H. G. WEBSTER.

TELEPHONE EXCHANGE SYSTEM.

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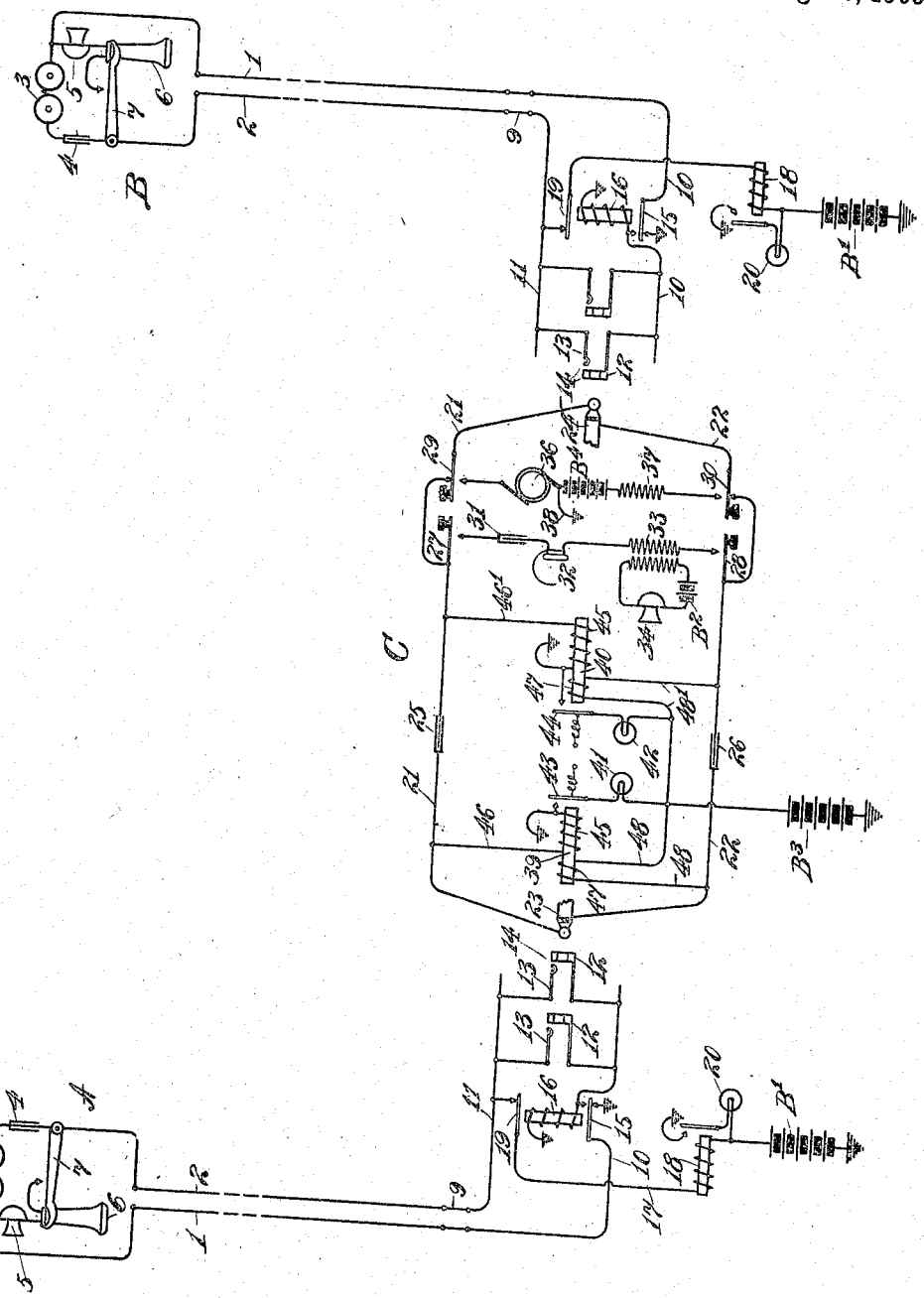

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TELEPHONE-EXCHANGE SYSTEM.

No. 930,515. Specification of Letters Patent. Patented Aug. 10, 1909.

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To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, a citizen of the United States, and resident of Chicago, county of Cook, and State of Illinois, have invented new and useful Improvements in Telephone-Exchange Systems, of which the following is a specification.

