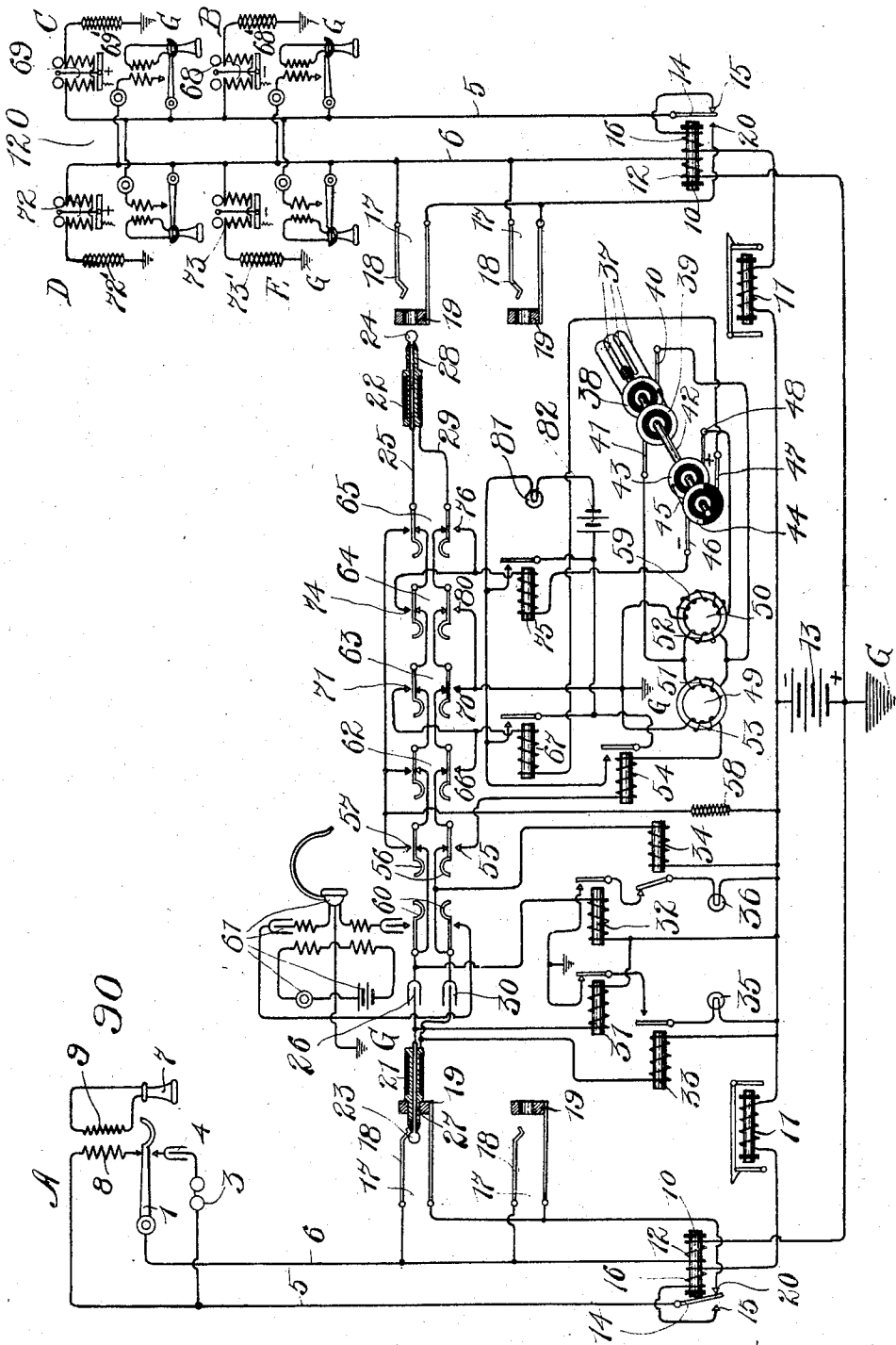


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H. G. WEBSTER.
TELEPHONE EXCHANGE SYSTEM.

