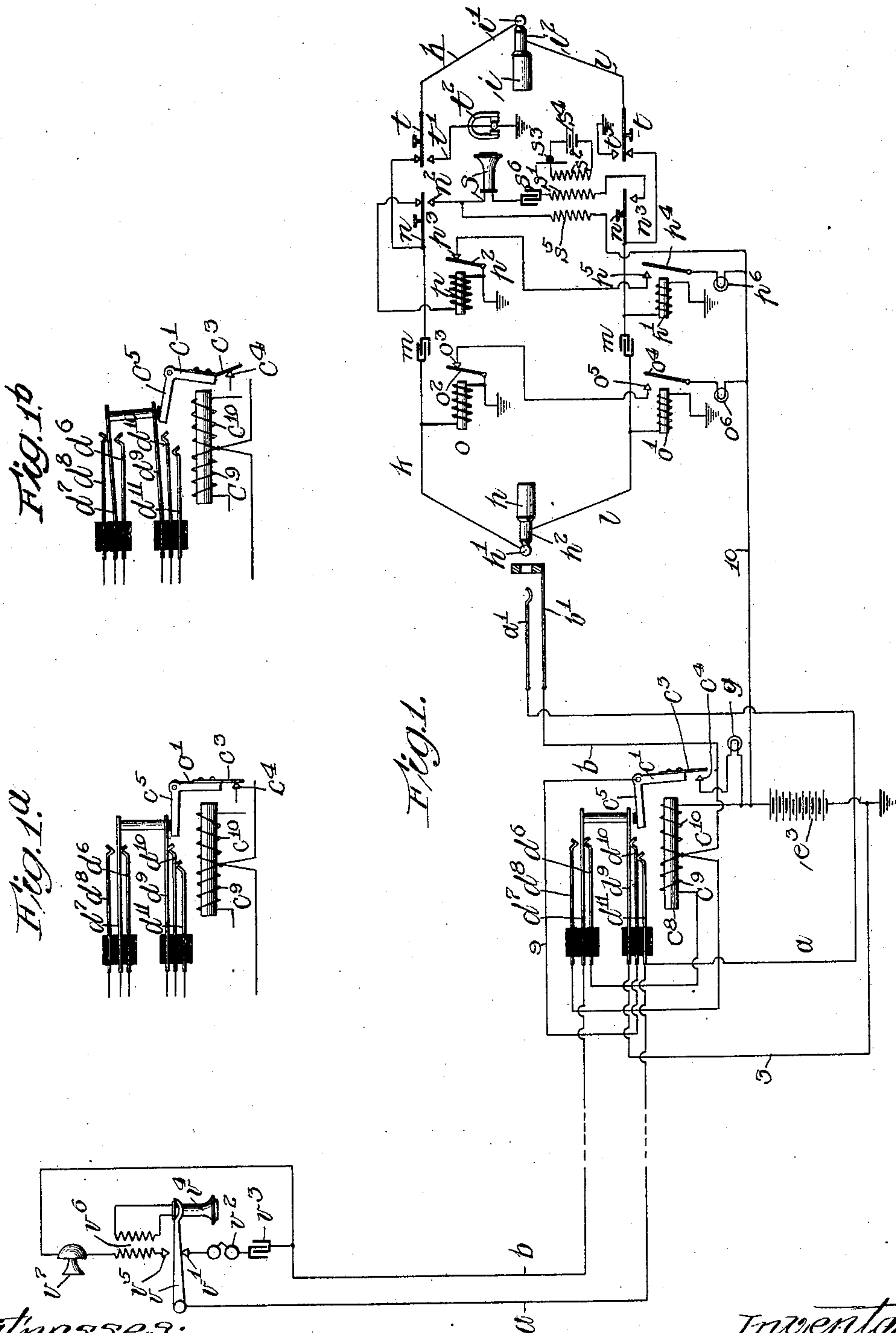


No. 897,234.

PATENTED AUG. 25, 1908.

H. G. WEBSTER.
TELEPHONE SYSTEM.
APPLICATION FILED OCT. 10, 1904.



Witnesses:

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TELEPHONE SYSTEM.

No. 897,234.

Specification of Letters Patent.

Patented Aug. 25, 1908.

Original application filed March 27, 1903, Serial No. 149,833. Divided and this application filed October 10, 1904.
Serial No. 227,878.

To all whom it may concern:

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

My invention relates to improvements in telephone systems, my object being to provide improved signaling apparatus therein.

In accordance with my invention I provide at the central station a signal controlling electromagnet which is under the control of the subscriber at the sub-station and is also under the control of the operator at the central station. This electromagnet in the preferred form of my invention is preferably a relay magnet which serves to control a signal, such as a lamp.

The signal controlling electromagnet is preferably constructed so that it is initially controlled by the subscriber at the sub-station, whereby a suitable signal may be actuated to call the attention of the operator to the fact that the subscriber desires a connection. The signal controlling electromagnet is also adapted to be actuated by the operator, preferably by the insertion of the connecting plug in a spring jack or switching terminal of the subscriber's line. The initial actuation of the magnet may be utilized to light a lamp as the calling signal, and the final actuation of the relay which is controlled by the operator may be utilized for rendering the signal inert.

I have illustrated my invention in connection with a signal controlling electromagnet in the form of a relay having a single armature adapted to partake of an initial movement under the control of the subscriber, and to partake of a final movement under the control of the operator, the initial movement serving to actuate the signal for the connection, and the final movement serving to render the signal inert; these movements may also be utilized for performing other functions as desired.

