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W. M. DAVIS.

TELEPHONE EXCHANGE SYSTEM.

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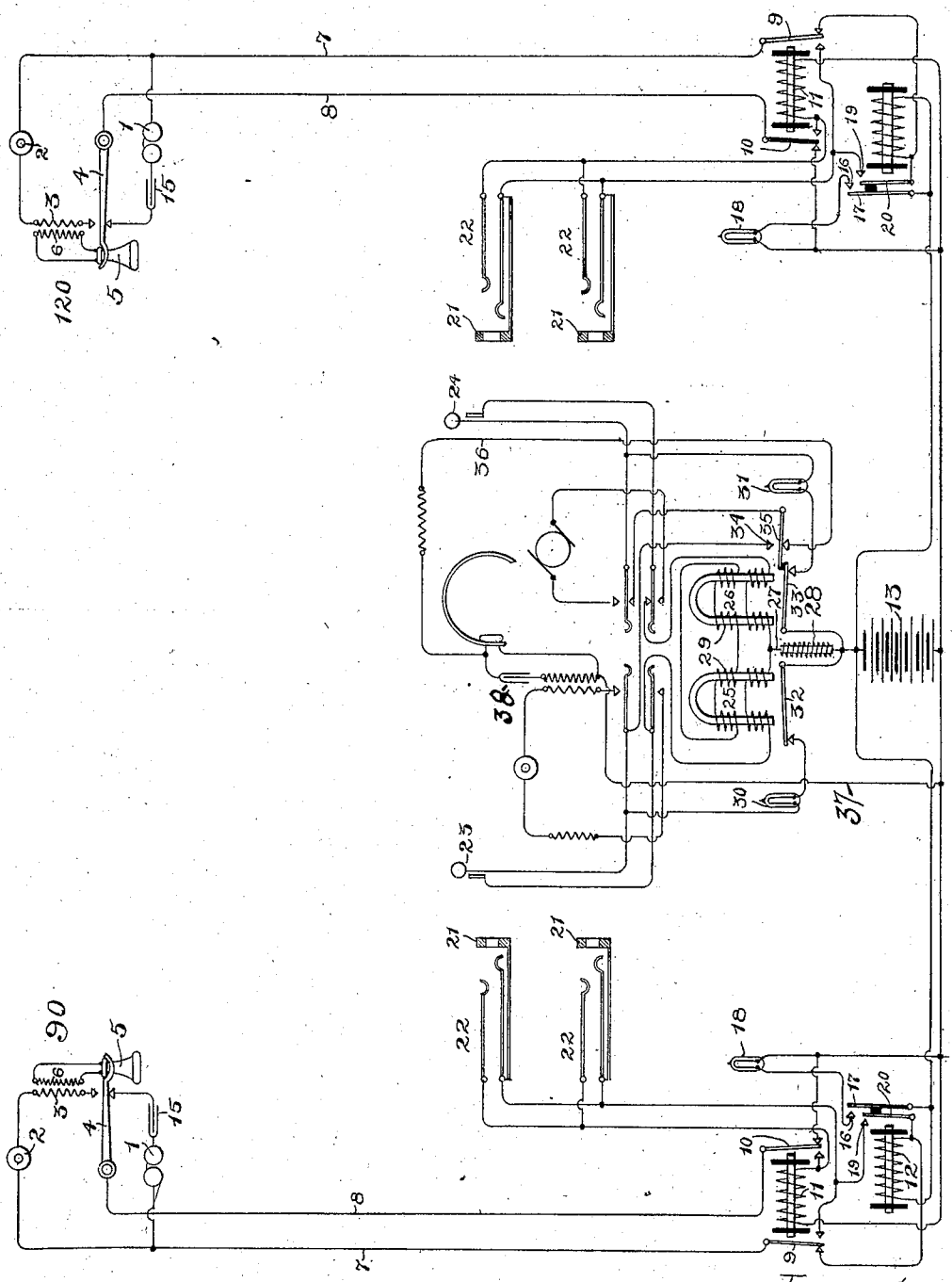

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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

No. 816,078. Specification of Letters Patent. Patented March 27, 1906.

Application filed August 5, 1901. Serial No. 70,924.

To all whom it may concern:

Be it known that I, WILLIAM M. DAVIS, 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 has two main objects.

One feature of the invention relates particularly to relay-switchboards employing cut-off relays, usually and preferably employed in combination with line-relays, the line-relays being energized through the agency of a calling-subscriber's apparatus to actuate a corresponding line-indicator, while the cut-off relay is energized through the agency of the operator's apparatus when she answers a call to interrupt the circuit including the line-relay, whereby the line-indicator is rendered inactive. Heretofore for the purpose of controlling the operation of the cut-off relays the cord-circuit has been equipped with a third cord-strand terminating in a third contact part carried by the plug, which third contact part constituted one terminal of the circuit, including the cut-off relay, the other terminal usually residing in a metallic thimble located before the jack. It is an object of my invention to equip a relay switchboard in a manner to dispense with this third conductor. This feature of the invention may be employed in connection with all types of multiple boards employing relays for controlling the line-indicators.