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Witnesses:

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TELEPHONE-EXCHANGE SYSTEM.

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Application filed December 5, 1903. Serial No. 183,861.

To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to telephone-exchange systems, and particularly to party-line systems in which a number of subscribers' substations are connected to a single telephone-line, such as a bimetallic line, and at each of which substations the signaling apparatus may be actuated separately and independently of the apparatus at all of the other substations. As distinguished from certain party-line systems of the prior art, however, all of the substation signaling apparatus is at all times connected with the line limbs in the same manner, there being no change or disconnection in the circuit arrangements for these signaling devices.

I have herein described a four-party-line system and a cord connecting apparatus and central-station apparatus adapted to cause the operation of the signaling devices connected with this four-party line. The signaling apparatus at two of the substations is connected between one of the line limbs and ground, while the signaling apparatus at the other substations is connected between the other line-limb and the ground.

I have shown my invention in conjunction with substation signaling apparatus containing biased ringers each of which is adapted to be actuated by a pulsating direct current. Of the two biased bells connected with either line limb one is positively adjusted and the other negatively, so that one may be actuated by pulsations in one direction and the other by pulsations in the reverse direction.

It is desirable in installing a system in accordance with my invention to serially include in circuit with each of the biased ringers a high non-inductive resistance, which prevents

excessive line leakage. The operator's cord-circuit at the central station contains either four or five ringing-keys, the embodiment which is here shown illustrating five such keys, one of which, however, is adapted to be used for sending alternating currents between the line limbs to cause the actuation of substations whose signal-bells are intended to be operated by alternating currents. The four other keys are intended when actuated to cause the connection of a proper source of signaling-current, each with one of the four biased ringers on a four-party line.

Four-party lines have heretofore been provided with such polarized or biased ringers, two connected between the ground and either line limb; but there has been this disadvantage in the operation of such lines that in case a subscriber at any substation has removed his telephone-receiver from the switch-hook there is provided a circuit between the two line limbs, and in sending a ringing-current, say, of positive polarity over one line limb to actuate one of the polarized bells part of the current will pass through the telephone apparatus and the other line limb and thence to ground through a polarized ringer which it was not intended to ring. In this way false signals have arisen, which have given great annoyance.

It is one of the features of my invention that means is provided in association with each of the pulsating-current ringing-keys whereby that line limb over which signaling-currents are not being passed is connected to ground by a short-circuit path, whereby the false operation of the biased ringers is prevented. I have found it desirable in the operation of a system constructed in accordance with my invention to utilize pulsating currents of comparatively high voltage for the operation of the polarized or biased ringers, while the current adapted for the actuation of a line provided with a regular alternating-current ringer may be considerably lower.

It is one of the features of my invention that I provide a single electric generator and two transformers adapted to furnish pulsating

currents in either direction and of relatively high voltage and also to furnish alternating currents of lower voltage. By means of the use of pulsating currents of higher voltage than is used for the operation of alternating-current ringers it is possible to give the tension-springs of the biased ringers considerable tension, whereby the false clicks and operations of these ringers due to the passage of discharge or other stray currents are prevented.

My invention will be understood by reference to the accompanying drawing, in which at substation A on line 90 I have illustrated the usual form of subscriber's substation apparatus comprising a switch-hook 1, which when in its normal depressed condition serves to connect the alternating-current ringer 3 and serially-connected condenser 4 in bridge of the line limbs 5 and 6. The receiver 7 when removed from the switch-hook 1 permits this switch-hook to assume its alternative position, in which the primary winding 8 of an induction-coil is connected in bridge of the line limbs, the secondary winding 9 being connected with the receiver, as shown. The line limbs 5 and 6 lead to the central station, where they may be connected to any suitable line signaling apparatus. That shown in the present embodiment of my invention comprises a cut-off relay 10 and a line-signal 11. The line limb 6 leads through a winding 12 of the cut-off relay 10 and thence to the positive grounded pole of the common battery 13. The other line limb, 5, is connected with the armature 14, which when in its normal retracted position makes connection with the back contact 15, which is connected, through the winding 16 of the differential cut-off relay and the line-signal 11, to the negative pole of the common battery 13. The usual line-jacks in multiple are shown at 17 17, the tip-springs 18 18 being connected directly with the line-limb 6, while the sleeve-contacts 19 19 are connected, through a common conductor, with the front contact 20 of the differential cut-off relay.

