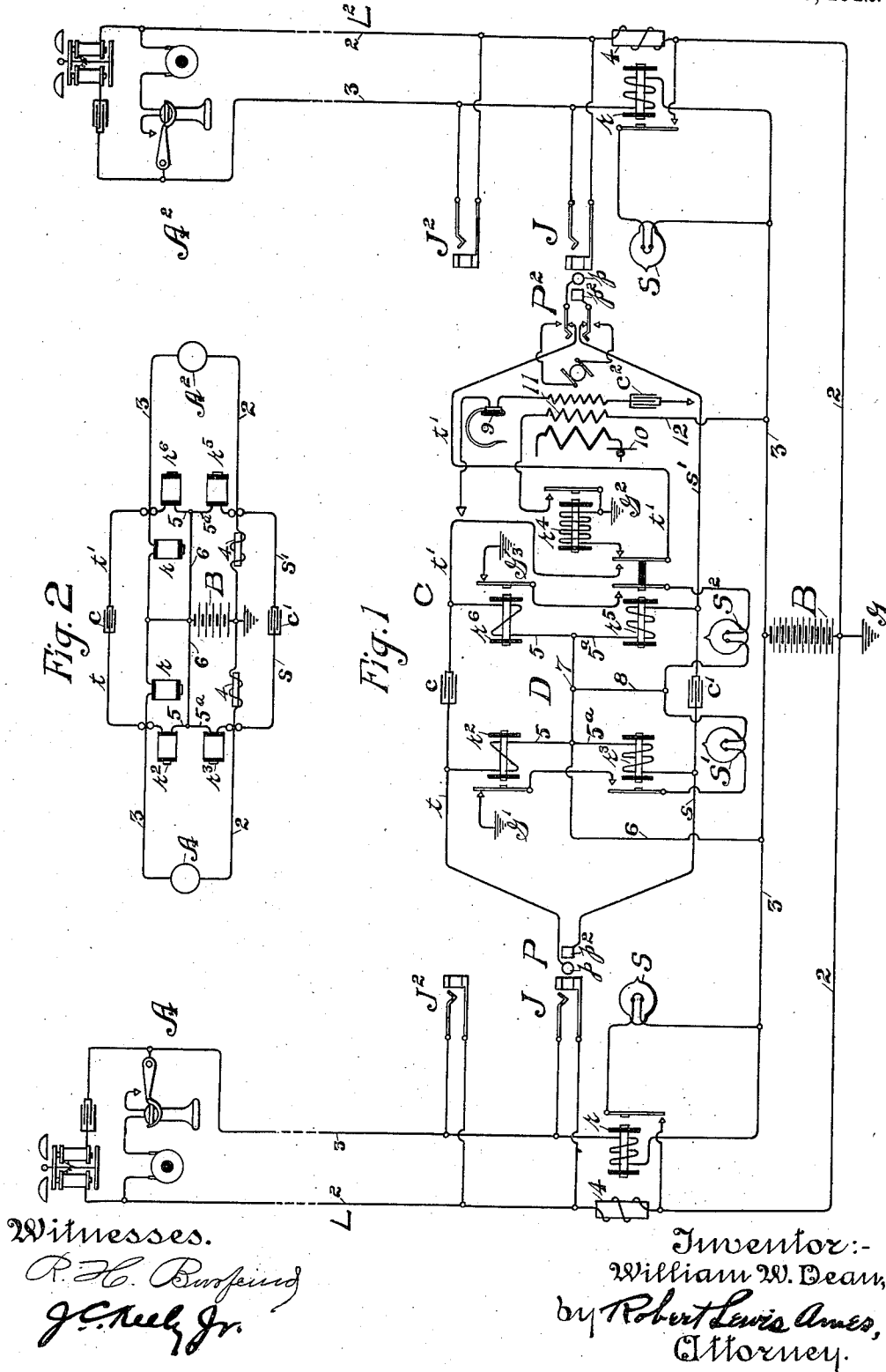


1,013,865.

Patented Jan. 9, 1912.



Witnesses.
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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

1,013,865.

Specification of Letters Patent.

Patented Jan. 9, 1912.

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To all whom it may concern:

Be it known that I, WILLIAM W. DEAN, a citizen of the United States of America, and resident of Chicago, county of Cook, and State of Illinois, have invented a certain new and useful Improvement in Telephone Systems, of which the following is a specification.