While I have thus shown the magnet with a single armature adapted to partake of the two distinctive movements, it is apparent that this selective operation may be procured in other ways, and I do not therefore desire to limit myself to this particular method of construction.

In its broader phases my invention is described and illustrated in my application for United States Letters Patent, Serial Number 149,833, filed March 27th, 1903. In the present application which is a division of said prior application I have illustrated my invention in connection with a signal controlling electromagnet in the form of a relay having two energizing windings of different energizing capacities normally differentially connected, and initially responsive to a control exercised by the subscriber, the circuit through one of said windings, however, being under the control of the operator whereby a greater energization of said relay may be secured.

I have illustrated this application of my invention in the accompanying drawings in which

Figure 1 is a diagram illustrating my invention in connection with a two wire metallic circuit telephone exchange system; Fig. 1^a is a detail view showing diagrammatically the armature and switching contacts of the relay in their second or intermediate position; Fig. 1^b is a detail view showing diagrammatically the armature and switching contacts of the relay in their third or final position.

Like letters refer to like parts in the several figures.

Referring first to Fig. 1, the subscriber's apparatus is represented as consisting of the telephone hook switch *v*, signal bell *v*², condenser *v*³, receiver *v*⁴, transmitter *v*⁷, and induction coil *v*⁶ including the said receiver in its secondary winding.

Although I have shown but one arrangement it will be understood by those skilled in the art that various other arrangements of the subscriber's apparatus may be used, and I do not confine myself to the particular arrangement illustrated.

Under normal conditions the receiver hangs upon its hook switch, thus closing the lower contact *v v'*, and maintaining the upper contact *v v*⁵ open. The condenser *v*³ prevents the normal flow of current from battery *e*³ at the central office over the telephone line. When, however, the subscriber removes his telephone from its hook, thus closing the contact *v v*⁵ and establishing a relatively low resistance path for the flow of current through the transmitter *v*⁷ and one winding of the re-

peating coil v^6 , the differentially wound relay c^8 at the central office will be energized to a limited extent by the flow of current from said battery e^3 , through winding c^{10} , winding c^9 in the opposite direction, through the normally closed contact between springs d^6 and d^7 , overlamps $b a$ of the telephone line, through the normally closed contacts of the springs d^{11} d^{10} and d^9 to the ground or common pole of the said battery e^3 via conductor 3. The said energizing winding c^{10} has a greater number of turns than the winding c^9 , or is placed so as to exert a greater attractive force upon the armature c' , or is otherwise made of greater energizing capacity, so as to secure a limited energization of the relay and a limited attraction of its armature c' to cause a limited movement thereof to close the contact c^3 c^4 , as shown in Fig. 1^a. In order that the armature c' may alter the contacts between the springs d^6 d^7 d^8 d^9 d^{10} and d^{11} , it is necessary that the core of the relay be energized to a greater extent than can be secured through the two differential windings c^{10} c^9 in series.

The closure of contact c^3 c^4 established a path for the flow of current from battery e^3 through the signal lamp g , contact c^4 c^3 , over conductor 9, through the contact between springs d^{10} and d^9 and to the other pole of the said battery. This flow of current causes the illumination of the said signal lamp g to indicate to the operator that the subscriber has removed his telephone from its hook for the purpose of making a call.

Each subscriber's line is provided with one or more spring jacks, each having contact pieces connected thereto in a manner similar to the one indicated in the drawing at a' b' . Each operator is provided with cord circuits adapted to unite the lines for conversation similar to the one diagrammatically illustrated. On observing the calling signal the operator will insert the left hand or answering plug of the cord circuit into a spring jack of the line corresponding to the calling signal, thus causing contact pieces h' h^2 of the said plug to engage respectively with the contact pieces a' b' of the spring jack. The contact pieces h^2 b' complete a new circuit for the flow of current from battery e^3 through winding c^{10} , contact b' h^2 , cord strand l , relay o' to the ground or common pole of the said battery e^3 . This flow of current causes the operation of the said relay o' and also causes the complete energization of the relay c^8 . The winding c^{10} now has a flow of current through it materially greater than the flow of current through the winding c^9 , and having a greater energizing capacity than said latter winding, causes the complete attraction of the armature c' to alter the contacts between the springs d^6 , d^7 d^8 d^9 d^{10} and d^{11} as follows:—Contact between springs d^{10} and d^9 is broken to interrupt the flow of current through the signal lamp g ; contact between springs d^{11} and d^{10} is broken

to disconnect the line circuit from the local signaling circuit; contact between springs d^6 and d^7 is broken to interrupt the flow of current through winding c^9 , and contact between springs d^7 and d^8 is established to connect the test contact b' of the jack directly to the limb b of the line without the intervention of the winding c^9 . As a result of the complete operation of the said relay c^8 the line signal g is effaced, the normal connections to the line circuit are destroyed and the said line circuit is connected directly to the cord circuit without intervening electromagnets or direct ground connections.

The energization of relay o' causes the attraction of its armature o^4 and would cause the illumination of the supervisory lamp o^6 were the subscriber's telephone not removed from its hook. The telephone being off its hook, however, a flow of current is established through the relay o as follows:—from battery e^3 through winding c^{10} , contact between springs d^7 d^8 , limbs b and a of the telephone line, over cord strand k , through relay o to the ground or common side of the said battery e^3 . Relay o is thus energized, attracts its armature o^2 , and opens the circuit through the supervisory lamp o^6 at the normally closed contact o^3 o^2 . The said supervisory lamp o^6 is thus prevented from giving its signal at this time.