The present invention relates to central battery telephone exchange systems and more particularly to the organization of circuits and apparatus by which the supervision of the subscribers' lines is obtained by the operator. In systems of this type, the various subscribers' telephone lines, terminating in the central office, are adapted to be connected by suitable link-circuits with which the supervisory signals are associated. In operation, these signals are displayed as soon as the operator plugs in to an idle line, and are effaced when the subscriber removes his receiver from its hook.

The object of the present invention is to provide a novel arrangement of circuits and apparatus by which these functions may be satisfactorily accomplished.

In carrying out my invention, I associate with each supervisory signal a differentially-wound electromagnet having its windings so arranged that one is included in a circuit local to the central office and under the control of the operator, while both are included in a circuit controlled by the subscriber. Preferably, the circuit under the control of the operator is made and broken by the connection or disconnection of the plug, forming the terminal of the link-circuit, with the jack comprising the terminals of the telephone line, and, when so connected, the circuit under the control of the subscriber is made and broken at the latter's switch-hook. By the closing of the former circuit, the energization of the differentially-wound electromagnet is sufficient to cause the display of the supervisory signal; and by the closing of the latter circuit, the action of the windings being differential, the energization of said electromagnet is decreased sufficiently to efface the supervisory signal.

The character of the invention, together with its object and scope, will be best understood upon reference to the following description and claims, taken in connection with the accompanying drawing.

Referring to the said drawing, which illustrates diagrammatically two telephone lines in association with a connecting-cord or link-circuit equipped with the improved supervisory apparatus of my invention, A and B represent the two subscribers' stations, each of which is connected to the central office C by a telephone line comprising the limbs 1 and 2. Since both stations A and B are similarly equipped, it will be sufficient to refer to the equipment of station A. At this station, the call-bell 3, connected in series with the condenser 4, is bridged across the limbs 1—2. The transmitter 5 and receiver 6 are connected in series in a parallel branch between the limbs 1 and 2, which may be made and broken by the switch-hook 7 in the usual manner. The substation equipment herein disclosed is merely illustrative and any desired type of substation apparatus may be employed. The limbs 1 and 2 of the telephone line are connected at the central office to the distributing-board 9. Line conductors 10 and 11 extend said limbs to the contact-sleeves 12 and contact-springs 13 of multiple-jacks 14 located on the switch-board. The extension-conductor 10 is normally broken, and the portion connected to limb 1 is normally grounded through the armature 15 of the line-signal-effacing electromagnet which is here shown as a cut-off magnet or relay 16. The other portion of the extension-conductor 10 is connected to ground through the winding of the cut-off relay 16. A grounded branch 17, extending through the winding of the line-relay 18 and the battery B′ is normally connected to the extension-conductor 11, but may be broken through the agency of the armature 19 of the cut-off relay 16. The relay 18, when energized, closes a grounded branch from the free side of the battery B′ to ground through a call-signal lamp 20.

The link-circuit in the present instance comprises two link-conductors or strands 21—22, connected between the tips and sleeves, respectively, of the plugs 23—24, and including in circuit the usual condensers 25—26. Associated with these conductors are the listening and ringing keys designated 27—28 and 29—30, respectively. The closing of the listening-key 27—28 completes a branch between the two link-conductors 21 and 23 which includes the condenser 31, receiver 32, and the primary of an induction coil 33. The transmitter 34 is included in a local circuit comprising the battery B^2 and

the secondary of the said induction coil 33. The closing of the ringing-key 29—30, including the generator 36, completes a circuit between the portions of the link-conductors 21—22 connected to the calling-plug 24, through a branch including the generator 36, battery B^4, and resistance 37, the pole of the generator adjacent to the battery being grounded at 38.

The supervisory signals associated with the link-circuit comprise the differentially-wound electromagnets 39—40, which control the supervisory lamp signals 41 and 42, respectively. Each of these lamps is included in a circuit extending from the live pole of the battery B^3 to ground through the armatures 43 and 44, respectively, of the relays 39—40. Both relays are wound substantially alike. The windings 45, which are included in the grounded branches 46 and 46′ respectively, extending from the link-conductor 21, have individually a relatively greater number of turns than the windings 47 which are included in the branches 48—48′ extending from the live pole of the battery B^3 to the other link conductor 22.