A second feature of the invention relates particularly to multiple switchboards, and consists in means whereby the thimbles of the spring-jacks of each subscriber's line are connected in a test-circuit immediately upon the removal of the receiver at the calling subscriber's station. By this means operators are prevented from effecting connection with a calling subscriber with whom another subscriber may desire connection, even though the calling subscriber has not been answered by his operator. As is well known, test-thimbles are usually not charged with test-battery or otherwise operatively associated with the test-circuit until the calling subscriber has been answered. As the operators may defer plugging into the jacks of calling subscribers until their connections have been completed, an interval may arise in which there are no means of determining the condition of the calling-subscriber's line as this line may then be tested "Not busy," so that the calling subscriber may then undesirably be connected with another calling subscriber wishing connection with him.

I practice the first feature of my invention by providing switching apparatus that serves to include the helix of the cut-off relay in bridge of the telephone-line, in which bridge is preferably included a source of current. A relay is preferably provided whose armature in its normally unattracted position serves momentarily to close circuit through the cut-off relay, not by including this relay in bridge of the telephone-line, but momentarily establishing a local circuit therefor as the plug enters the jack, the armature of the relay being included in this local circuit. When the plug has been fully inserted within the jack, the latter relay is operated to open the local circuit; but the cut-off relay, having been previously energized to include the same in bridge of the telephone-line, remains in this relation to the line until the plug is withdrawn.

In practicing the second feature of my invention, which is designed for multiple-switchboard telephone-exchange systems, I employ a relay, which may be the aforesaid line-relay, and provide a switch to be controlled thereby, which is operated when a subscriber operates the said relay upon removing his receiver from its hook to connect testing-battery with the test contacts or thimbles of the spring-jacks of the said line upon the various sections of the multiple board. The operator thus does not control the charging of the test-thimbles, this control being effected by the calling subscriber.

I will explain my invention more fully by reference to the accompanying drawing, in which the figure is a diagrammatic view illustrating a telephone-exchange system embodying the features of my invention.

At the substations 90 and 120 are illustrated well-known types of telephonic apparatus. At each station there is provided a signal-re-

ceiver 1, a telephone-transmitter 2, a primary winding 3, and a switch-hook 4 for including the bell 1 in circuit when the receiver 5 is in place upon the hook and for excluding this bell from circuit and including instead thereof the transmitter 2 with the primary winding 3 when the receiver is removed from its hook.

There is included in a local circuit with the receiver 5 the secondary 6 of a transformer. Other types of telephone-station apparatus, however, may be employed without departing from the spirit of my invention.

Telephone-lines extend by their limbs 7 and 8 to the armatures 9 and 10 of a cut-off relay 11. The limb 7 then extends when the armature 9 is in engagement with its normal contact through the winding of the line-relay 12 to one terminal of the common battery 13, in this instance the positive terminal, the limbs 7 thus when idle having common connection with this terminal of the battery. The limb 8 by reason of the engagement of the armature 10 with its normal contact is normally connected with the remaining terminal of the common battery. Thus the common battery is normally in bridge of the telephone-lines; but the condensers 15 at the substations prevent the flow of this battery by way of the telephone-lines when the telephone-receivers are upon their switch-hooks.

When a subscriber initiates a call by removing his receiver from its telephone switch-hook, the common battery 13 is closed through the winding of the relay 12, which thereupon attracts its armature, thereby uniting the contacts 16 17 to actuate the corresponding line-indicator 18, that is thus included in a local circuit with the common battery, and also closes the contacts 19 and 20 together, whereby one terminal of the common battery, in this instance the positive terminal, is connected with the test-thimbles 21 of the spring-jacks 22, distributed over the various sections of the multiple switch-board.

It will be observed that the test conditions are automatically supplied by the calling subscriber when he removes his telephone from the switch-hook. The test-controlling mechanism operated by the subscriber is thrown out of service when the operator answers his call; but the test conditions are immediately restored through the agency of the sleeve of the answering-plug engaging the test-thimble of the jack and including the common battery. The test of course is manifested upon the depression of the operator's listening-key if the line tested elsewhere is busy.

Thus is one object of my invention accomplished—namely, the immediate fulfilment of busy-test conditions for the calling-subscriber's line to prevent interference thereof after a call is initiated.