The operator's cord connecting apparatus comprises an answering-plug 21 and calling-plug 22, the tip-contacts 23 and 24 of these plugs being connected by means of the tip-strand 25, whose conductive continuity is interrupted by the serial inclusion of a condenser 26, which, however, permits the passage of telephonic voice-currents. The sleeve-contacts 27 and 28 of the plugs are connected by means of a sleeve-strand 29, in which there is included also a condenser 30. The double supervisory signal-controlling apparatus comprises a supervisory controlling-relay 31, connected between the negative pole of the common battery 13 and the section of the tip-strand 25 leading to the tip-contact 23. There is also provided a supervisory controlling-relay 32, which is connected between the

negative pole of the common battery and the other section of the tip-strand, which is connected with the tip-contact 24. There is also connected between the negative pole of the common battery and the section of the sleeve-strand leading to the sleeve-contact 27 a supervisory relay 33. A supervisory relay 34 is connected between the negative pole of the common battery and that section of the sleeve-strand which leads to the sleeve-contact of the calling-plug 22. The supervisory relays 31 and 33 control the illumination of a supervisory signaling-lamp 35 in the manner well understood by those skilled in the art. In the same manner the relays 32 and 34 jointly control the illumination of the supervisory signaling-lamp 36.

There is provided an alternating-current generator whose armature-winding is diagrammatically represented at 37, the terminals of this winding being shown connected with the collector-rings 38 and 39, upon which bear the brushes 40 and 41. Mounted upon the armature-shaft 42 or suitably connected therewith so as to rotate at the same speed there is provided a third collector-ring 43, which is a complete ring, and also a semicircumferential ring 44, these rings 43 and 44 being connected by the conductor 45, as shown. A brush 46 rides upon the segmental collector-ring 44, and a second brush 47 rides upon the same collector-ring. The collector-ring 43 is equipped with a single brush 48. It will be noted that the points of contact of the brushes 46 and 47 with the segmental collector-ring 44 are approximately diametrically opposite each other. Suitable transformers are shown at 49 and 50. These transformers are each provided with a primary 51 or 52, which are both connected in circuit with the brushes 40 and 41, which take off alternating currents from the armature-winding 37.

The transformer 49 is provided with a secondary alternating-current winding 53, one terminal of this winding being connected to the ground at G and the other leading through a ringing-signal-controlling relay 54 to the sleeve-contact 55 of the alternating-current ringing-key 56. The tip-contact 57 of this alternating-current ringing-key is connected through a non-inductive resistance 58 with the negative pole of the common battery 13. The other transformer, 50, is provided with a considerably longer secondary winding 59, one terminal of which is connected with the brush 48, which rides upon the continuous collector-ring 43, and the other terminal of which is connected with the ground G, as shown. It will be seen that the windings of the secondaries 53 and 59 are such that the currents set up in the winding 59 will be of approximately twice the voltage of those set up in the winding 53.

The usual listening-key 60 is provided for

the purpose of connecting the operator's telephone set in bridge of the cord-strands. The induction-coil of this operator's set is provided with a divided secondary, on either side of which a condenser is serially connected, and the middle point of the winding in the operator's receiver is connected with the ground G, as shown. This arrangement is for purposes of the busy-test circuit, which will hereinafter be more fully pointed out, but which forms no part of my present invention.