Condensers $m m$ are interposed in the strands of the cord circuit to allow the operator to converse with the calling subscriber at this time and to allow conversation between the two subscribers when the connection has been completely established. The operator depresses the listening-in keys $n n$, thus cutting her telephone s into the conversational circuit, and having determined from the calling subscriber the number of the subscriber desired, touches the tip contact piece i' of the right hand plug to the test ring b' of a spring jack of the line wanted. If the line be busy the said contact b' will have a potential different from that of the battery e^3 and a flow of current will result from the said battery e^3 , over conductor 10, through the tertiary winding s^5 of the operator's induction coil, contact n^2 n of the operator's listening-in key, over cord strand k , through the tip contact i' of the plug and testing contact b' of the spring jack of the line tested, where it unites with the current flowing from the battery e^3 through the winding c^{10} of the busy line. This flow of current through the tertiary winding s^5 will produce a flow of current through the circuit including the operator's telephone s causing a click therein. The operator upon hearing the busy click will advise the calling party that the desired subscriber is busy. Should, however, the desired line be idle the testing terminals b' of all spring jacks connected with the desired subscriber's line would be at the same poten-

tial as the battery e^3 and the testing contact i' of the plug, and no flow of current would result through the said tertiary winding s^5 when the test was made. The operator would thus hear no click, would know that the desired line was idle, would insert the right hand plug into the spring jack of the desired line, and depress the ringing keys $t t$ to include in circuit with the calling bell v^2 at the subscriber's station, the calling generator t^2 , thus causing the desired subscriber's bell to ring. At this time the relay c^8 associated with the desired subscriber's line is maintained in an operated position by a current flowing from battery e^3 through winding c^{10} , jack and plug contact $b' i^2$, cord strand l , through contact $t t^3$ to the ground pole of said battery e^3 . This flow of current through the winding c^{10} is sufficient to cause the complete energization of the said relay c^8 and the complete attraction of its armature c' just as described with reference to the calling subscriber's line. A path for the ringing current is thus established directly over the limbs a and b of the subscriber's line, the said current returning to the ground pole of the said generator through contact $t t^3$. The subscriber's bell is thus caused to ring and notify the subscriber that his attention is desired. Before the said subscriber responds to his call a path for the flow of current is provided from battery e^3 through winding c^{10} of the relay associated with the called for subscriber's line, jack and plug contact $b' i^2$, cord strand l , relay p' and to the ground pole of said battery e^3 . This flow of current causes the operation of both relay p' and c^8 , just as described with reference to the calling subscriber's line. The complete energization and operation of the said relay c^8 prevents the illumination of the line signal g , while the operation of relay p' closes the contact $p^4 p^5$ and causes the illumination of the supervisory lamp p^6 to indicate to the operator that the called-for subscriber has not as yet responded. No path for the flow of current through relay p exists at this time. As soon, however, as the called-for subscriber removes his telephone from its hook a new path for the flow of current from battery e^3 is provided through winding c^{10} , limbs b and a of the telephone line, through the said relay p and to the ground or common side of the said battery e^3 . Relay p is thus energized, attracts its armature p^2 and opens the circuit through supervisory lamp p^6 to cause its extinction and to notify the operator of the response of the called-for subscriber.

Both subscribers are now in conversation with each other through the cord strands $k l$ and condensers $m m$, their transmitters being energized by current from battery e^3 through the windings c^{10} of the relays c^8 , the current returning through the relays o and p . The relays o and p are of relatively low re-

sistance compared with the resistance of the relays $o' p'$, thus securing a sufficient flow of current over the telephone lines from battery e^3 to satisfactorily energize the transmitters. As soon as either subscriber replaces his telephone upon his hook the corresponding relay p or o is deenergized, thus causing the illumination of the corresponding supervisory signal p^6 or o^6 . When both subscribers replace their telephones upon their hooks both of said supervisory signals will be illuminated, thus indicating to the operator that disconnection is desired. Upon withdrawing the plugs from the spring jacks the relays and associated apparatus will return to their normal positions indicated in Fig. 1.

Recapitulating, the energizing winding c^{10} is made of sufficiently higher energizing capacity than the energizing winding c^9 to cause a limited energization only of the relay c^8 when the same current traverses both of said windings. This limited energization of the said relay causes a partial attraction of its armature, or a limited movement of its associated signaling mechanism, to cause the appearance of the calling signal to indicate to the operator that a connection is desired. When, however, the cord circuit is connected with the line circuit, either in response to a call or for the purpose of making connection with the called-for subscriber's line, a circuit is established through one of said energizing windings only to cause the complete attraction of the relay armature, or the further movement of the associated signaling mechanism, to efface the calling signal and to destroy the normal non-inductive path for the flow of current to ground from the conversational circuit thus established and to remove the inductive windings from said circuit.

It is apparent that many alterations and modifications will occur to those skilled in the art for securing a sufficient difference between the energization of the relay c^8 when windings c^{10} and c^9 are in circuit and when winding c^{10} is alone in circuit with the cord connecting apparatus, whereby the relay magnet may control two definite movements of its associated switching apparatus.

It will also be obvious to those skilled in the art that my invention is not confined to its application in a switch board system of the character illustrated in the accompanying drawings, but that it may be applied to and utilized in other telephone exchange systems, and in signaling systems in general.

I have found that a sufficient difference between the energizing capacities of the two windings c^{10} c^9 may be secured in practice by making winding c^{10} of 200 ohms and winding c^9 of 175 ohms of the same size of wire, properly disposed upon the core, but other proportions between the two windings may be advantageously used depending upon the resistance of the other associated parts.

