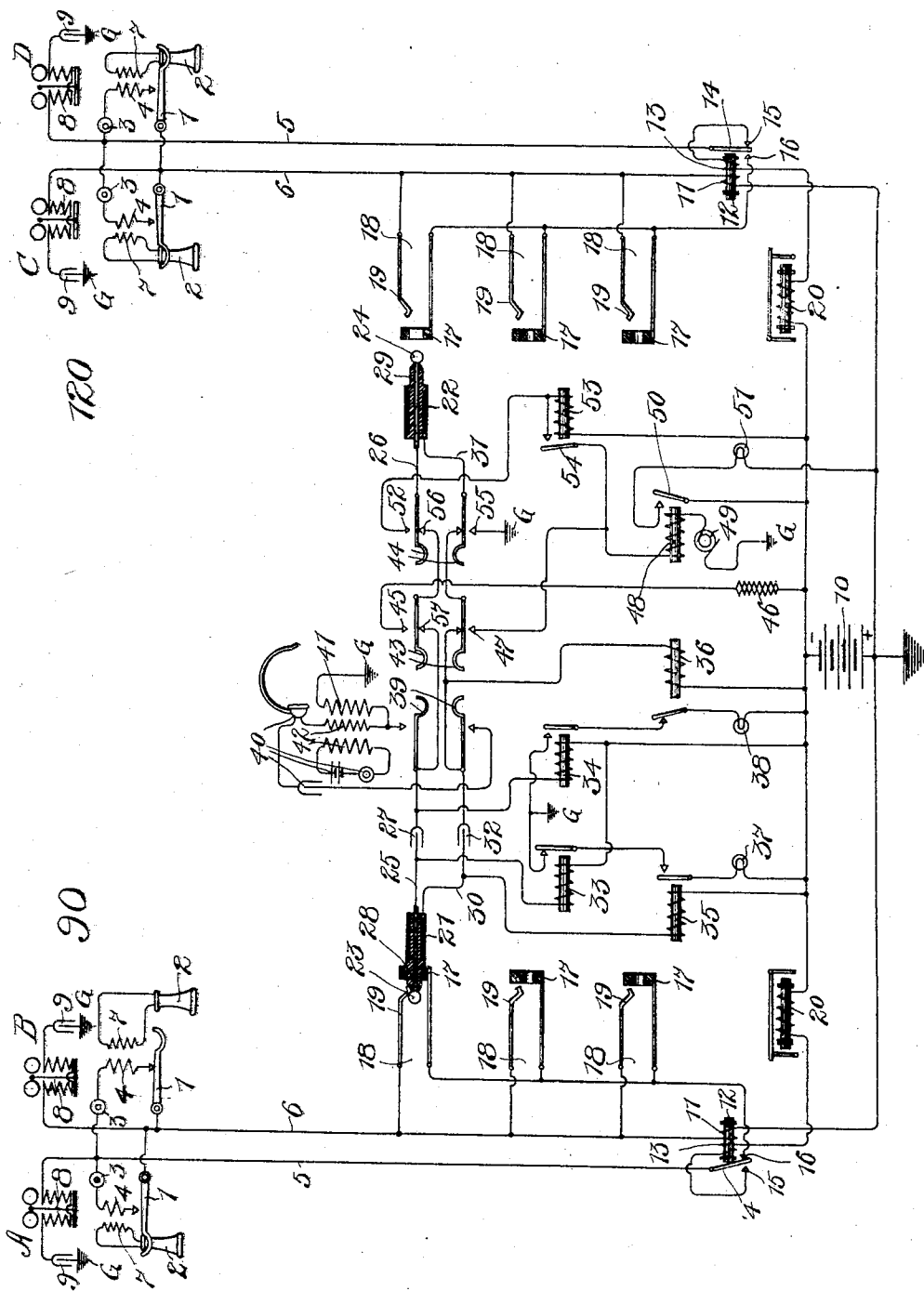


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H. G. WEBSTER.
TELEPHONE EXCHANGE SYSTEM.

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Witnesses

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TELEPHONE-EXCHANGE SYSTEM.

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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 drawings, forming a part of this specification.

My invention relates to telephone-exchange systems, and particularly to that part of telephone apparatus which is used for the purpose of ringing or signaling subscribers.

