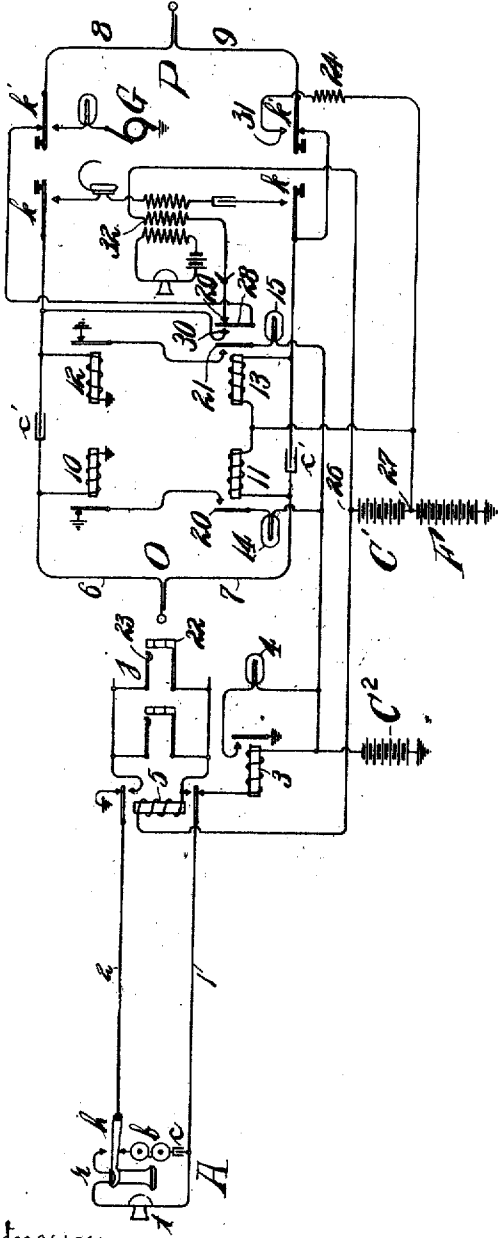


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Witnesses
G. E. Mueller
H. C. Olmstead

Inventor
Harry S Webster
by Thomas H Ferguson
Attorney

UNITED STATES PATENT OFFICE.

HARRY G. WEBSTER, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO
KELLOGG SWITCHBOARD & SUPPLY COMPANY, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

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Specification of Letters Patent.

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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 certain new and useful Improvements in Telephone 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 in which current for transmission and signaling is furnished from a central source located at the exchange, and in which the cut-off relay, which controls the normal connections of the line, is actuated by current flowing over a portion of the talking circuit when a link-conductor is connected with the spring-jack or switching terminal of the line.

It relates particularly to systems of this character in which the source or sources of current which serve to energize the substation transmitters may be associated with the cord connection apparatus only; and may be distinct and separate from that source associated with and furnishing current for the actuation of the apparatus which is individual to the various line circuits.

The object of my invention is to provide an improved organization of circuits and apparatus for systems of this class in which the circuit of the transmission source or that associated with the link-conductor, is so organized with relation to the circuit of the line battery or that source which furnishes current for the energization of the cut-off relay, that although the two separate sources have their circuits completed over the same strand of the cord circuit and are both connected to common conductors at the exchange, no interference between the two sources will result.

A further object of the invention is the provision of such a circuit arrangement in a structure of this character that the presence of an earth connection upon a line limb, external to the central office, will not cause the cut-off relay to be energized by current from the central source after the disconnection of the link-conductor from the spring-jack, this being an objectionable feature in systems heretofore proposed.

My invention will be more fully under-

stood from the accompanying drawing, 55 which is a diagram indicating a subscribers' line extending to the central office and there associated with appropriate cord connecting apparatus all organized in accordance with the preferred form of my invention, in 60 which the line battery is not directly connected to earth but is so connected that any flow to earth will be opposed by the potential of the transmission battery, the cut-off relay being thus connected to a battery 65 terminal which is inactive as far as a circuit to earth is concerned.

Referring to the drawing the subscriber's apparatus is shown at A as consisting of a hooked switch *h* normally including signal 70 bell *b* and condenser *c* in bridge of the line limbs and when moved to its alternate or raised position, closing an alternate bridge of the line through transmitter *t* and receiver *r*. Although I show but one substation 75 arrangement, it will be understood by those skilled in the art that various other arrangements of the apparatus may be used and I do not confine myself to the particular arrangement illustrated. Under normal 80 conditions the receiver hangs upon its hook switch maintaining its upper contact open and the condenser *c* prevents a normal flow of current from line battery C² at the central office through the line limbs. 85

The cut-off relay 5 is prevented from being held up by current through an accidental ground of the line limb, by connecting the battery with which it is associated in opposition to the battery which furnishes 90 current for transmission. The battery C' with which the relay 5 is connected may be of the same or somewhat lower potential than the transmission battery F.