I claim:

1. In a telephone exchange system, a central office and a subscriber's line circuit, a source of current for the line, means at the subscriber's station to determine the current flow in the line, a combined signal and cut-off magnet connected in the line and adapted to control its own circuit connections and controlled by the current in the line as determined by the subscriber for exhibiting a signal, together with operator's connective apparatus having means becoming operative in the use of the apparatus to produce an increase of the current flow in the windings of said signal and cut-off magnet to further energize the same and operate the cut-off, thereby removing itself from the possibility of line control as long as a connection continues.

2. In a telephone exchange system, a central station and a subscriber's station and a source of current supply with the subscriber's line normally connected thereto, a combined signal and cut-off magnet having two windings normally included in the line and in series with said source of current, an armature for said magnet adapted to set a signal in response to current flow in one winding of the magnet, as determined by the subscriber, together with means controlled in making connection with the line to produce an increased current flow in the other winding whereby the armature will sever the connection of the first winding of the line.

3. In a telephone exchange system, a subscriber's line circuit, a subscriber's station and a central station, and a source of current at the latter for supplying the line as determined by the subscriber, a signal magnet having its winding normally included serially in the line with said source, an armature for said magnet with a signal device and a line cut-off device controlled by the armature, means whereby the action of the armature in response to normal signaling current in the line is limited to setting a signal, and further means under the control of an operator to produce an increased current flow through a portion of the magnet winding whereby the armature will operate the cut-off device to remove the magnet from its serial connection with the line and to retire the signal.

4. In a telephone exchange system, a subscriber's line circuit, a subscriber's station and a central station, and a source of current at the latter for supplying the line as determined by the subscriber, a signal magnet having its winding normally included serially in the line with said source, an armature for said magnet with a signal device and a line cut-off device controlled by the armature, means whereby the action of the armature in response to normal signaling current in the line is limited to setting a signal, and further means under the control of an operator to

close a local circuit through the source of current and a portion of the magnet winding to produce an increased flow and increased energization of the magnet, whereby the armature will act further to break the connection of the magnet to line, and will retire the signal.

5. In a telephone exchange system, a central station and a subscriber's station and a metallic circuit interconnecting them, a source of current and means at the subscriber's station to determine the flow therefrom in the line, a signal controlling magnet for the line at the central office having its windings included serially in the line with an included cut-off device, an armature for the magnet adapted to be moved in two steps, the first step in response to line current to set the line signal, and the second step to work the cut-off device, connection terminals for the line, and means controlled by an operator in the use of said connection terminals to close a local circuit through a portion of the magnet winding to move the armature its second step and thereby to sever the line connection of the magnet winding and retire the signal.

6. In a telephone exchange system, a metallic line circuit, and a relay having its windings normally connected thereto through closed cut-off contacts, a local signal circuit connected to normally open contacts of said relay, means to limit the effective energization of the relay magnet by line current so that its armature will close the local signal circuit only, and means under the control of an operator to increase the effective energization of the magnet so that its armature will act further to open the cut-off contacts and sever the line connection to the relay.

7. In a telephone exchange system, a substation and a central station with a line circuit interconnecting them, means at the substation to determine the flow of current in the line, a combined signal and cut-off relay for the line at central having two windings normally included serially in the line with cut-off contacts normally closed, an armature for said relay adapted to control a normally open signal circuit and thereafter when actuated further to open the said cut-off contacts, connection terminals for the line and cord circuits cooperating therewith, a source of current and a pair of bridged relays in each cord circuit, a supervisory signal jointly controlled by said bridged relays, one relay adapted to be included in a local circuit to close the supervisory signal circuit when connection is made with the line, and the other relay to control the said signal circuit in response to current over the line circuit, together with means whereby current in the line circuit as determined by a call from the substation will attract the relay armature to close the normally open line signal circuit

but will not open the cut-off contacts, and means actuated by an operator in responding to the call to include one winding of the line relay in the local circuit with the first supervisory relay, whereby the line relay is cut off from line and the supervisory signal circuit is simultaneously closed.

8. In a telephone exchange system, the combination with a telephone line connecting a sub-station with a switching terminal at the central office, a switch at the sub-station controlling the flow of current over the said telephone line through the sub-station, a cord circuit at the central office adapted to make connection with the said switching terminal and to complete a circuit therethrough over said telephone line, a signal receiving electro-magnet, having two differentially connected energizing windings of different energizing capacities normally included in circuit with said telephone line and with a suitable source of current, and normally responsive to currents over said line controlled by the sub-station switch, associated signaling mechanism controlled by said electro-magnet and adapted, under the limited energization thereof controlled by said sub-station switch, to cause the display of its signal, means for energizing said electro-magnet to a greater extent over a circuit established through one of said energizing windings when the cord circuit is connected to the line whereby the said signaling mechanism is caused to efface the said signal, means whereby the operator may determine the idle or busy condition of a tested line, a signal controlling electro-magnet associated with said cord circuit and under the control of the sub-station switch when the telephone line is switched for conversation, a second signal controlling electro-magnet associated with said cord circuit and energized over the circuit established by the connection of the cord circuit to the telephone line, and a supervisory signal jointly controlled by the said two electro-magnets.