My invention provides means whereby a ringing-current may be conveyed to a substation over either limb of a bimetallic telephone-line, and provides means at the same time whereby a cut-off relay is energized by a continuous current to draw up its armature and to prevent the vibration of this relay due to the passage of alternating currents. In the preferred embodiment of my invention, which I shall describe more fully hereinafter, the cut-off relay is energized by a current passing from a common source of current through a tip-strand of an operator's cord connecting apparatus. Two ringing-keys are provided, one for sending an alternating ringing-current over the tip side of the line and the other over the sleeve side of the line. That key which causes the passage of an alternating current over the sleeve side is provided with a contact and an electrical connection, such that the tip-strand of the cord-circuit shall be connected with the common battery in such a way as to cause passage of a direct current through the cut-off relay when this ringing-key is actuated. The key which controls the passage of alternating ringing-currents over the tip side of the line is provided with a connection between the tip-strand and one side of the common battery, and this connection includes a relay which is cut in circuit upon the actuation of the associated ringing-key. This relay when thus energized by current passing through this relay and the cut-off relay causes the attraction of an armature which cuts the

alternating-current generator onto the tip-strand of the cord-circuit.

My invention will be more clearly understood by reference to the accompanying drawing, which diagrammatically illustrates a preferred embodiment of my invention.

I have illustrated at A, B, C, and D subscribers' substation sets, including in each instance a hook-switch 1, which when relieved of the weight of the receiver 2 serves to connect a transmitter 3 and the primary 4 of an induction-coil in bridge of the metallic line-limbs 5 and 6. The secondary 7 of the induction-coil is connected with the associated receiver, as shown. Each of the substations is provided with a signal-bell 8, adapted to be actuated by alternating currents, this bell in each instance being serially connected with a condenser 9, from which there is a connection to ground G. It will be noted that there are two substations connected with each of the metallic lines. One of the two substations connected with each line is provided with a call-bell and condenser connected between the wet side of the line and ground, while the call-bell and condenser at the other substation is connected between the dry side of the line and ground.

While my invention may be used with a great variety of line-circuits and supervisory systems, I have here illustrated a line-circuit in which the two line-limbs 5 and 6 are connected with opposite terminals of the common battery 10. The line-limb 6 is connected with the grounded positive pole of the common battery 10 through a winding 11 of the differential cut-off relay 12. The cut-off relay is provided with a second winding 13, which is normally included between the negative pole of the common battery and the line-limb 5 through a connection between the armature 14 and its back contact 15. When energized, the armature 14 is drawn up to break connection with the back contact 15 and to make connection with the front contact 16, the front contact 16 being connected with the sleeve-terminals 17 17 of the line-jacks 18 18. The tip-contacts 19 19 of these line-jacks are con-

nected directly with the line-limb 6. There is also included in the normal connection between the line-limb 5 and the negative pole of the common battery a line-signal of any well-known type, that here illustrated being in the form of a visual drop 20.

The operator's cord-circuit comprises an answering-plug 21 and a calling-plug 22, the tip-contacts 23 and 24 of these plugs being connected by a tip-strand comprising sections 25 and 26, which are inductively related through the condenser 27. The sleeve-contacts 28 and 29 of the connecting-plugs are connected by means of a sleeve-strand comprising the sections 30 and 31, these sections being inductively connected through a condenser 32.

Connected between section 25 of the tip-strand and the negative pole of the common battery 10 there is a supervisory controlling-relay 33. In the same way there is connected between the negative pole of the battery and the section 26 of the tip-strand a second supervisory controlling-relay 34. Between the section 30 of the sleeve-strand and the negative pole of the common battery there is connected a supervisory relay 35. A supervisory relay 36 is similarly connected between the negative pole of the common battery and the section 31 of the sleeve-strand. These supervisory controlling-relays and supervisory relays jointly control supervisory lamps 37 and 38 in the manner well understood by those skilled in the art and as will be more fully pointed out hereinafter.

The operator's cord-circuit is provided with the usual listening-key 39, which when actuated serves to connect the operator's telephone set 40 in bridge of the cord-circuit and to connect a separate test-winding 41 between the tip-strand of the cord-circuit and ground G, this winding 41 being in inductive relation with the induction-coil of the operator's telephone set.