My invention relates to telephone exchange systems and more particularly to that class of telephone exchanges in which centralized batteries are employed for the purpose of operating signals at the exchange in response to the operation of the subscribers' apparatus and for the purpose of operating supervisory signals, which batteries are also usually employed for the purpose of supplying current to the transmitter circuits at the subscribers' stations. In systems of this class the subscribers' lines are usually each provided at the central office with a line relay adapted to control the circuit of the individual line signal and are connected with the central source of current for the operation of said relay. A cut-off relay is also usually provided to entirely disconnect the line relay and battery from the main portion of the line, or to otherwise render the line relay inoperative when a connection is established with the line. Ordinarily, too, a subscriber's line does not test busy until a connection has been established therewith at the central station.

One object of this invention is to simplify and reduce the subscriber's apparatus at the exchange by entirely dispensing with the cut-off relay and by providing simple and convenient means for otherwise rendering the line relay or signaling device inoperative to current in the line when a connection is established therewith at the central office.

Other objects are the simplification and lessening of the apparatus required in establishing and supervising connections between the various subscribers' lines, and to provide at the same time a free path for the passage of voice currents without hindrance from relays, repeating coils or other objectionable apparatus in the conversational circuits.

Further objects are the provision of a busy testing system for the lines, that will

enable them to test "busy" from the time the receivers are removed from their hooks in initiating calls until they are returned, and the connection pulled down.

In carrying out the invention the lines, provided with the usual apparatus at the sub-stations, are extended through the line relays and include the central source of current. Operators' circuits are provided with the usual flexible strands and have connected therewith branches containing supervisory relays so arranged that when a connection is established with the line, the line relay is deprived of current sufficient to operate it and is therefore rendered inoperative to close or maintain closed the circuit of the individual signaling lamp. At the same time the said supervisory relays are placed in condition to be operated by current in the line and are therefore dependent in their action upon the position of the telephones at the subscribers' stations. As the busy testing terminals of the jacks are connected directly with the sleeve side of the line and the tip side thereof is connected with one pole of the battery, it follows that as soon as a receiver is taken from the hook as in calling, the testing terminals of that line are connected through the subscribers' stations with the same or ungrounded pole of the battery and are in condition to test "busy," the testing being accomplished through the agency of a contact of a testing plug connected with the opposite pole of the battery. The successful operation of this test presupposes that the testing terminal is raised to a potential above that pole of the battery connected with the test relay, to insure which the line conductor is provided with an artificial resistance, such as a coil of wire located between the testing terminal and the said pole of the battery. This insures a test not only during a connection but before the operator answers the call. The result is that the lines test "busy" from the initiation of a connection by a calling subscriber until the conversation has terminated and the plugs have been withdrawn, thus preventing the undesired breaking-in-upon waiting or connected parties.

In the drawings which accompany and

illustrate the specification and in which the same reference characters designate like parts throughout the several views, Figure 1 is a diagram of two subscribers' stations 5 and the central office apparatus, and Fig. 2 is a simple diagram of two united lines.

The reference characters L and L² represent telephone circuits extending between their respective sub-stations A and A² and 10 a central station C. They are provided at the sub-stations with telephones in a normally open bridge between the main conductors 2 and 3, and a standard call-bell in series with a condenser is connected in parallel with said telephones, as usual, the regular telephone switch being arranged while 15 supporting the receiving telephone to maintain the normal discontinuity of the telephone bridge, but to close the same when the receiver is displaced. At the central office these lines center in a switchboard where they are fitted with switch-socket connection-terminals or jacks J, J², or with 20 a single connection terminal according as to whether a multiple, or a simple board is used. These main conductors 2 and 3 are extended directly to a central source of current B, such as a battery, the conductor 3 including the winding of a line relay *r* 30 adapted to close, through its armature, the circuit of the individual signal or lamp S, while the main conductor 2 contains an impedance coil 4. As will be observed, no cut-off relay is provided for the line and the connections and parts above referred to are preferably permanent, *i. e.*, the line at all times includes line relay *r*, the battery B and the impedance coil 4. In view of this connection the said relay and the impedance 40 coil must have sufficient retardation to prevent the passage therethrough of voice currents to an appreciable degree so that they will not prevent the transmission of the voice currents to the desired point.