9. In a telephone exchange system, the combination with a telephone line connecting a sub-station with a switching terminal at the central office, a switch at the sub-station controlling the flow of current over the said telephone line through the sub-station, a cord circuit at the central office adapted to make connection with the said switching terminal and to complete a circuit therethrough over said telephone line, a signal receiving electro-magnet, having two differentially connected energizing windings of different energizing capacities normally included in circuit with said telephone line and with a suitable source of current, and normally responsive to currents over said line controlled by the sub-station switch, associated signaling mechanism con-

trolled by said electro-magnet and adapted, under the limited energization thereof controlled by said sub-station switch, to cause the display of its signal, means for energizing said electro-magnet to a greater extent over a circuit established through one of said energizing windings when the cord circuit is connected to the line whereby the said signaling mechanism is caused to efface the said signal, means whereby the operator may determine the idle or busy condition of a tested line, and a signal controlling electro-magnet associated with said cord circuit and under the control of the sub-station switch when the telephone line is switched for conversation.

10. In a telephone exchange system, the combination with a telephone line connecting a sub-station with a switching terminal at the central office, a switch at the sub-station controlling the flow of current over the said telephone line through the sub-station, a cord circuit at the central office adapted to make connection with the said switching terminal and to complete a circuit therethrough over said telephone line, a signal receiving electro-magnet, having two differentially connected energizing windings of different energizing capacities normally included in circuit with said telephone line and with a suitable source of current, and normally responsive to currents over said line controlled by the sub-station switch, associated signaling mechanism controlled by said electro-magnet and adapted, under the limited energization thereof controlled by said sub-station switch, to cause the display of its signal, means for energizing said electro-magnet to a greater extent over a circuit established through one of said energizing windings when the cord circuit is connected to the line whereby the said signaling mechanism is caused to efface the said signal, a signal controlling electro-magnet associated with said cord circuit and under the control of the sub-station switch when the telephone line is switched for conversation, a second signal controlling electro-magnet associated with said cord circuit and energized over the circuit established by the connection of the cord circuit to the telephone line, and a supervisory signal jointly controlled by the said two electro-magnets.

11. In a telephone exchange system, the combination with a telephone line connecting a sub-station with a switching terminal at the central office, a switch at the sub-station controlling the flow of current over the said telephone line through the sub-station, a cord circuit at the central office adapted to make connection with the said switching terminal and to complete a circuit therethrough over said telephone line, a signal receiving electro-magnet, having two differentially connected energizing windings of

different energizing capacities normally included in circuit with said telephone line and with a suitable source of current, and normally responsive to currents over said line controlled by the sub-station switch, associated signaling mechanism controlled by said electro-magnet and adapted, under the limited energization thereof controlled by said sub-station switch, to cause the display of its signal, means for energizing said electro-magnet to a greater extent over a circuit established through one of said energizing windings when the cord circuit is connected to the line whereby the said signaling mechanism is caused to efface the said signal, and a signal controlling electro-magnet associated with said cord circuit and under the control of the sub-station switch when the telephone line is switched for conversation.

12. In a telephone exchange system, the combination with a telephone line connecting a sub-station with a switching terminal at the central office, a switch at the sub-station controlling the flow of current over the said telephone line through the sub-station, a cord circuit at the central office adapted to make connection with the said switching terminal and to complete a circuit therethrough over said telephone line, a signal receiving electro-magnet, having two differentially connecting energizing windings of different energizing capacities normally included in circuit with said telephone line and with a suitable source of current, and normally responsive to currents over said line controlled by the sub-station switch, associated signaling mechanism controlled by said electro-magnet and adapted, under the limited energization thereof controlled by said sub-station switch, to cause the display of its signal, means for energizing said electro-magnet to a greater extent over a circuit established through one of said energizing windings when the cord circuit is connected to the line whereby the said signaling mechanism is caused to efface the said signal and means whereby the operator may determine the idle or busy condition of a tested line.

13. In a telephone exchange system, the combination with a telephone line connecting a sub-station with a switching terminal at the central office, a switch at the sub-station controlling the flow of current over the said telephone line through the sub-station, a cord circuit at the central office adapted to make connection with the said switching terminal and to complete a circuit therethrough over said telephone line, a signal receiving electro-magnet, having two differentially connected energizing windings of different energizing capacities normally included in circuit with said telephone line and with a suitable source of current, and normally responsive to currents over said line controlled by the sub-station switch, associated signaling mechanism

controlled by said electro-magnet and adapted, under the limited energization thereof controlled by said sub-station switch, to cause the display of its signal and means for energizing said electro-magnet to a greater extent over a circuit established through one of said energizing windings when the cord circuit is connected to the line whereby the said signaling mechanism is caused to efface the said signal.

14. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided with a switching terminal thereat, a signal receiving electro-magnet associated with said line and having two differentially connected energizing windings of different energizing capacities normally in circuit therewith adapted to energize said electro-magnet to a limited extent only to cause the display of its signal when the line circuit is closed at the sub-station, cord connecting apparatus adapted to make connection with the said switching terminal and establish a new path for the greater flow of current through one of said energizing windings to cause a greater energization of said electro-magnet whereby the said signal is again effaced when the said line is switched for conversation, switching mechanism also controlled by said electro-magnet adapted to remove the impedance of its other energizing winding from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation, means whereby the operator may determine the idle or busy condition of a tested line, a signal controlling electro-magnet associated with said cord connecting apparatus and under the control of the sub-station switch when the telephone line is switched for conversation, a second signal controlling electro-magnet associated with said cord connecting apparatus and energized over the said circuit established by the connection of the cord circuit to the telephone line, and a supervisory signal jointly controlled by the said two electro-magnets.

15. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided with a switching terminal thereat, a signal receiving electro-magnet associated with said line and having two differentially connected energizing windings of different energizing capacities normally in circuit therewith adapted to energize said electro-magnet to a limited extent only to cause the display of its signal when the line circuit is closed at the sub-station, cord connecting apparatus adapted to make connection with the said switching terminal and establish a new path for the greater flow of current through one of said energizing windings to cause a greater energization of said electro-

magnet whereby the said signal is again effaced when the said line is switched for conversation, switching mechanism also controlled by said electro-magnet adapted to
 5 remove the impedance of its other energizing winding from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation, means whereby the operator may determine the idle or busy condition of a tested
 10 line, and a signal controlling electro-magnet associated with said cord connecting apparatus and under the control of the sub-station switch when the telephone line is
 15 switched for conversation.

16. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided with a switching terminal thereat,
 20 a signal receiving electro-magnet associated with said line and having two differentially connected energizing windings of different energizing capacities normally in circuit therewith adapted to energize said electro-
 25 magnet to a limited extent only to cause the display of its signal when the line circuit is closed at the sub-station, cord connecting apparatus adapted to make connection with the said switching terminal and establish a
 30 new path for the greater flow of current through one of said energizing windings to cause a greater energization of said electro-magnet whereby the said signal is again effaced when the said line is switched for con-
 35 versation, switching mechanism also controlled by said electro-magnet adapted to remove the impedance of its other energizing winding from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversa-
 40 tion and a signal controlling electro-magnet associated with said cord connecting apparatus and under the control of the sub-station switch when the telephone line is
 45 switched for conversation.

17. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided with a switching terminal thereat,
 50 a signal receiving electro-magnet associated with said line and having two differentially connected energizing windings of different energizing capacities normally in circuit therewith adapted to energize said electro-
 55 magnet to a limited extent only to cause the display of its signal when the line circuit is closed at the sub-station, cord connecting apparatus adapted to make connection with the said switching terminal and establish a new path for the greater flow of current through one of said energizing windings to cause a greater energization of said electro-magnet whereby the said signal is again effaced when the said line is switched for con-
 60 versation, and switching mechanism also con-

trolled by said electro-magnet adapted to remove the impedance of its other energizing winding from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation. 70

18. In a telephone exchange system, the combination with a telephone line connecting the sub-station with the central office and provided with a switching terminal thereat, 75
 a signal receiving electro-magnet associated with said line and having two differentially connected energizing windings of different energizing capacities normally in circuit therewith adapted to energize said electro- 80
 magnet to a limited extent only to cause the display of its signal when the line circuit is closed at the sub-station, cord connecting apparatus adapted to make connection with the said switching terminal and to establish 85
 a new path for the flow of current through one of said energizing windings only to cause a greater energization of said magnet whereby the said signal is again effaced when the said line is switched for conversation and 90
 switching mechanism also controlled by said electro-magnet adapted to remove the impedance of its other energizing winding from the circuit extending between the sub-station and the said switching terminal when 95
 the line is switched for conversation.

19. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided with a switching terminal thereat, 100
 a signal receiving electro-magnet associated with said line and having two differentially connected energizing windings of different energizing capacities normally in circuit therewith adapted to energize said electro- 105
 magnet to a limited extent only to cause the display of its signal when the line circuit is closed at the sub-station, cord connecting apparatus adapted to make connection with the said switching terminal and to establish 110
 a new path for the flow of current through one of said energizing windings only to cause a greater energization of said magnet whereby the said signal is again effaced when the said line is switched for conversation, switch- 115
 ing mechanism also controlled by said electro-magnet adapted to remove the impedance of its other energizing winding from the circuit extending between the sub-station and the said switching terminal when the line is 120
 switched for conversation, and means whereby the operator may determine the idle or busy condition of a tested line.

20. In a telephone exchange system, the combination with a telephone line connect- 125
 ing a sub-station with the central office and provided with a switching terminal thereat, a signal receiving electro-magnet associated with said line and having two differentially connected energizing windings of different 130

energizing capacities normally in circuit therewith adapted to energize said electro-magnet to a limited extent only to cause the display of its signal when the line circuit is closed at the sub-station, cord connecting apparatus adapted to make connection with the said switching terminal and to establish a new path for the flow of current through one of said energizing windings only to cause a greater energization of said magnet whereby the said signal is again effaced when the said line is switched for conversation, switching mechanism also controlled by said electro-magnet adapted to remove the impedance of its other energizing winding from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation, and a signal controlling electro-magnet associated with said cord connecting apparatus and under the control of the sub-station switch when the telephone line is switched for conversation.

21. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided with a switching terminal thereat, a signal receiving electro-magnet associated with said line and having two differentially connected energizing windings of different energizing capacities normally in circuit therewith adapted to energize said electro-magnet to a limited extent only to cause the display of its signal when the line circuit is closed at the sub-station, and cord connecting apparatus adapted to make connection with the said switching terminal and establish a new path for the greater flow of current through one of said energizing windings to cause a greater energization of said electro-magnet whereby the said signal is again effaced when the said line is switched for conversation.

22. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided with a switching terminal thereat, a signal receiving electro-magnet associated with said line and having two differentially connected energizing windings of different energizing capacities normally in circuit therewith adapted to energize said electro-magnet to a limited extent only to cause the display of its signal when the line circuit is closed at the sub-station, and cord connecting apparatus adapted to make connection with the said switching terminal and to establish a new path for the flow of current through one of said energizing windings only to cause a greater energization of said magnet whereby the said signal is again effaced when the said line is switched for conversation.