In the operation of the system, if the subscriber at substation A removes his receiver 6, a circuit is completed from the battery B′, through the winding of call signal relay 18, the branch 17, the extension conductor 11, limb 2 of the telephone line, through switch-hook 7, receiver 6 and transmitter 5 at the substation, through limb 1 of the telephone line, extension conductor 10 and armature 15 of the cut-off relay to ground. This circuit causes the energization of the call signal 20. The operator thereupon inserts the answering plug 23 into a jack 14. This act completes a circuit of definite resistance local to the exchange and through the winding of cut-off relay 16, as follows: from the free pole of battery B^3, through branch 48, including winding 47 of the supervisory relay 39, through link-conductor 22 to the sleeve of the plug 23, thence through the sleeve 12 of the jack and the winding of the cut-off relay 16, to ground. This causes the cut-off relay to break the grounded branch 17 and to complete the circuits between the portions of the extension conductor 10. The breaking of the former branch removes the call signal 20 from the control of the subscriber at the substation A, while the completion of the circuit between the portions of the extension conductor 10 completes the metallic circuit from the substation to the operator's set, which may be included in circuit by closing the listening-key 27—28. It should be noted that when the operator inserts the plug 23 into one of the jacks 14, not only is a circuit completed through the winding 47 of the supervisory relay 39, but also through the winding 45 of said relay. The circuit through the latter winding may be traced as follows: from the free pole of the battery B^3, through the branch 48 including the winding 47, link-conductor 22, sleeve of the plug 23, contact 12 of the jack 14 to the winding of the cut-off relay 16 as before, thence through the armature 15, conductor 10, limb 1 of the telephone line, through the substation, limb 2 of the telephone line, extension conductor 11 to the contact spring 13 of the jack 14, thence through the tip of the plug 23, link-conductor 21 and grounded branch 46 which includes the winding 45. The windings 45 and 47 are opposed and so proportioned that when both of these circuits are completed, the armature 43 will not be drawn against its contact to complete the circuit through the supervisory lamp 41. When the operator has closed the listening-key 27—28 and obtained the wishes of the calling subscriber at station A, assuming that the desired station is station B, she will then test the circuit of the latter station by touching the tip of the plug 24 against a sleeve 12 of one of the jacks 14 of the latter line.

From the circuits previously traced, it will be seen that if the latter line is busy, there will be a potential on the sleeve 12 which will cause a flow of current from the said sleeve 12, through the tip of the plug 24, the link-conductor 21 and the branch 46′ including the winding 45 of the supervisory relay 40, to ground. With the listening-key 27—28 closed at this instant, the operator will obtain a "click" in her receiver 32, indicating the busy condition of the line. If the line is found to be idle, the operator will insert the plug 24 into a jack 14 of the telephone line running to the substation B. This act will complete a circuit local to the exchange and through the winding 47 of the supervisory relay 40, as follows: from the free pole of the battery B^3, through the branch 48′, winding 47 of relay 40, link-conductor 22, sleeve of the plug 24, sleeve 12 of a jack 14 and extension conductor 10 through the winding of relay 16 to ground. This will cause the energization of the cut-off relay and disconnect the call signal 20 from the line, thus removing it beyond the control of the subscriber at station B. The operator then closes the ringing-key 29—30 and thereby completes a circuit from the generator, through the contact 29 of the ringing-key, link-conductor 21, tip of the plug 24, spring contact 13 of the jack 14, extension conductor 11, limb 2 of the telephone line, the condenser and call-bell at station B, limb 1 of the telephone line, extension conductor 10 including the armature 15 of the cut-off relay 16, sleeve 12 of the jack, sleeve of the plug 24, link-conductor 22, the contact 30 of the ringing-key, resistance 37, battery B^4 to the generator. The closing of this circuit actuates the call-bell at the substation B to call the subscriber at said station. The closing of this circuit also breaks

the circuit from the battery B^3 through the winding of the cut-off relay 16. Therefore, in order to hold the cut-off relay in the proper position to maintain the ringing circuit to the substation, the battery B^4 is preferably employed to supply current to the winding of said cut-off relay. The circuit through this winding may be traced from the ground at 38, through the battery B^4, resistance 37, contact 30 of the ringing-key, link-conductor 22, sleeve of the plug 24, sleeve 12 of the jack 14 and a portion of the extension conductor 10, through the winding of the relay 16 to ground. The resistance 37 is included in this circuit merely for the purpose of protecting the system from an excessive flow of current in case of a ground on the telephone line. For example, in case of a ground on the limb 1 running to station B, without the resistance 37 the battery B^4 would be short circuited and an injurious flow of current would result.