The subscriber calls in the usual way by 95 removing receiver *r* from its switch hook *h*, thus energizing relay 3 by current from battery C² flowing over line limbs 1 and 2 to ground at upper contact of relay 5, thus lighting line lamp 4, and when the answering plug O is inserted into the jack, current from terminal 27 of battery C' will 100 flow through relay 11, strand 7, contact 22 and the winding of relay 5 to terminal 26 of the battery, operating the relay and connecting the line limbs to the spring-jack terminals. It is evident that if limb 1 of the line be grounded at this time and the 105

answering plug O be removed, current would tend to flow from terminal 26 through winding 5 and through the lower armature and normally open contact of the relay to limb 1 and ground if it were not for the opposing potential of battery F. The opposing potential of this battery prevents such flow and if the difference in potential between the two batteries be sufficiently great will cause a reversal of current in the winding of relay 5 when the plug is removed, thus momentarily deenergizing the relay and allowing the armature to drop back and disconnect the relay from the line.

The operator having answered the call by inserting plug O into a spring jack j, current will flow from the active pole of battery F through the winding of relay 11, strand 7, sleeve contacts of plug o and jack j, line limb 1, sub-station A, returning over line limb 2 and tip conductor of jack j, strand 6 and through relay 10 to grounded pole of battery F. Thus both of the relays 10 and 11 being energized lamp 14 is not lighted. The operator now proceeds to test the called for line in the usual manner by touching the tip of plug P to the sleeve of the jack of the called line and if the line be idle, the contact 22 of the line tested is at the potential of terminal 26 of battery C' as is also the tip of the calling plug P. If the line be busy, the consequent difference of potential will cause a flow of current to the tip of the plug, strand 8, armature 28 and contact 29 of relay 13 and thence, through the common test winding 32 of the operator's in action coil to terminal 26 of the battery. Assuming the called for line is idle the operator inserts plug P into the spring jack of the called line, thereby energizing relay 13 and the cut-off relay 5 of the called line, by current from battery C', the winding of relay 13, strand 9, plug and jack sleeve contacts and winding of the cut-off relay to terminal 26 of battery C'. The operation of relay 13 disconnects the winding 32 from the tip strand of the cord circuit at contact 29 and closing of contacts 28, 30, is effective to cause continuity of strand 8. The operator now presses ringing keys k' thus connecting ringing current from generator G to the terminals of the called line, a return path for the said current being supplied by the closing of contact 31, through battery F to ground. Although when key k' is operated relay 13 is deenergized, energizing current for the cutoff relay is supplied through resistance 24 and contact 31 from battery C'. The subscriber in response to the signal removes his receiver from its switch hook thereby causing a path for direct current from battery F over the limbs of the telephone line, returning through supervisory relay 12 to ground, energizing relay 12 and extinguish-

ing lamp 15. After the subscribers have finished conversation, by replacing their receivers upon their switch hooks the circuits for relays 10 and 12 are interrupted, thereby deenergizing the said relay and lighting lamps 14 and 15. The operator in response to this signal removes plugs O and P from the spring jacks, thereby restoring all apparatus to normal. While I am not limited to specific resistances and voltages in this arrangement, I have found that the battery C' may have a potential of 18 or 20 volts, that battery F may have a potential of 24 volts, while the relay 5 may be of 500 ohms resistance and relays 10 and 11 of 100 ohms each. It will be evident that the battery C' which is shown as supplying current for the relay 3 may be replaced by a suitable connection from battery F.

In the structure illustrated it will be seen that the battery which supplies current for the energization of the cut-off relay may be of lower voltage than that which serves to energize the transmitter at the substation; that when the line is connected for conversation the two batteries have their circuit completed through a conductor common to both; and that they are also both connected to ground or to the office return. The various resistances and voltages are so proportioned however, that current from the transmission battery does not flow through the cut-off relay, and the substation transmitter is therefore not unduly shunted by the presence of the cut-off relay winding connected to the line limb; and the circuit is so balanced that the proper current is provided for transmission and for the operation of the various parts of the apparatus. It is also seen that the circuit of the cut-off relay is under absolute control of the operator and that the relay will not be locked up by the presence of an earth connection to the line limb. It will be understood that the various earth connections shown are or may be connections to the office return which is ordinarily grounded, and while I have indicated various values of potential and resistance which may be used, I do not wish to be limited to these particular values nor to the specific structures illustrated.

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

1. A telephone exchange system comprising a telephone line, a connection terminal normally disconnected therefrom, a relay for connecting said connection terminal with the line, a source of current associated with said relay, said source and the winding of said relay being adapted to be connected in shunt of a portion of one limb of the telephone line, means whereby the currents from said source through said relay

are restricted to circuits local to the exchange, a cord connector terminating in a connecting plug, a source of current connected between the strands of said cord connector constituting the sole source for furnishing current for talking purposes, and means whereby the insertion of the connecting plug into the connection terminal sends current from said first mentioned source over a circuit including a talking strand of said cord connector, a terminal of the connecting plug, a line contact of the telephone line, and the portion of a talking limb of the telephone line extending between said line contact and said relay.