There is a series of pulsating-current ringing-keys (lettered 62, 63, 64, and 65) each of which when actuated serves to connect with a cord-strand leading to the calling-plug a source of pulsating direct currents. The actuation of the ringing-key 62, for instance, serves to connect the tip-strand leading to tip-contact 24, through the non-inductive resistance 58, with the negative pole of the common battery 13, while the sleeve-strand leading to sleeve-contact 28 is connected, through contact 66 and relay 67, to the brush 47. The actuation of this key 62 when the plug 22 is inserted within a line-jack 17, associated with line 120, causes the closure of the following circuit: from the ground G at the central station, through the secondary winding 59, to brush 48, through collector-ring 43, conductor 45, semicircumferential collector-ring 44, brush 47, relay 67, contact 66, sleeve-strand 29, sleeve-contact 28, the thimble 19 to front contact 20, armature 14, and thence through line limb 5 to substations B and C on line 120, and through the biased ringers 68 and 69 and their associated non-inductive resistances 68' and 69' to the ground G.

It will be noted that the brush 47 makes contact with the terminal collector-ring 44 during only one-half of its revolution, and the disposition of the parts is made such that this connection is established only during one-half of the period of the alternating current—that is, pulsations in one direction are taken off the segmental collector-ring 44 by the brush 47, while pulsations in the reverse direction are taken off the segmental collector-ring by the brush 46. We may assume that the brush 47 takes off pulsations in the positive direction and that the brush 46 takes off pulsations in the negative direction. Therefore the pulsations caused to traverse the line-limb 5 to ground, due to the actuation of the pulsating-current ringing-key 62, being in the positive direction would cause the actuation of the biased ringer 69 and would not cause the actuation of the biased ringer 68, for the reason that the ringer 69 is positively polarized or biased and that the ringer 68 is negatively polarized. A manipulation of the pulsating-current ringing-key 63 serves, by means of the contact 70, to establish a connection between the sleeve-strand 29 and the ground G. The connection between the tip-strand of the cord-circuit and the contact 71 leads through the relay 67 to

the brush 47, which takes off the positive pulsations from the segmental collector-ring 44. As the contact 71 makes connection with the tip-strand, which is connected, through the tip-spring of the line-jack 18, to a tip-line limb 6, positive pulsations are sent out over the line limb 6 to actuate the positively-polarized ringer 72 at substation D, this ringing-current traversing also the serially-connected non-inductive resistance 72'. The negatively-polarized ringer 73 at substation E is connected in a circuit between the line-limb 6 and the ground G, there being included in this circuit also a non-inductive resistance 73'. A manipulation of the pulsating-current ringing-key 64 serves to connect the sleeve-strand 29 directly with the ground G and at the same time, by means of the contact 74, to connect the tip-strand 25, through a relay 75, with the brush 46, which takes off negative impulses from the segmental collector-ring 44. Current may be traced from this brush 46 through the tip-strand 25, tip-contact 24, line limb 6, and the negatively-polarized ringer 73 to ground G at substation E. The pulsations sent out over the line limb 6 to ground will not effect the operation of the ringer 72 on account of its positive polarization. An actuation of the pulsating-current ringing-key 65 serves, in the first place, to cause a connection between the tip-strand 25 and the negative pole of the common battery and thence through the battery to ground by way of the non-inductive resistance 58. At the same time the actuation of this key causes a connection, by means of the contact 76, through the relay 75, with the negative brush 46. Currents may be sent over this circuit to cause the operation of the negatively-polarized ringer 68, connected with the line limb 5. It will thus be seen that by means of the actuation of the proper pulsating-current ringing-key any one of the substations B, C, D, or E may be signaled without causing the operation of the bell at any other substation.