23. In a telephone exchange system, the combination with a telephone line connect-

ing the sub-station with the central office and provided with a switching terminal thereat, a signal receiving electro-magnet associated with said line and having two differentially connected energizing windings of different energizing capacities normally in circuit therewith adapted to energize said electro-magnet to a limited extent only to cause the display of its signal when the line circuit is closed at the sub-station, cord connecting apparatus adapted to make connection with the said switching terminal and establish a new path for the greater flow of current through one of said energizing windings to cause a greater energization of said electro-magnet whereby the said signal is again effaced when the said line is switched for conversation, and means whereby the operator may determine the idle or busy condition of a tested line.

24. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided with a switching terminal thereat, a signal receiving electro-magnet associated with said line and having two differentially connected energizing windings of different energizing capacities normally in circuit therewith adapted to energize said electro-magnet to a limited extent only to cause the display of its signal when the line circuit is closed at the sub-station, cord connecting apparatus adapted to make connection with the said switching terminal and establish a new path for the greater flow of current through one of said energizing windings to cause a greater energization of said electro-magnet whereby the said signal is again effaced when the said line is switched for conversation, and a signal controlling electro-magnet associated with said cord connecting apparatus and under the control of the sub-station switch when the telephone line is switched for conversation.

25. In a telephone exchange system, the combination with a telephone line connecting the sub-station with the central office and provided with a switching terminal thereat, a signal receiving electro-magnet associated with said line and having two differentially connected energizing windings of different energizing capacities normally in circuit therewith adapted to energize said electro-magnet to a limited extent only to cause the display of its signal when the line circuit is closed at the sub-station, cord connecting apparatus adapted to make connection with the said switching terminal and establish a new path for the greater flow of current through one of said energizing windings to cause a greater energization of said electro-magnet whereby the said signal is again effaced when the said line is switched for conversation, means whereby the operator may determine the idle or busy condition of a tested line, and a

signal controlling electro-magnet associated with said cord connecting apparatus and under the control of the sub-station switch when the telephone line is switched for conversation.

26. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided with a switching terminal thereat, a signal receiving electro-magnet associated with said line and having two differentially connected energizing windings of different energizing capacities normally in circuit therewith adapted to energize said electro-magnet to a limited extent only to cause the display of its signal when the line circuit is closed at the sub-station, cord connecting apparatus adapted to make connection with the said switching terminal and establish a new path for the greater flow of current through one of said energizing windings to cause a greater energization of said electro-magnet whereby the said signal is again effaced when the said line is switched for conversation, means whereby the operator may determine the idle or busy condition of a tested line, a signal controlling electro-magnet associated with said cord connecting apparatus and under the control of the sub-station switch when the telephone line is switched for conversation, a second signal controlling electro-magnet associated with said cord connecting apparatus and energized over the said circuit established by the connection of the cord circuit to the telephone line, and a supervisory signal jointly controlled by the said two electro-magnets.

27. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line, having two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the display of its signal is effected, switching contacts adapted, when the line is connected with the cord circuit, to cause a greater flow of current through one of said energizing windings whereby a greater energization of said electro-magnet is caused to efface said signal, switching mechanism controlled by said electro-magnet adapted to remove the impedance of its other energizing winding from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation, means whereby the operator may determine the idle or busy condition of a tested line, a signal controlling electro-magnet as-

sociated with said cord circuit and under the control of the sub-station switch when the telephone line is switched for conversation, a second signal controlling electro-magnet associated with said cord circuit and energized over the circuit established by the connection of the cord circuit to the telephone line, and a supervisory signal jointly controlled by the said two electro-magnets.

28. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line, having two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the display of its signal is effected, switching contacts adapted, when the line is connected with the cord circuit, to cause a greater flow of current through one of said energizing windings whereby a greater energization of said electro-magnet is caused to efface said signal, switching mechanism controlled by said electro-magnet adapted to remove the impedance of its other energizing winding from the circuit extending between the sub-station and the switching terminal when the line is switched for conversation, means whereby the operator may determine the idle or busy condition of a tested line, and a signal controlling electro-magnet associated with said cord circuit and under the control of the sub-station switch when the telephone line is switched for conversation.

29. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line having two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the display of its signal is effected, switching contacts adapted, when the line is connected with the cord circuit, to cause a greater flow of current through one of said energizing windings whereby a greater energization of said electro-magnet is caused to efface said signal, switching mechanism controlled by said electro-magnet adapted to remove the impedance of its other energizing winding from the circuit extending between the sub-station and the said switching terminal

nal when the line is switched for conversation, and a signal controlling electro-magnet associated with said cord circuit and under the control of the sub-station switch when the telephone line is switched for conversation.

30. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line having two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the display of its signal is effected, switching contacts adapted, when the line is connected with the cord circuit, to cause a greater flow of current through one of said energizing windings whereby a greater energization of said electro-magnet is caused to efface said signal, and switching mechanism controlled by said electro-magnet adapted to remove the impedance of its other energizing winding from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation.

31. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line having two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the display of its signal is effected, switching contacts adapted, when the line is connected with the cord circuit, to cause a flow of current through one of said energizing windings without also passing through the other energizing winding, whereby a greater energization of said electro-magnet is caused to efface said signal, and switching mechanism controlled by said electro-magnet adapted to remove the impedance of its said other energizing winding from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation.

32. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line hav-

ing two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the display of its signal is effected, switching contacts adapted, when the line is connected with the cord circuit, to cause a flow of current through one of said energizing windings without also passing through the other energizing winding, whereby a greater energization of said electro-magnet is caused to efface said signal, switching mechanism controlled by said electro-magnet adapted to remove the impedance of its said other energizing winding from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation, and means whereby the operator may determine the idle or busy condition of a tested line.

33. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line having two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the display of its signal is effected, switching contacts adapted, when the line is connected with the cord circuit, to cause a flow of current through one of said energizing windings without also passing through the other energizing winding, whereby a greater energization of said electro-magnet is caused to efface said signal, switching mechanism controlled by said electro-magnet adapted to remove the impedance of its said other energizing winding from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation, and a signal controlling electro-magnet associated with said cord circuit and under the control of the sub-station switch when the telephone line is switched for conversation.

34. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line having two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the

circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the display of its signal is effected, and switching contacts adapted, when the line is connected with the cord circuit, to cause a flow of current through one of said energizing windings whereby a greater energization of said electro-magnet is caused to efface said signal.

35. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line having two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the display of its signal is effected, and switch contacts adapted, when the line is connected with the cord circuit, to cause a greater flow of current through one of said energizing windings without also passing through the other energizing winding, whereby a greater energization of said electro-magnet is caused to efface said signal.

36. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line having two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the display of its signal is effected, switch contacts adapted, when the line is connected with the cord circuit, to cause a greater flow of current through one of said energizing windings whereby a greater energization of said electro-magnet is caused to efface said signal, and means whereby the operator may determine the idle or busy condition of a tested line.

37. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line having two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the circuit is closed at the sub-station to

cause a limited energization only of said electro-magnet whereby the display of its signal is effected, switch contacts adapted, when the line is connected with the cord circuit, to cause a greater flow of current through one of said energizing windings without also passing through the other energizing winding, whereby a greater energization of said electro-magnet is caused to efface said signal, and a signal controlling electro-magnet associated with said cord circuit and under the control of the sub-station switch when the telephone line is switched for conversation.

38. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line having two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the display of its signal is effected, switch contacts adapted, when the line is connected with the cord circuit, to cause a flow of current through one of said energizing windings without also passing through the other energizing winding, whereby a greater energization of said electro-magnet is caused to efface said signal, and means whereby the operator may determine the idle or busy condition of a tested line.

39. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line having two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the display of its signal is effected, switch contacts adapted, when the line is connected with the cord circuit, to cause a greater flow of current through one of said energizing windings whereby a greater energization of said electro-magnet is caused to efface said signal, means whereby the operator may determine the idle or busy condition of a tested line, a signal controlling electro-magnet associated with said cord circuit and under the control of the sub-station switch when the telephone line is switched for conversation, a second signal controlling electro-magnet associated with said cord circuit

cuit and energized over the circuit established by the connection of the cord circuit to the telephone line, and a supervisory signal jointly controlled by the said two electromagnets.

40. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office, a cord circuit at the central office for making connection with the said line, a signal receiving electro-magnet associated with said line having two differentially connected windings of different energizing capacities, a connection to a source of current extending from one side of said line adapted to complete the circuit through both of said windings when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the display of its signal is effected, switch contacts adapted, when the line is connected with the cord circuit, to cause a greater flow of current through one of said energizing windings whereby a greater energization of said electro-magnet is caused to efface said signal, a signal controlling electro-magnet associated with said cord circuit and under the control of the sub-station switch when the telephone line is switched for conversation, a second signal controlling electro-magnet associated with said cord circuit and energized over the circuit established by the connection of the cord circuit to the telephone line, and a supervisory signal jointly controlled by the said two electromagnets.

41. A telephone system comprising a telephone line extending from a substation to a central office, a cord-circuit for making connection to said line, means for holding conversation over said line and cord-circuit, a call-signal associated with said line at the central office, a controlling electromagnet for said signal having a plurality of energizing windings, means under the control of the subscriber for energizing said electromagnet by supplying current over a path through a plurality of said windings, means under the control of the operator for modifying the said energization by supplying current through a less number of said windings, and means responsive to the initial energization to display said signal and to the modified energization to efface said signal.

42. A telephone system comprising a telephone line extending from a substation to a central office, a cord-circuit for making connection to said line, means for holding conversation over said line and cord-circuit, a

call-signal associated with said line at the central office, a controlling electromagnet for said signal having a plurality of energizing windings, means under the control of the subscriber for energizing said electromagnet by supplying current over a path through a plurality of said windings, means under the control of the operator for increasing the said energization by supplying current through a less number of said windings, and means responsive to the initial energization to display said signal and to the increased energization to efface said signal.

43. A telephone system comprising a telephone line extending from a substation to a central office, a cord-circuit for making connection to said line, means for holding conversation over said line and cord-circuit, a call-signal associated with said line at the central office, a controlling electromagnet for said signal having a plurality of energizing windings, means under the control of the subscriber for energizing said electromagnet by supplying current over a path through a plurality of said windings, means under the control of the operator for modifying the said energization by supplying current to one only of said windings, and means responsive to the initial energization to display said signal and to the modified energization to efface said signal and to render certain of the remaining energizing windings non-effective.

44. A telephone system comprising a telephone line extending from a substation to a central office, a cord-circuit for making connection to said line, means for holding conversation over said line and cord-circuit, a call-signal associated with said line at the central office, a controlling electromagnet for said signal having a plurality of energizing windings, means under the control of the subscriber for energizing said electromagnet by supplying current over a path through a plurality of said windings, means under the control of the operator for modifying the said energization by supplying current to one only of said windings, and means responsive to the initial energization to display said signal and to the modified energization to efface said signal and to render all of the remaining energizing windings non-effective.

In witness whereof, I hereunto subscribe my name this 8th day of October A. D., 1904.

HARRY G. WEBSTER.

Witnesses:

A. H. DYSON.

CAROLYN WEBER.