As on each of the bimetallic lines there is a signal-bell connected between a line-limb and ground, it is necessary to provide means for sending an alternating signaling-current between either line-limb and ground. The ringing-key 43 is provided for the purpose of sending an alternating signaling-current between the sleeve side of the line and ground, while the ringing-key 44 is provided for the purpose of sending an alternating ringing-current over the tip side of the line to ground. The ringing-key 43 is provided with a tip-contact 45, connected, through a non-inductive resistance 46, with the negative pole of the common battery 10. It is also provided with a sleeve-contact 47, connected, through a ringing signal-relay 48, to one terminal of a source of alternating current, such as the alternating-current generator 49, whose other terminal is connected, as shown, to the ground G. This relay controls, by means of an armature 50, a local actuating-circuit for a ringing-sig-

nal, such as the small incandescent lamp 51. The tip ringing-key 44 is provided with a tip-contact 52, which is connected, through a cut-in relay 53, with the negative pole of the common battery 10, the energization of this cut-in relay causing the attraction of its armature 54 to provide a connection between one terminal of the alternating-current generator through the ringing signal-relay 48 to the tip-contact 52, this tip-contact 52 being connected to the tip-strand of the cord-circuit upon an actuation of the key 44. The tip ringing-key 44 is also provided with a sleeve-contact 55, connected directly to ground G.

The operation of a system constructed in accordance with my invention may be described as follows: A subscriber, for instance at substation B on line 90, upon removing his receiver 2 from the switch-hook 1 closes a conductively-continuous circuit between the line-limbs 5 and 6, whereby current is caused to traverse the line-signal 20 and the differential windings of the cut-off relay 12. The line-signal will be actuated by the passage of this current to indicate to the operator at the central station that a connection is desired. The cut-off relay will not be actuated by the passage of this current for the reason that there is no net energization of the relay-core on account of the differential relation of the relay-windings. The operator in answer to the signal inserts her answering-plug 21 within one of the line-jacks associated with line 90, whereupon the following circuit may be traced: from the negative pole of the common battery 10, through supervisory controlling relay 33, section 25 of the tip-strand, tip-contact 23, tip-spring 19, winding 11 of the differential cut-off relay, and thence to the positive grounded pole of the common battery 10. The closure of this circuit of decreased resistance through one winding of the cut-off relay causes a net energization thereof, whereupon its armature 14 is attracted to break the connection with the back contact 15 and thence through the line-signal 20 to the negative pole of the common battery. The interruption of this path also causes a discontinuance of the passage of current through the winding 13 of the differential cut-off relay. The connection of the armature 14 with its front contact 16 at the same time causes a direct connection through a non-inductive path between the line-limb 5 and the sleeve-contacts 17 of the multiple line-jacks. The insertion of this answering-plug into the jack of a line upon which the receiver has been removed from its switch-hook also causes the closure of the following circuit: from the negative pole of the common battery 10, through the supervisory relay 35, section 30 of the sleeve-strand, sleeve-contact 28 of the answering-plug 21, thimble 17 of the answering-jack 18, front contact 16, armature 14, line-limb 5, through the subscriber's sub-

station apparatus to line-limb 6, and thence through winding 11 of the differential cut-off relay back to the positive grounded pole of the common battery 10. The passage of current over this circuit causes an energization of the supervisory relay 35, whereupon its armature is attracted to break the otherwise completed circuit through the supervisory lamp 37. The operator after establishing connection with the calling-line manipulates her listening-key 39 to connect her telephone set in bridge of the cord-circuit and by conversing with the calling subscriber ascertains the number of the desired connection. Learning that one of the subscribers on line 120 is desired, she first applies the tip 24 of her cord-circuit to the test-thimbles 17 of the called line. When the line is not busy and under normal conditions, it will be seen that the thimbles 17 are disconnected from everything, there being no connection of any sort with the contact 16 to which these thimbles are all tied. If, however, a plug at some other operator's position has been inserted in one of the multiple line-jacks associated with line 120, the application of the testing tip-contact 24 to a sleeve 17 will cause the closure of the following circuit: from the positive grounded pole of the common battery 10, through the ground G to the test-winding 41 in inductive relation with the operator's induction-coil, thence through the actuated listening-key to the tip-strand of the cord-circuit, to tip-contact 24, to the thimble 17 to which the test is applied, thence to the other thimble of the multiple-jacks with which there is a plug in electrical connection, thence through the sleeve-strand of this other cord-circuit and through the associated supervisory relay corresponding with the relay 35 or 36, as here shown, and thence to the negative pole of the common battery 10. The closure of this circuit causes a click in the operator's telephone-receiver to indicate that the line is busy. If no such click is produced, the operator inserts her plug within the jack and proceeds to signal the subscriber at either substation C or substation D. The insertion of the calling-plug 22 within one of the multiple jacks 18 associated with the line 120 causes the closure of the following circuit: from the positive pole of the common battery 10, through the winding 11 of the differential cut-off relay, thence through a tip-spring 19 to the tip-contact 24 of the calling-plug, thence through the section 26 of the cord-circuit and through the supervisory controlling-relay 34 to the negative pole of the common battery 10. It will be noted that this circuit passes through the normal contacts 56 and 57 of the ringing-keys 44 and 43. The closure of this circuit causes an energization of the cut-off relay 12, whereupon its armature 14 is attracted to break the connection through the line-signal of the negative pole of the battery and to connect the