By the insertion of the plug 24 into a jack 14, a second circuit, open only at the substation B, is formed. This circuit includes the winding 45 and, as previously traced, extends from the free pole of the battery B^3, through the winding 47 of the relay 40, thence through the cord-conductor 22 and the extension conductor 10, limb 1 of the telephone line extending to the substation B through the branch including the transmitter, receiver and switch-hook at said substation, through the limb 2, extension conductor 11, link-conductor 21 and grounded branch 46', through the other winding 45 of the supervisory relay 40. It will be noted that this circuit is completed at all points except the subscriber's hook-switch, and that the energization of the winding 47 is sufficient to cause the display of the signal 42. This signal remains displayed until the subscriber at substation B removes his receiver and thereby closes the circuit including both windings of the relay 40. This causes a decreased energization of the relay 40 and a consequent effacing of the associated signal 42. It should be noted that the supervisory relay is marginal to this extent that practically the full energizing effect of the low efficiency winding when placed in the local circuit of fixed resistance, that including the cut-off relay 16, is required to attract the relay's armature while any material decrease from that energization will allow the armature to be retracted. When the subscribers have finished their conversation and hung up their receivers, the circuits controlling both windings of both supervisory relays 39 and 40 will be broken, while the circuits local to the exchange, including windings 47 of said relays, will remain closed, thereby again causing a display of the signals 41 and 42 and thus indicating to the operator that conversation has been completed.

In carrying out my invention, in a twenty-four volt system, cut-off relays having five hundred ohms resistance each, and supervisory relays having the windings 45 arranged to give three thousand five hundred turns and one hundred ohms resistance, and the windings 47 two thousand turns and one hundred ohms resistance, will be found satisfactory. This is merely given as a typical example of the relative dimensions of these relays, which, obviously, may be varied to suit the exigencies of any given case. The different batteries, B', B^2 and B^3, may obviously be one and the same battery, and the grounds associated therewith and with other parts of the system may be replaced by a connecting conductor. It will also be apparent that other alterations and modifications may be made in the specific matter disclosed, without departing from the spirit and scope of my invention; I, therefore, do not wish to be limited to the precise arrangement illustrated and described, but aim to cover, by the terms of the appended claims, all such alterations and modifications.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. The combination with a telephone line, of a cord circuit adapted for connection therewith, a supervisory signal for said circuit, a relay for controlling said signal, a winding of relatively low efficiency for said relay, a second winding of relatively high efficiency therefor, means for operatively including said first-mentioned winding in a circuit of fixed resistance on connection made with said line to operate said relay to display said signal, a substation switch for said line adapted when shifted to include said winding in a circuit of less resistance and simultaneously include said winding of greater energizing capacity operatively in circuit, said two windings being then electromagnetically opposed to produce a decreased energization of said relay to efface said signal.

2. The combination with a telephone line, of a differential relay in circuit therewith, having two windings of different efficiencies, a switch at the substation of said line for causing equal current flows through said substation through said windings, a cut-off relay for said line, and a path for current including the winding of less efficiency and said cut-off relay to cause a preponderating current flow in said last-mentioned winding.

3. The combination with a telephone line, of a springjack therefor at the exchange, a cut-off relay for said line connected between a contact of said springjack and a local return conductor, a central source of current, a cord circuit having a terminal connected with said springjack, a supervisory relay for said cord circuit having differential windings, one having a greater number of turns than the other, a path for current including

said source, said windings, said terminal, said springjack and said telephone line, and a branch path for current including the winding of less efficiency, said cut-off relay and return conductor to counter-balance the greater efficiency of said other winding, substantially as described.

In witness whereof, I hereunto subscribe my name this 2nd day of December, A. D 1905.

HARRY G. WEBSTER.

Witnesses:

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A. H. DYSON.