45 In Fig. 1, D represents a switch cord circuit adapted to form an operative union between any two telephone circuits of the system. P and P² are switch plugs of ordinary construction belonging to the cord circuit, each being provided with a tip and a sleeve contact surface to register respectively with corresponding line contact surfaces in the plug sockets J. The sleeve contact surface of the jack is sometimes termed the 50 ring contact. The tips of the plugs are connected together by means of the usual flexible strands *t*, *t'* which are united by the condenser *c* for the free passage of voice currents and to prevent the passage of steady 60 currents, the latter strand being completed during an established connection through the outer armature and contact of the supervisory relay *r*⁵. The sleeve contact surfaces of the plugs are likewise joined by the 65 strands *s*, *s'* conductively divided but in-

ductively united through the interposed condenser *c'*.

In order to render the line relay inoperative when a connection is established with the line, a conductor 5 including the winding of the supervisory relay *r*² is connected 70 between the strand *t* and the conductor 6 leading to the battery B over a portion of the main conductor 3, or battery lead. This provides a path for current from the battery 75 B parallel to that through the line relay *r*, which path should be of low resistance as compared with that through the line relay so as to deprive it of sufficient current and render the same inoperative. As this path 80 is to receive the greater part of the current and as impedance is desired therein, both facts are made use of by locating the supervisory relay *r*² therein, its ohmic resistance being comparatively low to permit a large 85 flow of current and its retardation being sufficiently high to prevent the passage of voice currents. Good results have been obtained with line relays and supervisory relays of 500 and 100 ohms resistance respectively, though other resistances might be 90 used. When the connecting plug P is inserted in the jack J it will thus be seen that a parallel path for the current which originally flowed through the relay *r* from the 95 battery B is now provided through the tip contacts of the jack J and the plug P, the tip strand *t*, the conductor 5 containing supervisory relay *r*², and conductor 6. As this path is of lower resistance than that 100 through the relay *r* the desired result is accomplished and the latter no longer maintains its armature closed or, if the subscriber's receiver is upon the hook when the connection is made, the relay cannot thereafter 105 close the circuit of the signal S.

The supervisory relay *r*² is utilized to control the circuit of a supervisory signal S' associated with the answering plug. The relay *r*², it is observed, is under the control 110 of the subscriber with whose line it is temporarily associated and it is adapted to open the circuit of said signal to extinguish the same when the subscriber's instrument is in use and to close said circuit to light the 115 lamp when the subscriber's instrument is not in use. While the relay *r*² could be relied on for the operation of the supervisory signal as stated, it is apparent that it would, without assistance of other apparatus, close 120 the circuit of the supervisory signal normally, or when the plug circuit was not in use. This is of course, undesired, for various reasons, and to prevent it the cooperating relay *r*³ is employed and is included 125 in a branch conductor 5^a extending from the conductor 6 to the sleeve strand *s* of the same plug P; it is excited over a branch circuit as soon as the plug is inserted in the switch socket J, which may be traced from 130

battery B, the conductors 6 and 5^a, sleeve strand *s*, a portion of the main conductor 2 through the impedance coil 4, back to the battery B. This circuit is completed as soon as the connection is established, regardless of whether the subscriber's instrument is off or upon the hook and serves to operate relay *r*³ to close the circuit of the supervisory signal S' which remains closed until the plug is withdrawn.

The apparatus connected with the calling plug P² of the cord circuit D is substantially the same and operates in substantially the same way as that associated with the answering plug P. Provision is made, however, at this end of the circuit for bridging the operator's head telephone 9 across the circuit by any suitable switch or key, the same being indicated diagrammatically. Said bridge as usual includes the secondary winding of her induction coil and a condenser *c*². The transmitter 10 in circuit with the primary winding of the induction coil is preferably charged from the main battery B, the complete circuit of which is not shown, though a separate battery could be employed for the purpose.

In order to test the subscriber's lines, a tertiary winding 11 is provided for the operator's induction coil and is included in a circuit from ground G, through the battery B, a battery lead to the conductor 12 in which the tertiary winding is located, thence through the armature of the test relay *r*⁴ to ground at G². The test relay *r*⁴ is of high resistance and consists of many turns of wire; it is possessed of considerable impedance and its circuit is normally completed through the outer armature of the supervisory relay *r*⁵ to that portion of the tip strand *t'* connected with the calling plug P². It will thus be seen that when the tip of the plug in the testing operation is touched to the testing or ring terminal of a line that is raised to a potential above the potential of that pole of the battery which is connected to the test relay a path for current is provided over the said tip contact of the testing plug through the portion *t'* of the cord strand connected therewith, the outer armature of the relay *r*⁵, its normal contact and the winding of relay *r*⁴ to the aforesaid pole of the battery. The resistance of this path is so large as to prevent a great reduction of current or potential on the lines so tested and at the same time its impedance prevents its current from building up too suddenly, all of which prevents noise in the subscribers' telephones, while at the same time sufficient current passes through its winding to cause it to attract its armature and close the circuit before described through the tertiary winding of the operator's induction coil, the resistance of this latter winding being regulated to produce the desired "click" in the

