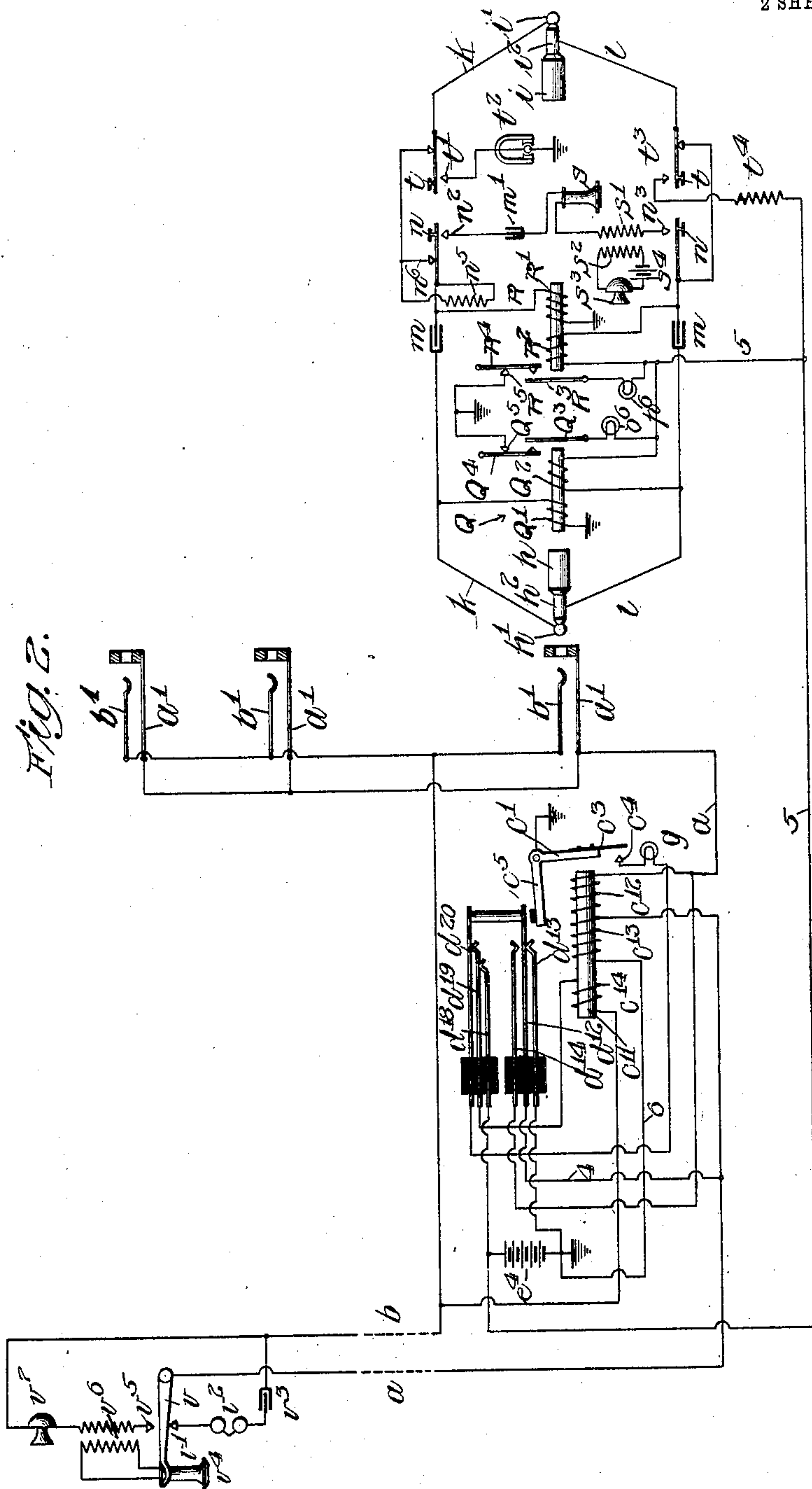


No. 897,235.

PATENTED AUG. 25, 1908.

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

2 SHEETS—SHEET 2.



Witnesses:

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TELEPHONE SYSTEM.

No. 897,235.

Specification of Letters Patent.

Patented Aug. 25, 1908.

Application filed October 10, 1904. Serial No. 227,879.

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.