The short line-springs of the various spring-jacks are adapted for connection with the limb 8, while the long line-springs are adapted for connection with the limb 7, these springs being also connected with the test-thimbles. Cord-circuits are employed, one of which is illustrated, comprising in this instance answering and connecting plugs 23 24, the tips whereof are united by a tip-strand, while the sleeves are united by a sleeve-strand that includes in circuit therewith the operating helices of supervisory relays 25 26, a bridge-conductor 27 being included between these helices and including an inductive resistance 28, whereby the control of these supervisory relays may be independently effected by the corresponding subscriber's apparatus. Each supervisory-relay core is provided with a supplemental winding 29, these supplemental windings being included in a closed local circuit. These supervisory relays control the supervisory signals 30 31 by means of their armatures 32 33.

As a result of the manipulation of the apparatus to be hereinafter set forth contacts 34 35 are closed to complete a cord-circuit, the armature 33 effecting this engagement of the contacts and disrupting the test-circuit, including the testing-conductor 36, which forms the subject-matter of my Patent No. 697,991, issued April 22, 1902.

It will be seen that when a subscriber's line is busy a connection is effected between the positive terminal of the battery 13 and the thimbles 21 of the spring-jacks 22, which connection is completed through the winding of the relay 12, the armature 20, and the contact-anvil 19. This condition lasts during the interval of time that elapses when the subscriber takes his receiver off the switch-hook and until connection is effected by means of a plug. When connection is effected, the thimble 21 is still connected to the positive battery-terminal, but now receives its current directly from the sleeve of the plug 24, which is directly connected to the positive terminal of the battery 13 through the primary winding of the relay 26 and the inductive resistance 28. It will thus be apparent that the thimble 21 has at all times positive connection with the source of current when the line is in use. The calling side of the cord-circuit terminating in the plug 24 is used in making a test to ascertain whether a subscriber's line is busy. As this plug 24 has not been inserted in the spring-jack of the called subscriber, the repeating coil-relay 26 is not energized and the switch 35 is in its unattracted condition, not engaging its alternate contact-anvil 34. The operator in making the test applies the tip of the plug 24 to the thimble 21, and if the subscriber's line is busy it will be apparent to the operator, as a circuit is completed through the various connections and instrumentalities as follows: from the positive pole of the battery 13, in

either of two ways, to the thimble 21 of the spring-jack, from thence through the tip of the plug 24, through the tip-strand, to the switch 35, the conductor 36, the operator's receiver, and by way of the conductor 37 to the negative terminal of the battery 13. Thus a complete circuit, including the battery 13 and the operator's head-receiver, may be effected when the tip of the plug 24 comes in contact with the thimble 21, if the line is busy. If no click is apparent—that is, if no circuit is formed around the battery 13—when the said plug touches the thimble 21, the line is not busy, as the thimble 21 is then normally disconnected from the battery. The switch 35 serves to close the normally disrupted tip-stand of the cord-circuit when the called subscriber removes his receiver, the purpose of keeping the tip-strand open until the parties are ready for conversation being solely to avoid occasioning a disagreeable click in the receiver of the calling subscriber while making a test. It will be apparent that if the tip-strand is not kept open while a test is being made a portion of the current will be diverted through the subscriber's line to the negative terminal of a battery instead of being constrained, as in the present case, to flow altogether through the head-telephone of the operator. A condenser 38 is employed, so that the test-current, which may be made small, if desired, will not flow through the secondary of the operator's induction-coil, but will flow through the head-receiver. The cut-off relay 11 is in this instance connected with the short line-springs at one terminal and with one pole of the common battery at the other terminal. The remaining pole of the common battery is connected with the tip-strand of the cord-circuit by way of the clearing-out or supervisory indicator 30 or 31 corresponding to the particular line, these connections being effected by the armatures 32 and 33 when they are unattracted, so that when a plug is inserted within a jack a local circuit is momentarily closed, which may be traced (taking the line of subscriber 120, for instance) from the short line-spring of the engaged jack, through the winding of the cut-off relay, the common battery, the armature 33, its normal contact, the supervisory indicator 31, to the tip-strand and the tip of the plug engaging the short line-spring. Immediately the corresponding relay 26 is energized, disconnecting the lamp 31 from the tip-strand, the winding of the cut-off relay being then included in bridge of the telephone-lines, which parallel relation of the cut-off magnet is maintained until connection between the subscribers is broken.

The parallel connection of the cut-off relay 11 may be traced from the tip side of the cord-circuit which is connected with one terminal of the helix of said cut-off magnet by the engagement of the tip of the inserted plug with the short line-spring, the other terminal of the magnet 11 being connected with the sleeve side of the cord-circuit through the battery 13 and the inductive resistance 28. This will be readily apparent from the drawing, as the only connection between the telephone-lines and the negative terminal of the battery when said lines are united for conversation is completed through the winding of the relay 11, each of the short line-springs of the two talking subscribers being furnished with negative current from the battery, while said line-springs are at the same time metallically connected through the tip-strand of the cord-circuit, which practically short-circuits the two springs and places the two relays 11 in parallel between the negative terminal of the battery and the said tip-stand, the battery being included in a bridge of said cord-circuit. Thus by means of very much simplified apparatus I am enabled to effect a control of the cut-off relay, for which hitherto it was customary to employ a third cord-strand and a special circuit.