At each of the substations B, C, D, and E there is provided any suitable form of telephone instruments, which may be connected in bridge of the line limbs by removing the telephone-receiver from the switch-hook. If a receiver at one of these substations is removed from the switch-hook, there is provided a path for current between one line limb and the other, and as the ringing-circuits are between the ground and one of the line limbs such a removal of a receiver would provide four paths for ringing impulses which were intended only for passage over one line limb, and as there is connected with either line limb bells of both polarizations there would be two bells actuated instead of one upon the connection of a pulsating current of one character between one line limb and ground. It is one of the features of my invention that means is provided to prevent the false operation of a

signal-bell upon the removal of a receiver in this way to connect the two line limbs together. This is accomplished by providing with each of the pulsating-current ringing-keys a ground connection adapted to ground the line limb which is not used in sending out a pulsating calling-current through a short or low-resistance circuit. For instance, it will be seen that the actuation of ringing-key 62 serves to connect the source of pulsating direct currents between ground and the sleeve side of the line. At the same time the tip side of the line is connected, through the non-inductive resistance 58 and the battery 13, with the ground G. If, therefore, one of the receivers upon line 120 be removed from its hook, the two line limbs will be connected together; but current passing over from the sleeve-line to the tip-line will take the low-resistance path to ground which is afforded at the central station rather than the high-resistance non-inductive path through the polarized ringer connected between ground and the tip side of the line. The resistance 58 is preferably of comparatively low resistance—for instance, fifty ohms. A manipulation of the key 63, in addition to connecting the source of pulsating currents with the tip side of the line, also connects the sleeve side of the line, through contact 70, directly with the ground G. Thus if there is provided upon the line a leakage-path between the tip side of the line and the sleeve side, over which pulsating currents might otherwise pass, these leakage-currents will traverse the short-circuit path afforded at the central station to the ground G rather than the path at the substations through the ringers and high non-inductive resistances. The manipulation of the key 64, which connects pulsating currents to the tip side of the line, also serves to connect the sleeve side directly with the ground G by means of the contact 80. A manipulation of the key 65 in the same way connects the source of pulsating currents with the sleeve side of the line and connects the tip side to the fifty-ohm non-inductive resistance 58 and the common battery 13 with ground G. In ringing over the sleeve side of the line it is necessary that the armature 14 be in its forward or attracted position. In order to cause or maintain the attraction of this armature during the passage of such ringing-currents over the sleeve side of the line, a circuit may be traced from the positive pole of the battery through the winding 12 of the cut-off relay, the tip-spring 18 of the jack within which the calling-plug 22 has been inserted, the tip-contact 24 of this plug, tip-strand 25, and thence through a contact of either one or the other of the sleeve ringing-keys 62 or 65 and through the non-inductive resistance 58 back to the negative pole of the common battery. Current flowing over this source when the as-

sociated ringing-key is manipulated causes a net energization of the differential cut-off relay 12 to maintain the armature 14 in its forward attracted position, whereby ringing-currents may be sent from the sleeve-contacts 19 of the jacks through the front contact 20 and the armature 14 to the line-limb 5.

The operation of a system constructed in accordance with my invention will be at once apparent to those skilled in the art. A subscriber at substation A in initiating a call removes his receiver from the switch-hook, whereupon the line signaling apparatus is actuated to indicate to the central-station operator that a connection is desired. The operator answers this signal by inserting the answering-plug within a line-jack associated with the line 90, whereupon a circuit of decreased resistance is closed through one winding of the differential relay to cause a net energization thereof, whereupon its armature is attracted to cut out the line-signal and to connect the sleeve-contacts of the jacks directly with the line-limb. This circuit through the winding 12 of the differential cut-off relay upon plugging into the associated jack causes the energization of the supervisory controlling relay 31. The supervisory relay 33 is of course energized by current through the substation apparatus, whereupon its armature is attracted to prevent the illumination of the supervisory lamp 35. The operator, after ascertaining the number of the substation desired inserts the calling-plug within a line-jack associated with the line to be called. If this line is such a one as illustrated at substation A upon line 90, the regular alternating-current ringing-key 56 is manipulated, whereupon an alternating-current source of current—in this instance the secondary winding 53—is connected between the ground and the sleeve side of the line. As the tip side of the line is grounded at central, as shown, an alternating current will be caused to pass through the alternating-current ringer to cause an actuation thereof. If, however, any one of the substations upon such a four-party line as No. 120 is desired, the operator after inserting the calling-plug in the associated line-jack manipulates the pulsating-current ringing-key to correspond with the connection and polarization of the signal-bell at the desired substation. Thus to call the subscriber at substation C the operator manipulates key 62. A manipulation of the key 63 causes an actuation of the signal-bell at substation D. An actuation of the key 64 causes the operation of the call-bell at substation E, and an actuation of the key 65 causes the operation of the signal-bell at substation B. A subscriber at any one of these substations answers the call in the usual manner, causing the extinguishment of the supervisory lamp 36, due to the energization of the associated supervisory re-