sleeve side 5 of the line directly with the sleeve-contacts 17 of the multiple jacks. If substation D on line 120 is to be signaled, the operator actuates the sleeve ringing-key 43, which, it will be noted, breaks the connection with the normal contact 57, through which the circuit through the cut-off relay 12 was traced. This would cause a deenergization of the cut-off relay, whereupon the armature 14 would fall back to break the connection with the sleeve-contacts of the jacks. The ringing-currents must pass from the sleeve-strand of the cord-circuit through the sleeve-contacts of the jacks to the sleeve-limb 5 of the telephone-line to substation 120 in order to pass through the ringing-bell and condenser at substation D. It is therefore necessary that the armature 14 remain in its attracted position to make a connection between the line-limb 5 and the thimble 17. The current to maintain the energization of the cut-off relay 12 may be traced through the following circuit when the sleeve ringing-key 43 has been actuated: from the positive pole of the common battery 10, through the winding 11 of the differential relay, tip-spring 19, tip-contact 24, section 26 of the tip-strand of the cord-circuit, tip-contact 45 of the sleeve ringing-key 43, and thence through the non-inductive resistance 46 to the negative pole of the common battery 10. The energization of the cut-off relay due to the passage of current through this circuit maintains the armature in its attracted position. The alternating ringing-current may be traced as follows: from ground G at the central station, through the ringing-generator 49, the ringing-signal-controlling relay 48 to contact 47, thence through section 31 of the sleeve-strand of the cord-circuit, sleeve-contact 29 of the calling-plug, sleeve-contact 17 of the multiple jack, front contact 16 of the cut-off relay, armature 14, line-limb 5, through the call-bell 8 at substation D, the associated condenser 9, and thence back through the ground G to the central station. The passage of current through this circuit causes the attraction of the armature 50 of the signal-indicating relay 48 to cause an illumination of the lamp 51, thus providing the operator with a suitable ringing-signal. The passage of current through this circuit also causes an actuation of the call-bell 8 at substation D to call the subscriber to his telephone. In case the subscriber at substation C is desired the operator manipulates the tip ringing-key 44, whereby the following circuits are established: from the positive pole of the common battery 10 through the winding 11 of the differential cut-off relay, the tip-spring 19, the tip-contact 24, section 26 of the tip-strand of the cord-circuit, contact 52, relay 53, and thence to the negative pole of the common battery. The passage of current over this circuit causes in the first place an actuation of the cut-off relay 12, whereby the armature

14 is attracted by a continuous direct current to close the connection between the line-limb 5 and the sleeve-contacts 17 of the multiple jacks. It will be remembered that the manipulation of the ringing-key 44 causes a break in the path for the current which served to energize the cut-off relay 12, and this path afforded through the relay 53 prevents the retraction of the armature 14 of the cut-off relay. At the same time the cut-in relay 53 is energized to cause an attraction of the armature 54. This contact 54 when making connection with its front contact serves to connect the ringing-generator 49 through the ringing-signal relay 48 with the tip-contact 52, and thence through the section 26 of the tip-strand, the tip-contact 24, the jack-spring 19, line-limb 6, call-bell 8, and condenser 9 at substation C to ground, the return-path to the generator being through the ground, as shown. As the relay 12 during this operation is energized by the passage of a direct and continuous current, there is no vibration and consequent wear upon the relay 12, not to speak of the annoyance which would be caused by the vibration of the armature. As in the case of the manipulation of the ringing-key 43, the passage of current from the generator 49 causes an energization of the relay 48, whereby the armature 50 is attracted to cause the illumination of the ringing-signal lamp 51, thereby indicating to the operator that the ringing-key is in its actuated position. The subscribers upon completing their conversation replace their receivers upon the switch-hooks, whereupon the supervisory apparatus is actuated in the well-known manner to cause the illumination of the supervisory signaling-lamps, whereupon the operator breaks the connection which has already been set up by removing her cord connecting-plugs from the line-jacks associated with the connected lines.

