 through the winding of relay 440, thence through the resistance 442 to battery. Relay 440 becomes energized in this circuit and connects the ground on conductor 441 through the left-hand armature and front contact of relay 440 through the winding of relay 438, thence through the

resistance 443 to battery. The energization of relay 438 opens the circuit for relay 440 whereby after a short interval it becomes deenergized. The retraction of its armatures by relay 440 in turn opens the circuit for relay 438 whereby after a short interval it becomes deenergized. Thereupon the circuit for the energization of relay 440 is again established and so on. It will thus be seen that relays 438 and 440 are alternately energized and deenergized and being slow-to-release relays, the resultant action is a slow making and breaking of the circuit including the primary winding of transformer 437. Thus the source of busy tone 429 is made periodically effective.

The ground on conductor 441, placed there by the left-hand armature of relay 433, may be periodically extended through the right-hand armature and back contact of relay 440, the outer right-hand armature and front contact of relay 433 to conductor 444. From thence it is extended through the right-hand armature and back contact of relay 445, the winding of relay 446, the back contacts and inner left-hand armature of relay 445 to battery. Relay 446 is energized in this circuit. When relay 440 becomes energized, the ground is removed from conductor 444 whereupon a circuit is established from battery, the inner left-hand armature and back contact of relay 445, the winding of relay 446, front contact and right-hand armature of relay 446, the left-hand winding of relay 445 to ground. The current in this circuit causes the energization of relay 445, whereupon the right-hand winding of relay 445 is now included in the circuit just traced. When relay 440 again becomes deenergized, ground from conductor 441 is connected to conductor 444 and thence through the front contact and right-hand armature of relay 445, the right-hand winding of relay 445 to battery. The ground connected at this point causes the short-circuiting of the left-hand winding of relay 445 and the winding of relay 446. Relay 446 becomes deenergized. In a short interval relay 440 again becomes energized. Thereupon the ground is removed from conductor 444 which results in the deenergization of relay 445. It will thus be seen that the pair of relays 445 and 446 cooperate to close the left-hand armature and front contact of relay 446, once for every two movements of the armature of relay 440. In other words, the movement of the pair of relays 445 and 446 is half as fast as the movement of the pair of relays 438 and 440. The pair of relays 445 and 446 is used to periodically place battery through the outer left-hand armature and back contact of relay 445, the left-hand armature and front contact of relay 446, through conductor 447 so that current will flow through either the right-hand or left-hand primary windings of the source of ringing current 448 to the outer left-hand armature and contacts of relay 449, the front contact and inner right-hand armature of relay 433 to ground. This battery connection to conductor 447 is thus made only when relay 446 is energized and relay 445 is deenergized and since this condition obtains only once during every other closure of the right-hand armature and back contact of relay 440, the ringing period will be one third as long as the silent period. In other words the pair of relays 438 and 440 constitute a primary interrupter arrangement delivering impulses in cycles in which the circuit closures and the circuit breaks are uniform in duration and this device controls a secondary interrupter device, comprising relays 445 and 446, which delivers impulses in cycles in which the circuit closures and the circuit breaks are non-uniform in duration and of a lower frequency than the impulses delivered by the said primary interrupter device. The pair of relays 449 and 450 act in exactly the same manner as the pair of relays 438 and 440. Both being fast relays, their vibration is fast enough to cause the currents flowing in the primary windings of the transformer 448 to set up an alternating current of the proper frequency for ringing purposes in the secondary windings of the transformer 448.

Thus, when a relay such as 430 becomes energized, in turn causing the relay 433 to become energized, the ringing relays are started and a source of ringing current is placed on conductors 434 and 445. When a called line has been found busy, a circuit is established from ground, winding of relay 401, winding of relay 439, secondary of transformer 429, conductor 451, back contact and outer right-hand armature of relay 403, front contact and middle left-hand armature of relay 404, lower normal contacts of relay 422, front contact and outer right-hand armature of relay 419, right-hand winding of relay 404 to battery. This causes the energization of relay 401 and 439 whereby a source of busy tone 429 is made effective and through the inductive relation of the windings of relay 404 busy tone is transmitted to the calling subscriber.

A system of this character may be adapted for trunk connections with central office equipment as disclosed in the above mentioned Patent 1,507,116 granted September 2, 1924.

What is claimed is:

1. In a telephone system, an interrupting device comprising a pair of relays arranged in a circuit with means controlled by each relay for controlling the other, whereby said relays operate periodically and automatically, and interrupting contacts controlled by

said relays, another pair of relays arranged in a circuit including said contacts whereby two successive closures and openings of said contacts will cause said other pair of relays to be successively actuated in all possible combinations and a circuit periodically controlled by said second pair of relays.

2. In a telephone system, an interrupting device comprising a pair of relays arranged in a circuit with means controlled by each relay for controlling the other, whereby said relays operate periodically and automatically, and interrupting contacts controlled by said relays, at a uniform rate, another pair of relays arranged in a circuit including said contacts whereby two successive closures and openings of said contacts will cause said other pair of relays to be successively actuated in all possible combinations and contacts controlled by said other pair of relays in non-uniform periods.

3. In a telephone system, a ringing device comprising a ringing current generator and an interrupting device, said interrupting device comprising a pair of relays arranged in a circuit, with means controlled by each relay for controlling the other, whereby said relays operate periodically and automatically, and interrupting contacts controlled by said relays, another pair of relays arranged in a circuit including said contacts whereby two successive closures and openings of said contacts will cause said other pair of relays to be successively actuated in all possible combinations and a circuit including said ringing current generator periodically controlled by said second pair of relays.

4. In a telephone system, a ringing device, comprising a ringing current generator and an interrupting device, said interrupting device comprising a pair of relays arranged in a circuit with means controlled by each relay for controlling the other, whereby said relays periodically and automatically at a uniform rate and interrupting contacts controlled by said relays, another pair of relays arranged in a circuit including said contacts whereby two successive closures and openings of said contacts will cause said other pair of relays to be successively actuated in all possible combinations and a circuit including said ringing current generator controlled by said second pair of relays in non-uniform periods.

5. In a telephone system, a ringing device comprising a ringing current generator and an interrupting device, said ringing current generator comprising an arrangement of relays and a transformer, said relays being arranged in a circuit with means controlled by each relay for controlling the circuit of the other, whereby said relays operate periodically and automatically, said relays controlling a switching device for alternately energizing different windings of said transformer, said interrupting device comprising a pair of relays arranged in a circuit with means controlled by each relay for controlling the other, whereby said relays operate periodically and automatically and interrupting contacts controlled by said relays, another pair of relays arranged in a circuit including said contacts whereby two successive closures and openings of said contacts will cause said other pair of relays to be successively actuated in all possible combinations and a circuit including said transformer windings periodically controlled by said second pair of relays.

In witness whereof, I hereunto subscribe my name this 25th day of September A. D. 1923.

EDWARD E. HINRICHSEN.