operator's receiver. As soon as a subscriber calls the central office, or as soon as the operator has inserted a connecting plug into a switch socket of the line, the line is in condition to test "busy," since the ring terminals are at once altered in potential, in the first instance due to current flowing through the subscriber's instruments and back to the central office over main conductor 3, and in the second case, through the ring of the jack connected with the sleeve strand of the inserted plug, through the supervisory relay connected therewith and over conductor 6 to the side of battery B opposite to that side connected to the test relay. In both these testing circuits, the portion of the conductor 2 connected with one pole of the battery, is connected directly with the testing terminals. If this conductor had no appreciable resistance, the potential of the said terminals would not be raised above that of the said pole and consequently no "click" would be received when the operator touched the tip of her plug to the test terminal. To avoid this condition the resistance coil 4 is placed in the said conductor between the battery and the testing terminals to cause a difference of potential between them and is made of high impedance to prevent leakage of voice currents. It is made of low resistance, for as seen hereinafter, the sub-station transmitters are charged through it and it is not desired to cut down the charging current more than necessary. One hundred ohms is found to give a satisfactory test and does not harmfully interfere with the battery current.

The supervisory relays *r*⁵ and *r*⁶ are connected with the tip and sleeve strands of the plug P² in a manner similar to that described with reference to the like parts associated with the plug P and are therefore not specifically described, except to state that the supervisory lamp S² is associated with the plug P² and is controlled through the inner armature of the relay *r*⁵, which is adapted to be operated over a branch circuit upon the insertion of the plug into the switch socket of the subscriber's line; its circuit is also opened and closed by the supervisory relay *r*⁶, which is placed under the control of the subscriber by the establishment of such a connection.

A suitable ringing generator is provided in connection with the plug P² and is adapted to be connected therewith by any suitable switch key under the control of the operator to ring the subscriber's bell.

Assuming that subscriber A wishes to communicate with subscriber A², he removes the receiver from the hook and closes a circuit through main conductors 2 and 3 from the central battery B. The line relay is operated over this circuit to light the individual signal lamp S. Upon observing the

signal the operator inserts the answering plug P of the cord circuit D into the jack J of the line, thus closing a circuit for the supervisory relay r^2 from the battery B through the conductors 6 and 5, the winding of the relay r^2 , the tip strand t , line conductor 3 to the sub-station and back over the line conductor 2 to the battery B. The line relay is shunted by this path of lower resistance as before explained through the supervisory relay r^2 , and is rendered inoperative or unresponsive to current in the line while the relay r^2 is placed in operative or responsive condition. The insertion of the plug P also closes a branch circuit for the supervisory relay r^3 from the battery B through the conductor 6, conductor 5^a including the relay r^3 , sleeve strand s , the corresponding part of the connection terminal J, impedance coil 4 and a portion of the main conductor 2 or the battery lead to the other side of battery B. These circuits are clearly illustrated in Fig. 2; here it is plain that the current from the battery B first flowed directly through the line conductors 2 and 3 including the line relay r , and the impedance coil 4 to the station A, to operate the said relay; but when the connection is established, the relay r^2 is placed in a by-path composed of the conductors 6 and 5 about the relay r , and being of lower resistance the battery current is mainly sent through the relay r^2 and the line relay r does not receive enough to operate it. The circuit for supervisory relay r^3 is also here clearly shown; it includes the conductor 6, conductor 5^a through relay r^3 , the portion of the line conductor containing impedance coil 4 and the battery B. In order to prevent undue waste of current in this branch circuit, the supervisory r^3 is preferably made of high resistance, a satisfactory proportion being obtained with 500 ohms, while the impedance coil 4 is of 100 ohms. The supervisory relays are also seen to be in a bridge of the conversational circuit but they have sufficient impedance to prevent short circuiting the voice currents so as not to affect the transmission of speech waves. Both relays are located on the same side of the charging battery B. The line relay r and the impedance coil 4 also serve to stop the passage of speech waves through their circuits. The operation of relay r^3 has the effect of closing the circuit of the supervisory signal S' through its armature but as the subscriber's telephone is off the hook the relay r^2 is also now operated, which opens the circuit of the supervisory signal S' and the latter therefore remains inert. Upon connecting her telephone with the cord circuit and learning the wants of the subscriber, the operator proceeds to test the condition of the line A². If the line is idle no noise is heard in the operator's receiver; but if busy,