lay 34, this lamp having been caused to glow upon the insertion of the calling-plug, due to the energization of the supervisory controlling-relay 32 over a circuit including the tip-strand, the tip-spring 18, and the winding 12 of the differential cut-off relay. The differential relay is of course energized and actuated at the same time, due to the passage of this current. The subscribers upon completing the conversation replace their receivers upon the switch-hooks, whereupon the supervisory signaling-lamps are caused to glow in the well-known manner, whereupon the operator removes the plugs from the jacks and restores the apparatus to its initial condition.

There is shown in connection with each of the ringing-circuits a relay. I refer now to the relays 54, 67, and 75, which may be known as "ringing-signal" relays. These relays each control a local circuit for a ringing-signal lamp 81, which may derive its current from a local battery 82, as shown. The actuation of any one of the ringing-keys causes energization of the associated ringing-relay and the illumination of the lamp 81 upon closure of the local lamp-circuit in order to give the operator a suitable signal of the operativeness of the ringing-circuits. Before inserting the calling-plug within a jack associated with a called line the operator applies the testing tip-contact 24 to the thimble of the jack to ascertain whether or not the called line is busy. Under normal conditions when the line is not in use the tip-contacts will be insulated, so that there will be no effect upon applying the testing-tip to such an idle thimble. If, however, a plug at some other position on the switchboard has been inserted within one of the associated multiple jacks, the application of the tip-contact to such a thimble will cause a click in the operator's receiver to indicate that the tested line is busy. When a plug is inserted within any one of the multiple jacks associated with the line, the sleeve-contacts of these jacks are charged to the potential of the negative pole of the common battery 13. It will be seen that the middle point of the operator's receiver is connected to the ground and that one coil of the receiver may be connected by a manipulation of the listening-key with the tip-strand of the cord-circuit, this path including a condenser. If, therefore, the tip-contact 24 is applied to a thimble which has been charged to a potential above that of the ground, there will be a discharge of the condenser in the operator's circuit, which serves to give her a busy test.

While I have herein shown and described a preferred embodiment of my invention, it will be apparent to those skilled in the art that many modifications may be employed without departing from the spirit thereof. I do not, therefore, wish to limit myself to the precise disclosure herein set forth; but,

Having described my invention, I claim as new and desire to secure by Letters Patent—

1. In a telephone-exchange system, the combination with a central exchange, of a telephone-line leading therefrom, a plurality of substations connected with each limb of the telephone-line, a signal-bell at each substation connected between one of the limbs and ground, a source of signaling-current at the central exchange, an operator's cord-circuit, means associated with said cord-circuit for connecting said source of current with one of the limbs of the telephone-line and ground, means for connecting the other limb of the line to ground, a relay at the central exchange through which the signaling-current flows, a local circuit controlled by said relay, and a signal in said circuit.

2. In a telephone-exchange system, the combination with a central exchange, of a metallic telephone-line leading therefrom, a plurality of substations connected with each limb of the telephone-line, a polarized signal-bell at each substation connected between one limb of the line and ground, an operator's cord-circuit, a plurality of keys for said circuit, a source of pulsating current, actuation of one of said keys serving to connect said pulsating current with one limb of the telephone-line to actuate one of the polarized signal-bells connected with said limb, actuation of said key serving also to connect the other limb of the line to ground, a relay at the central exchange through which the signaling-current flows, a local circuit controlled by said relay, and a signal in said circuit.