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 made 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 telephone-line terminating at a central exchange, of cord connecting apparatus for connecting said line with another for conversation, a cut-off relay adapted to be energized during the connection of said cord connecting apparatus with said line due to current passing over one strand of said cord connecting apparatus, a signaling-generator, a ringing-key, and an auxiliary relay adapted to be connected with said strand of the cord connecting apparatus upon the actuation of said ringing-key whereby a circuit is formed through said auxiliary relay and said cut-off

relay to maintain the energization of the latter, the energization of said relay serving to connect said signaling-generator with one of the cord-strands.

2. In a telephone-exchange system, the combination with a telephone-line terminating at a central exchange, of cord connecting apparatus for connecting said line with another for conversation, a cut-off relay adapted to be energized during the connection of said cord connecting apparatus with said line due to current passing over one strand of said cord connecting apparatus, a signaling-generator, a ringing-key, and an auxiliary relay adapted to be connected with said strand of the cord connecting apparatus upon the actuation of said ringing-key whereby a circuit is formed through said auxiliary relay and said cut-off relay to maintain the energization of the latter, the energization of said relay serving to connect said signaling-generator with the same cord-strand.

3. In a telephone-exchange system, the combination with a telephone-line extending from spring-jacks at a central exchange to two substations, signaling apparatus at one substation connected between one of the line-limbs and ground and signaling apparatus at the other substation connected between the other line-limb and ground, cord connecting apparatus at the central exchange for connecting said line with another for conversation, a cut-off relay adapted to be energized upon the connection of said cord connecting apparatus with said line, the circuit over which the cut-off relay is energized including the tip-strand of said cord connecting apparatus, two ringing-keys, the actuation of the first of said ringing-keys serving to connect a signaling-generator between ground and the sleeve-strand of said cord connecting apparatus, means whereby the actuation of said first ringing-key interrupts the energizing-circuit for said cut-off relay, means whereby the actuation of this key also serves to close an alternative path for current through said cut-off relay to maintain the energization thereof, and an auxiliary relay adapted to be included in an energizing-circuit with said cut-off relay upon an actuation of said second ringing-key, the circuit through the auxiliary relay including a portion of the tip-strand of said cord-circuit, the energization of said auxiliary relay serving to connect said ringing-generator between ground and the tip-strand of the cord connecting apparatus.

4. The combination with a telephone-line, of a relay in a bridge between the two limbs of said line, a charging source of electricity adapted when connection is made with the line to energize said relay, a calling-generator, a ringing-key adapted to connect said calling-generator with the line and to open the circuit of said charging source through said relay, means whereby the actuation of said

ringing-key causes the closure of an alternative circuit through said charging source and said relay to maintain the energization thereof during the actuation of said ringing-key, and a second relay in said alternative circuit, said relay controlling the circuit from said generator to said key.

5. The combination with a telephone-line, of a connection-terminal normally disconnected therefrom, a relay for connecting said connection-terminal with the line, a charging source of continuous current adapted to energize said relay, a calling-generator, a ringing-key adapted to connect said calling-generator with the line and to open the circuit of said charging source through said relay, means for temporarily sending a continuous current for said relay through a substitute circuit during the time the calling-generator is connected in circuit, and a relay in said substitute circuit, the generator-circuit being controlled by said relay.

6. The combination with a main circuit, of a call-bell at the substation responsive to non-continuous ringing-currents, a non-continuous-ringing-current generator at the central station, a continuous-current generator associated therewith, a signal at the central station, an electromagnetic device connected with the talking-circuit to render said signal inoperative during the connection, a circuit-closing device controlling the terminals of both of said generators and their connections with the main circuit so that when operated to

make connections the said device will be operated by the continuous current to prevent the operation of said signal by the ringing-current, and a relay in the continuous circuit for controlling the connection of said non-continuous generator with the circuit-closing device.

7. In a telephone-exchange system, the combination with a telephone-line terminating at a central exchange, of a cord-circuit for connecting said line with another for conversation, a relay adapted to be energized during a connection of said cord connecting apparatus with said line over a circuit including one of the said cord-strands, a ringing-key in said cord-circuit, a signaling-generator associated with said key, actuation of said key causing connection of the said signaling-generator circuit with the cord-circuit and line and causing a break in the circuit including said relay, a substitute circuit associated with said key and adapted when said key is actuated to again close the circuit through said relay to maintain energization thereof, and an additional relay in said substitute circuit, said additional relay controlling the continuity of the circuit from said generator to said key.

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

HARRY G. WEBSTER.

Witnesses:

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