the ring contact of the jack is altered in potential, as before explained, by current through the corresponding contact of the jack with which the connection is established, the sleeve strand of the inserted plug, through the supervisory relay and the conductor 6 to the battery. A testing circuit is therefore completed through the testing relay r^4 , which closes the battery circuit through the operator's tertiary winding and inductively causes a "click" in her receiver. If the subscriber has just called central and the operator has not had time to connect with the line, the circuit will still test "busy," but in this case the testing circuit is completed through the subscriber's station and over the tip side of the line to one pole of the battery. In view of the permanent connection from the testing terminals of the lines to the battery, the resistance coil 4 therein is provided to cause a sufficient difference of potential between it and the testing terminals, to cause a deflection of the current through the operator's testing devices. If idle, the plug is inserted and the ringing key is depressed to connect the ringing generator with the plug P² to call the wanted subscriber. The line relays r must, of course, be prevented from lighting the line signal S at this time to prevent false signals being given, and this may be accomplished in any desired or usual way, one common method being to provide a relay of such construction that while it is responsive to the steady current from the battery, it will not respond to the alternating ringing current. After ringing and before the subscriber's response, the relay r^5 is operated, and the circuit of supervisory lamp S^2 is closed through its inner armature and the armature of relay r^6 , which is not yet energized. This signal is therefore lighted and remains exposed until the subscriber responds when the circuit for the supervisory relay r^6 is completed through the subscriber's telephone instruments and the same is operated to open the circuit of the supervisory signal S^2 and render the same inert. The operation of relay r^5 also closes the two portions of the tip strand together. The subscribers are now united for conversation, each having under its control a supervisory signal temporarily associated therewith, so that the operator is always informed of the condition of the lines at the respective sub-stations. Moreover, a path for conversational currents is provided directly between the line conductors through the tip and sleeve strands of the cord circuit having the interposed condensers c, c' . This is clearly shown in Fig. 2 in which the outside strands t, t' , and s, s' are shown as by-paths around the impedance coils 4 and line relays r of the united lines. It is apparent therefore that while current from the battery B flows out

to the respective stations through the supervisory relays r^2 and r^6 and the coils 4 for charging their transmitters, the fluctuating or voice currents are transmitted or shunted by all obstructions at the central office through the agency of the said tip and sleeve strands with their interposed condensers. The relay r^2 and the coil 4 are of sufficient impedance to prevent the passage of voice currents and not of high enough resistance to greatly cut down the battery current. It will be understood that so far as some features and claims are concerned any suitable source may be employed to energize the sleeve relay. At the termination of the conversation when the subscribers return their receivers to their respective hooks, current is cut off from the supervisory relays r^2 and r^6 , and the circuits of the lamps S' and S^2 are completed to indicate that fact to the operator. The line relays of course cannot operate at this time for they are also deprived of current due to the opening of the circuits at the sub-stations. The operator may now take down the connection, when the lamps S' and S^2 are extinguished and all parts are restored to normal condition.

The several ground connections referred to it is well understood may be the usual office return. So, too, the line signals may be any electro-magnetic signaling device in place of the line relays, and the supervisory relays r^2 and r^6 so far as some features of the invention are concerned may be replaced by any suitable signaling device. Again, many of its novel points are independent of multiple boards and may be employed with any preferred type of board. The several connections shown with the line conductors 2 and 3 beyond the jacks, or similar connections throughout the exchange may of course lead directly to the battery B or said portions of the lines may be considered as the battery leads extending throughout the system.

The operator's switch for connecting her telephone and the generator with the cord circuit may be of any well known construction, preferably such as the self-locking cam key in extensive use, which when depressed to connect the operator's telephone with the circuit will so remain until manually released, and when depressed in the opposite direction will connect the ringing generator with the circuit.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. The combination with a telephone line, of a line signaling device therefor, a battery and a comparatively low resistance impedance coil in series in the line; a cord connector having a tip strand, a supervisory relay of comparatively low resistance possessing impedance and normally connected

between said tip strand and the same pole of the battery as the said signaling device, whereby the latter is short circuited by the relay when the connector is connected with the line for conversation, a supervisory signal having its circuit at one point controlled by said relay, and means to open the circuit of said signal at a different point when the connector is not connected with the line to prevent the normal operation of the signal, substantially as described.