3. In a telephone-exchange system, the combination with a central exchange, of a metallic limbed line extending therefrom, a plurality of substations connected with said line, telephonic apparatus at each substation connected in bridge of the metallic limbs, a polarized signal-bell at each substation connected between one of said limbs and ground, an operator's cord-circuit, a plurality of keys for said cord-circuit, a source of pulsating current, actuation of one of said keys serving to connect one of said limbs with ground and to connect the other limb with said pulsating current whereby one of the polarized signal-bells connected with said other limb is actuated, relays through which the ringing-current passes, a local circuit controlled by said relays, and a signal in said circuit.

4. In a telephone-exchange system, the combination with a central exchange, of a bimetallic telephone-line leading therefrom, a plurality of substations connected with said line, telephonic apparatus at each substation connected in bridge of the metallic limbs, a signal-receiving device at each substation connected between one of said limbs and ground, an operator's cord-circuit, a plurality of signaling-keys in said cord-circuit, one key being

associated with each of the substation signal-receiving apparatus, a source of signaling-current at the central exchange, the actuation of one of said keys serving to connect
5 said signaling-current with a metallic limb to which is connected the signaling receiving device associated with the actuated key, actuation of said key serving also to connect the other metallic limb with ground, relays through
10 which the signaling-currents flow and a signal controlled by said relays.

5. In a telephone-exchange system, the combination with a central exchange, of a bimetallic telephone-line leading therefrom, a plurality of substations connected with said line,
15 telephonic apparatus at each substation connected in bridge of the metallic limbs, a polarized signal-bell at each substation connected between one of said limbs and ground, an operator's cord-circuit, a plurality of signaling-
20 keys in said cord-circuit, each key being associated with one of the substation signal-bells, a source of pulsating current at the central exchange, actuation of one of said keys
25 serving to connect said pulsating current with the metallic limb to which is connected the signal-bell associated with said actuated key, actuation of said key serving also to connect the other metallic limb with ground, relays
30 through which the signaling-currents flow and a signal controlled by said relays.

6. In a telephone-exchange system, the combination with a central exchange, of a bimetallic telephone-line leading therefrom, a plurality of substations connected with said line,
35 telephonic apparatus at each substation connected in bridge of the metallic limbs, a signal-bell at each substation connected between one of the limbs and ground, the signal-bells
40 connected with each limb being differently polarized, an operator's cord-circuit, a plurality of signaling-keys in said circuit, each key being associated with one of the signaling-
45 bells, a source of pulsating current, actuation of any one of said keys serving to connect the appropriate pole of said source of current with the metallic limb to which is connected the signal-bell associated with said actuated
50 key, actuation of said key serving also to connect the other metallic limb to ground through a path of low resistance, relays through which the signaling-currents flow and a signal controlled by said relays.

7. In a telephone-exchange system, the combination with a central exchange, of a bimetallic telephone-line leading therefrom, a plurality of substations connected with said line,
55 telephonic apparatus at each substation connected in bridge of the metallic limbs, a signal-bell at each substation connected between one of said limbs and ground, a non-inductive high resistance in circuit with each signal-
60 bell, the signal-bells connected with each limb being differently polarized, an operator's cord-circuit, a plurality of signaling-keys in said

cord-circuit, each key being associated with one of said signal-bells, a source of pulsating current, actuation of any one of said signaling-keys serving to connect the appropriate
70 pole of said source with the metallic limb to which is connected the polarized signal-bell associated with said key, actuation of said key serving also to connect the other limb with ground through a path of low resistance, a relay included in each path of the pulsating current, and a local signal-circuit controlled by the relays. 75

8. In a telephone-exchange system, the combination with a central exchange, of a bimetallic telephone-line leading therefrom, a plurality of substations connected with said line,
80 signal-receiving apparatus at each substation, a source of signaling-current at the central exchange, a transformer adapted for inclusion in circuit with said source for transforming the current therefrom, means for connecting the transformed signal-current with the telephone-line to selectively actuate substation signaling apparatus, a relay through which the transformed current passes, and a
90 signal controlled by said relay.