2. A telephone exchange system comprising a telephone line a connection terminal normally disconnected therefrom, a relay for connecting said connection terminal with the line, a source of current associated with said relay, a separate source of current adapted to be connected in the metallic circuit for talking purposes, means for operating said relay from said first mentioned source when connection is made with the line by current flowing over a path including a portion of the talking circuit, means whereby said relay does not receive current from said second source, and means for sending a calling current over the line of the called subscriber only and at the same time maintaining said relay in operative condition.

3. A telephone exchange system comprising a telephone line, a normally disconnected talking contact of a spring jack associated with the said line, a plug, a cord circuit, a battery associated with the said circuit adapted to be included in the metallic circuit of the line and constituting the sole source for furnishing current for talking purposes, a second source of current, a cut-off relay operated from said second source of current over a portion of the talking circuit and means whereby the currents from said source through said relay are restricted to circuits local to the exchange.

4. A telephone exchange system comprising a metallic telephone line, a talking contact forming a part of a connection terminal for the line, said contact being normally disconnected therefrom, a central source of current associated with the line and adapted to be included in the metallic circuit of the line when a connection exists and constituting the sole source for furnishing current to the substation transmitters for talking purposes, means for disconnecting said contact from the line when the line is not in use, a second source of current, means operated by current from said second source over a portion of the talking circuit to connect the contact with the line when the line is in use, means whereby the currents from said source through said relay are restrict-

ed to circuits local to the exchange, and testing apparatus to cooperate with said contact to indicate the condition of the line.

5. A telephone exchange system comprising a telephone line, a test terminal normally disconnected therefrom, a relay for connecting said test terminal with the line, a source of current associated therewith, testing apparatus, a cord circuit terminating in a connecting plug, supervisory signaling apparatus associated with the cord circuit, a second source of electricity associated with the cord circuit, means for closing the circuit of said second source over the telephone line to operate the said supervisory apparatus, means whereby said relay does not receive current from said second source, and means for closing the circuit of said first mentioned source through said relay when connection is made with the line, said relay circuit including one of the main terminals of the connecting plug and a line contact of the telephone line with suitable return.

6. A telephone exchange system comprising a telephone line, a cord circuit adapted to be included in a talking circuit, a line signal and a cut-off relay for the line, a source of current associated with said relay, means whereby the currents from said source through said relay are restricted to circuits local to the exchange, means for closing circuit from said source through said relay over a portion of one side of the talking circuit, including a portion of the telephone line and the cord circuit, a second source for supplying current for talking purposes, connected in bridge of said cord circuit and means whereby said relay does not receive current from said second source.

7. A telephone exchange system comprising a telephone line and a connection terminal in the form of a spring jack, a connecting plug and a cord circuit, a central source of current associated with said circuit to furnish current for talking purposes, supervisory signal apparatus associated with the cord circuit and operated from said source of current, a relay actuated from a second source of current by the insertion of said plug into, and its withdrawal from, said jack for controlling a connection of said jack with said line, said relay being actuated by current flowing over a portion of a strand of the cord circuit, a talking contact of the plug and jack and a portion of the telephone line and means whereby the currents from said second source are restricted to circuits local to the exchange.

8. A telephone exchange system comprising a telephone line, signal receiving mechanism for said line at the exchange, a cut-off relay for operation to render said mechanism ineffective, an ungrounded source of current having a terminal connected with

said cut-off relay, a plug and jack contact for closure by an operator to establish a metallic circuit of said source through said cut-off relay to operate the same, a second source of current associated with said line, said second source being grounded and having its active terminal connected in opposition to said first-mentioned source, and means for connecting said second source to said line, whereby talking current is solely supplied to said line therefrom.

9. A telephone system comprising a telephone line and a cord-circuit for connection therewith, a pair of sources of electrical energy connected to one strand of said cord-circuit, one of said sources only being operatively connected with the other strand of said circuit, a relay 10 for said cord-circuit operated solely by current from one of said sources, a relay 5 for said line operated solely by current from the other of said sources, a second relay 11 for said cord-circuit included in a circuit to receive current from both said sources, and a metallic connection uniting terminals of opposed po-

larity of said sources. 25

10. A telephone system comprising a telephone line and a cord-circuit for connection therewith, a pair of sources of electrical energy connected to one strand of said cord-circuit, one of said sources only being operatively connected with the other strand of said circuit, a relay 10 for said cord-circuit operated solely by current from one of said sources, a relay 5 for said line operated solely by current from the other of said sources, a second relay 11 for said cord-circuit included in a circuit to receive current from both said sources, a metallic connection uniting terminals of opposed polarity of said sources, and an operative earth connection for one of said sources only. 35 40

In witness whereof, I hereunto subscribe my name this 14th day of July 1906.

HARRY G. WEBSTER.

Witnesses:

A. H. DYSON,

H. C. OLMSTEAD.