2. The combination with a telephone line, of a connecting jack for the line, a line relay in one of the conductors of the line, a battery having a pole connected with said conductor and its other pole connected with the other line conductor, a cord circuit, a relay for the cord circuit connected with a limb thereof and with the former pole of said battery, the connection of said cord with said jack being adapted to include said relay in a local branch circuit comprising the entire battery, the coil of said relay, a portion of one limb of the cord circuit, contacts of said jack and the portion of said other line conductor between the contact of said jack and said source, substantially as described.

3. The combination with a telephone line, of a battery and two supervisory relays adapted to be associated with the line during a connection therewith for conversational purposes, said relays having their coils directly connected to the same pole of the battery, and a supervisory signal jointly controlled by said relays, substantially as described.

4. The combination with a telephone line, of a battery connected with the line, two supervisory relays adapted to be bridged across the line when a conversational circuit is established, the coils of said relays being directly connected with the same pole of the battery, and a supervisory signal controlled jointly by said relays.

5. The combination with a telephone line, of a battery, a cord circuit and supervisory relays associated with the end of the cord circuit adapted to be connected with the line and connecting directly with a common pole of the battery, said relays serving to jointly control a supervisory signal, substantially as described.

6. The combination with a telephone line, of a battery, a cord circuit, two supervisory relays bridged across the cord circuit and normally connected with one pole of the battery, and a supervisory signal jointly controlled by said two relays, substantially as described.

7. The combination with a telephone line, of a battery, a cord circuit, two supervisory signal controlling electro-magnet windings bridged across the same, said bridge intermediate of said windings being connected

with one pole of the battery, one of said windings being under the control of the subscriber and the other under the control of the operator.

5 8. The combination with a pair of telephone lines, of a battery permanently connected with the lines, a cord circuit, a plurality of supervisory relays for each end of the cord circuit and connected between
10 the cord circuit and the battery, means for including one of said relays at each end of the cord circuit in a circuit from the battery including the corresponding telephone line to the substation, and a supervisory
15 signal for each end of the cord circuit having its circuit controlled by the corresponding supervisory relays, substantially as described.

20 9. The combination with a telephone line, of a battery permanently connected with the line, a cord circuit, supervisory relays normally connected between the same and the battery, means for including one of said relays in a circuit from the battery including
25 the telephone line to the sub-station and for including the other in a branch circuit composed of a portion of one of the line conductors to the battery and a part of the cord circuit, and a supervisory signal having
30 its circuit controlled by said relays.

35 10. The combination with a telephone line, of a battery permanently connected with the line, a cord circuit, a relay connected between each strand of this circuit and the same pole of the battery, whereby
40 when a connection is established with the line, one relay is adapted to be energized over a circuit including the battery, the relay conductor, the cord strand with which it is connected and the telephone line to the
45 sub-station, and the other relay is adapted to be energized over a branch circuit containing its conductor, the cord strand and a portion of one line conductor to the other pole of the battery, and a supervisory signal having its circuit controlled by said relays.

50 11. The combination with a telephone line, of a line relay and a battery permanently connected in series in the line, a cord circuit, two relays bridged across the circuit, a connection from said bridge between the relays to one pole of the battery, a switch
55 socket for the line on the sub-station side of the line relay, whereby when a connection is established with the line one supervisory relay is connected in parallel relation with the line relay and the other supervisory relay is included in a branch circuit from the battery, and a supervisory signal having its circuit controlled by said relays.

60 12. The combination with two telephone lines, a central battery bridged thereacross, a line relay on one side of the battery and an
65 impedance coil on the other side of the bat-

tery in each line, connection terminals for each line on the sub-station side of the line relay and impedance coil, a cord circuit adapted to be connected with said connection terminals, condensers interposed in
70 each strand of the cord circuit, a pair of supervisory relays bridged between the strands of the cord circuit on each side of the condensers, a connection from the middle point of each bridge to one pole of the
75 battery, whereby when a connection is established with the line for conversational purposes the line relays are substantially short circuited by one of each pair of the supervisory relays, and the other supervisory relays are energized over branch circuits from the battery, while a by-path for voice currents is provided by the cord circuit strands past the line relays and the impedance coils.

80 13. The combination with a multiple switchboard telephone line, a battery connected between one line conductor and a third conductor, the other line conductor being also connected with said third conductor, a plurality of busy testing terminals
85 connected with the latter line conductor, a portion of said conductor between the testing terminals and the third conductor possessing an appreciable resistance whereby when a subscriber calls and connects two
90 conductors together the testing terminals are raised to a potential above that of the third conductor and the line is in condition to test busy, and a cord circuit having a busy testing conductor normally connected
95 to the said third conductor but adapted to be disconnected therefrom when a connection is established by the cord circuit with the line, substantially as described.