9. In a telephone-exchange system, the combination with a central exchange, of a bimetallic telephone-line leading therefrom, a plurality of substations connected with said line,
95 a polarized signal-bell at each substation, an operator's cord-circuit, a source of pulsating current at the central exchange connected with the cord-circuit, a transformer for increasing the voltage of the current from said
100 source, signaling-keys in said cord-circuit for appropriately associating the transformed current with said telephone-line whereby one of said polarized signal-bells is actuated, relays included in the ringing-circuits and a signal controlled by said relays. 105

10. In a telephone-exchange system, the combination with a central exchange, of a bimetallic telephone-line leading therefrom, a plurality of substations connected with each
110 line, telephonic apparatus at each substation connected in bridge of the metallic limbs of the line, a signal-bell at each substation connected between one of said limbs and ground, the bells connected with each limb being differently polarized, an operator's cord-circuit, a source of pulsating current at the central exchange, means for increasing the voltage of said pulsating current, switching mechanism included in said cord-circuit for connecting the appropriate pole of said source with one of said limbs whereby one of said polarized signal-bells is actuated, a relay in each path of the ringing-current and a local signal-circuit controlled by the relays. 125

11. In a telephone-exchange system, the combination with a central exchange, of a bimetallic telephone-line leading therefrom, a plurality of substations connected with said
130 line, telephonic apparatus at each substation

connected in bridge of the metallic limbs of the line, a signal-bell at each substation connected between one of the limbs and ground, the bells connected with each limb being differently polarized, an operator's cord-circuit, a plurality of signaling-keys in said circuit, each key corresponding with one of the signal-bells, a source of pulsating current at the central exchange, a transformer for increasing the voltage of the current flowing from said source, actuation of any one of said keys serving to connect the transformed current of proper polarity with the limb to which is connected the signal-bell associated with the actuated key, relays in the different paths of a ringing-current, and a signal controlled by said relays.

12. In a telephone-exchange system, the combination with a central exchange, of a bi-metallic telephone-line leading therefrom, a plurality of substations connected with said line, telephonic apparatus at each substation connected in bridge of the metallic limbs of the line, a signal-bell at each substation connected between one of said limbs and ground, a non-inductive high resistance included in circuit with each bell, the bells connected with each limb being differently polarized, an operator's cord-circuit, a plurality of signaling-keys in said circuit, each key being associated with one of said signal-bells, a source of pulsating current at the central exchange, a transformer for increasing the voltage of current flowing from said source, actuation of any one of said signaling-keys causing the transformed current of appropriate polarity to be connected with the metallic limb to which is connected the signal-bell associated with the ac-

tuated key, actuation of said key serving also to connect the other limb with ground through a path of low resistance, a relay in each path of the ringing-current and a signal controlled by the relays.

13. In a telephone-exchange system, the combination with a central exchange, of a bi-metallic telephone-line leading therefrom, a plurality of substations connected with said line, telephonic apparatus at each substation connected in bridge of the metallic limbs of the line, a signal-bell at each substation connected between one of said limbs and ground, a non-inductive high resistance included in circuit with each bell, the bells connected with each limb being differently polarized, an operator's cord-circuit, a plurality of signaling-keys in said circuit, each key being associated with one of said signal-bells, a source of pulsating current at the central exchange, a transformer for increasing the voltage of current flowing from said source, actuation of any one of said signaling-keys causing the transformed current of appropriate polarity to be connected with the metallic limb to which is connected the signal-bell associated with the actuated key, actuation of said key serving also to connect each limb with ground through a path of low resistance, relays at the central exchange included in the signaling-circuit, a local circuit controlled by said relays, and an indicating-signal in said circuit.

In witness whereof I hereunto subscribe my name this 17th day of September, A. D. 1903.

HARRY G. WEBSTER.

Witnesses:

HARVEY L. HANSON,
JOHN STAHR.