While I have herein shown and particularly described the preferred embodiment of my invention, it is obvious that changes may be made without departing from the spirit thereof, and I do not, therefore, wish to be limited to the precise disclosure herein set forth; but,

Having thus 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 extending from a subscriber's substation to a central exchange, a plurality of spring-jacks of a multiple switchboard normally disconnected from the line-limbs, a single common source of current at the central exchange, a line-relay normally connected with the line-limbs through said source of current, a cut-off relay having a single winding, one terminal of said cut-off relay being connected with one terminal of said source and normally with one line-limb, the other terminal of the cut-off relay being connected with spring-jack contacts, a cord-circuit for connecting telephone-lines together, actuation of substation apparatus causing energization of said line-relay independently of the cut-off-relay winding, and means upon connection of said cord-circuit with one of said multiple sections for closing a local circuit containing said cut-off-relay winding and said source of current whereby said cut-off relay is energized to disconnect said line-relay from circuit, and to connect the spring-jack contacts with the line-limbs, said local circuit including one of the cord-circuit conductors and one limb of the telephone-circuit.

2. In a telephone-exchange system, the combination with a telephone-line extending

from a substation to a central exchange, of a plurality of multiple spring-jacks at the central exchange normally disconnected from the line-limbs, a single source of current at the central exchange for supplying both talking and signaling currents, a line-relay, a cut-off relay controlling said line-relay, one terminal of said line-relay being permanently connected with one pole of said source, and the other terminal of the line-relay being normally connected with one line-limb independently of the cut-off-relay winding, actuation of substation apparatus causing a circuit to be completed through said line-relay and source, one terminal of said cut-off-relay winding being permanently connected with one pole of said source, the other terminal of said winding being normally connected with a contact of each of the multiple spring-jacks, and two strand cord-circuits for connecting telephone-lines together, one of said strands being normally connected with one pole of said source, connection of said cord-circuit with the spring-jack causing a local circuit to be closed through said cut-off-relay winding, said source of current, said cord-strand and said spring-jack whereby said line-relay is rendered inert, a relay for controlling said local circuit, the second cord-strand being also connected with the same pole of said source through the winding of said relay controlling said local circuit, connection of said cord-circuit with a spring-jack causing closure of a circuit including said winding, said source of current, said second cord-strand, said spring-jack, said cut-off-relay winding and the telephone line-limbs and substation apparatus.

3. In a telephone-exchange system, the combination with a telephone-line extending from a subscriber's station to a central exchange, of a plurality of multiple spring-jacks at the central exchange, a single source of current at the central exchange for supplying talking and signaling currents, a line-relay, a line-indicator governed by said line-relay, actuation of substation apparatus causing actuation of said line-relay, a cut-off relay having a single winding for excluding the line-relay from circuit, cord connecting apparatus for connecting subscribers for conversation, a local circuit closed by the answering plug or switch of the cord-circuit upon connection of the cord-circuit with a spring-jack, said local circuit including the cut-off-relay winding, said source of current, a telephonic portion of the cord-circuit and a conductor portion constituting a continuation of the telephone-line, a switch included in said local circuit, and a relay in the cord-circuit for operating said switch, actuation of substation apparatus causing closure of the circuit through said relay whereby said switch is connected to open the local circuit, the circuit through said relay including the winding of said cut-off relay whereby said line-relay is maintained inoperative.

4. In a telephone-exchange system, the combination with a telephone-line extending from a substation to a central exchange, multiple spring-jacks at the central exchange normally disconnected from the line-limbs, a common source of current at the exchange for supplying talking and signaling currents, a line-relay, a line-indicator governed thereby, said line-relay being adapted for operation through the agency of the apparatus at the substation, a cut-off relay having a single winding for excluding the line-relay from circuit, cord connecting apparatus for uniting subscribers for conversation, connection of the cord connecting apparatus with a spring-jack causing closure of a local circuit, said local circuit serially including the entire cut-off-relay winding, a telephonic portion of the cord-circuit, and a conductor portion constituting a continuation of the telephone-line, a switch included in said local circuit, and a relay in the cord-circuit for operating said switch, actuation of substation apparatus causing the closure of the circuit through said relay whereby said switch is actuated to open the local circuit, said second circuit serially including said source of current, said cut-off-relay winding, a cord-circuit conductor and said line-limbs and substation apparatus.

In witness whereof I hereunto subscribe my name this 13th day of July, A. D. 1901.

WILLIAM M. DAVIS.

Witnesses:
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