100 14. The combination with a multiple switchboard telephone line, a battery permanently connected between one line conductor and a third conductor, the other line conductor being also connected with said third conductor, a plurality of busy testing
105 terminals connected with the latter line conductor, a portion of said conductor between the testing terminals and the third conductor possessing an appreciable resistance, and a cord circuit having a busy testing conductor normally connected with said third conductor but adapted to be disconnected therefrom when a connection is established by the cord circuit with the line, substantially as described.

110 15. The combination with a multiple switchboard telephone line, of a grounded battery permanently connected between the line conductors, a plurality of busy testing terminals connected with the grounded line
115 conductor, an appreciable resistance in said conductor on the battery side of the testing terminals, and a cord circuit having a testing conductor normally connected with the earth but adapted to be disconnected there-
120
125
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from when a cord circuit is connected with the line for conversational purposes, substantially as described.

16. In a telephone busy testing system, the combination with a multiple switch-board telephone line having tip and sleeve conductors, of a battery permanently connected between said conductors of the line and grounded at its sleeve pole, a plurality of busy testing terminals for the line connected with this sleeve conductor, a resistance coil between said terminals and battery, and a cord circuit having a busy testing conductor normally connected with the ground but adapted to be disconnected therefrom when a cord circuit is connected with the line for conversation, substantially as described.

17. The combination with a telephone line, of a cord circuit to connect therewith, a pair of supervisory relays and a battery associated with the cord circuit, each of said relays being permanently connected upon one side with a different limb of the talking circuit and upon the other side with the battery so as to receive current of the same polarity therefrom, and a supervisory signal jointly controlled by said relays, substantially as described.

18. The combination with a telephone line connected for conversation, of two supervisory signal controlling electro-magnets and a battery associated therewith, the outside terminals of said magnets being connected with the two sides of the line and the inside terminals being connected together and to the same pole of the battery, and a supervisory signal jointly controlled by said magnets, substantially as described.

19. The combination with a telephone line connected for conversation, of a high resistance relay and a low resistance relay and a battery associated therewith, each of said relays being connected upon one side with a different limb of the talking circuit and upon the other connected directly together and with the battery so as to receive current from the same pole thereof, the low resistance relay being connected in the circuit of the telephone line and therefore under the control of the subscriber, and the other relay being in a branch circuit and under the control of the operator, and a supervisory signal jointly controlled by said relays, substantially as described.

20. In a common battery telephone system, the combination with a subscriber's telephone line, of a central common source of current connected with the line to enable the subscriber to call the central office and adapted also to be included in the metallic line to furnish current thereover for conversation, a cord circuit to establish connections with the line for conversation, a pair of supervisory relays bridged across

the cord circuit and having their windings connected directly together and with said source, a supervisory signal controlled by said relays, and means whereby when a connection is established by said cord circuit with the line for conversation one of said relays is included in a branch circuit and the other is in the path of current over the telephone line to the subscriber's station, substantially as described.

21. In a common battery telephone system, the combination with subscribers' telephone lines, of a central common source of current connected with the lines to enable the subscribers to call the central office and adapted also to be included in the metallic lines to furnish current thereover for conversation, a cord circuit to establish connections with the lines for conversation, a condenser in each strand of the cord circuit to conductively separate the two ends thereof and inductively unite them, a pair of supervisory relays bridged across each end of the cord circuit and upon each side of the condensers, said bridges between said relays being connected with the same pole of said source, a supervisory signal controlled by each pair of relays, and means whereby when a connection is established with the pair of lines one relay of each pair is included in a branch circuit and is adapted to cause the operation of the corresponding signal; while the other relay of each pair is actuated by current over the corresponding telephone line and serves when actuated to prevent the operation of the signal, substantially as described.

22. In a telephone system, the combination with telephone lines extending from the subscribers' stations to the central office, of a cord circuit at the central office to loop said lines together for conversation, a condenser in one side of the cord circuit, a central source of current adapted to be included in the metallic telephone lines during connections to furnish current thereover for conversation, relays connected between one pole of said source and the said strand, one on each side of the condenser, whereby current is fed through the said relays to the subscribers' stations during conversation and the relays are independently controlled by the subscribers, a supervisory signal for each end of the cord circuit having its operation controlled during connections by the associated relay, and electro-magnetic means connected between the same pole of said source and the other talking circuit strand of the cord circuit and serving to normally prevent the operation of said signals but to cause their operation when connections are established and the said relays do not interfere, substantially as described.

23. In a telephone system, the combination with telephone lines extending from

subscribers' stations to the central office, of a cord circuit at the central office to loop said lines together for conversation, condensers in each side of the cord circuit, a central source of current adapted to be included in the metallic telephone lines during connections to furnish current thereover for conversation, a pair of relays associated with each end of the cord circuit and connected between the same pole of said source and the corresponding end of the cord circuit one to each strand thereof and upon opposite sides of the condensers, a supervisory signal for each end of the cord circuit controlled by the corresponding pair of relays, and means whereby when a connection is established with a line one of each pair of relays is adapted to be included in a branch circuit at the central office and the other relay of each pair is adapted to be included in the metallic circuit of the corresponding telephone line and under the control of the subscriber, substantially as described.

24. In a telephone system, the combination with a telephone line, of a cord circuit to establish connections therewith for conversation, a central source of current, a pair of relays associated with the cord circuit and connected with the said source so as to receive current direct from the same pole thereof, the other pole of said source being connected direct to one line conductor through a coil having impedance to voice currents, whereby current is fed to the line through the latter coil and the relay connected to the opposite side of the cord circuit, a branch circuit for the other of said relays, and a supervisory signal having its operation suitably controlled by the said relays, substantially as described.

25. In a telephone system, the combination with a telephone line, of a cord circuit to establish connections for conversation, a source of current associated with the line and circuit at the central office and adapted to be included in the metallic line to furnish current thereover for conversation, a supervisory apparatus also associated with the cord circuit and comprising a pair of electromagnet windings, a winding of said pair being in the path of current over each talking circuit strand of the cord circuit, and directly connected with the same pole of said battery, one of said windings being energized by current over the metallic line and therefore under the control of the subscriber, and the other being energized over a circuit at the central office, and a supervisory signal caused to operate by the energization alone of said latter winding and rendered inoperative by the energization of the former winding, substantially as described.

26. The combination with a telephone line, of a cord circuit to establish connections

with the line for conversation, a battery associated therewith and adapted to be included in the metallic line to furnish current thereover for conversation, a pair of supervisory relays associated with the cord circuit and normally legged from the two sides of the cord circuit to the battery to receive current therefrom of the same polarity, and a supervisory signal jointly controlled by said relays, substantially as described.

27. The combination with a telephone line, of a battery and two supervisory relay windings adapted to be associated with the line during a connection therewith for conversational purposes, said relay windings being connected directly between the opposite sides of the talking circuit and the same pole of battery to receive current of the same polarity from the battery, and a supervisory signal jointly controlled by said windings, substantially as described.

28. The combination with a telephone line, of a battery connected with the line, two supervisory relays normally bridged across the cord circuit, said relays being connected with the same pole of the battery, and a supervisory signal controlled jointly by said relays, substantially as described.

29. In a telephone system, the combination with telephone lines extending from the subscribers' stations to the central office, of a cord circuit at the central office to loop said lines together for conversation, a condenser in one side of the cord circuit, a central source of current adapted to be included in the metallic telephone lines during connections to furnish current thereover for conversation, relays connected between one pole of said source and the said strand, one on each side of the condenser, whereby current is fed through the said relays to the subscribers' stations during conversation and the relays are independently controlled by the subscribers, a supervisory signal for each end of the cord circuit having its operation controlled during connections by the associated relay, and electromagnetic means connected between the same pole of said source and the other talking circuit strand of the cord circuit and serving to place said signals in condition to operate when connection is established with the line, substantially as described.

30. In a telephone system, the combination with a plurality of telephone lines, of a cord circuit consisting of only two strands to interconnect said lines for conversation, a condenser interposed in one of said strands, a central source of current associated with the lines and cord circuit, a low resistance supervisory winding connected between said strand on each side of the condenser and one pole of the said source, a low resistance coil connected between the

other pole of the source and the line conductor of each line opposite that with which the said strand of the cord circuit is to be connected, a high resistance supervisory winding connected between the first named pole of the said source and the opposite strand of the cord circuit, and a supervisory signal for each end of the cord circuit suit-

ably controlled by said windings, substantially as described.

Signed by me at Chicago, county of Cook,
State of Illinois, this 3rd day of July, 1901.
WILLIAM W. DEAN.

Witnesses:

L. D. KELLOGG,
ROBERT LEWIS AMES.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."