I have illustrated my invention in connection with the signal controlling electromag-

net in the form of a relay having three energizing windings, one of said windings being normally in circuit and of low energizing capacity whereby the subscriber may control the partial energization of the said relay to cause the appearance of the signal. The other two windings are of greater energizing capacity and are under the control of the operator whereby a greater energization may be imparted to the relay to cause the extinction of the said signal.

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 the 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; Fig. 2 is a diagram illustrating my invention in connection with another two-wire metallic circuit telephone exchange system in which the cord circuit is provided with two relays only, controlling the corresponding supervisory signals, and in which the winding of low energizing capacity of the signal controlling relay associated with the line, is removed from circuit when the line is connected at the central office.

The embodiment of my invention illustrated in Figs. 1, 1^a and 1^b, is divided out of my prior application, Serial No. 149,833, filed March 23, 1903, and allowed June 17, 1908.

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*¹, and maintaining the upper contact *v v*⁵ open. The

condenser v^3 prevents the normal flow of current from the battery e^4 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 repeating coil v^6 , the signal controlling relay c^{11} at the central office will be energized to a limited extent by the flow of current from the said battery e^4 through the winding c^{14} of low energizing capacity, over the limb b of the telephone line, through the sub-station, back to the central office over limb a , continuing over conductor 4, and the contact between springs d^{12} , d^{13} to the ground terminal of the said battery e^4 . This energization of the relay c^{11} will cause a sufficient attraction of its armature c^1 to close the contact $c^3 c^4$, but this energization is insufficient to change the relation between the contacts of the springs d^{12} d^{13} d^{14} d^{15} . The closing of contact $c^3 c^4$ permits a flow of current through the calling lamp g from the source of current e^4 , contact $c^3 c^4$ and the normally closed contact between springs d^{13} d^{15} to the grounded terminal of the said source of current e^4 . This will cause the illumination of the calling lamp g and indicate to the operator that the subscriber has removed his telephone from its hook for the purpose of making a call. It will be noticed that winding c^{13} is at this time short circuited by the contact between springs d^{13} and d^{12} and that the winding c^{12} is connected directly between the switching terminal at the switch-board and the limb a of the subscriber's line. 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 $a^1 b^1$. Each operator is provided with cord circuits adapted to unite the lines for conversation, one only of these cord circuits being 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 $h^1 h^2$ of the said plug to engage respectively with contact pieces $b^1 a^1$ of the spring jack. The contact pieces $h^2 a^1$ complete a new circuit for the flow of current from battery e^4 over conductor 5, relay o^1 , talking strand l of the cord circuit, contact $a^1 h^2$, winding c^{12} , conductor 4 through the contact between springs d^{13} d^{12} to the ground pole of the said source of current. This flow of current will cause the operation of the said relay o^1 , and also on account of the high energizing capacity of the winding c^{12} will cause the complete energization of the relay c^{11} , thus attracting its armature to its third or final position and causing the con-

tacts between springs d^{15} , d^{13} and d^{12} to be broken, but establishing contact between the springs d^{14} and d^{12} . The opening of the contact between springs d^{12} and d^{13} causes the flow of current through the winding c^{12} to continue through the winding c^{13} to the ground terminal of the said battery e^4 , thus momentarily placing both of said higher energizing windings in circuit. The closing of the contact between springs d^{12} d^{14} , however, short circuits the winding c^{12} , thus leaving the winding c^{13} alone in circuit.

The operation of relay o^1 which resulted when the plug was inserted in the spring jack closed its armature contact $o^4 o^5$ and would have caused the illumination of the supervisory lamp o^6 were the supervisory relay o not then energized over a path for the flow of current through the calling subscriber's sub-station. This path for the flow of current was established also by the insertion of the plug into the answering jack, said path extending from battery e^4 over conductor 5, relay o , talking strand k of the cord circuit, contact $b^1 h^1$ of the jack and plug, limb b of the telephone line, through the subscriber's transmitter and one winding of the induction coil, back over limb a to the central office where it unites with the current through relay o^1 , and continues through the said winding c^{13} to the ground pole of the said source of current. The energization of relay o opens its armature contact $o^2 o^3$ and prevents the illumination of the supervisory lamp o^6 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 into the conversational circuit, and having determined from the calling subscriber the number of the subscriber desired, touches the tip contact i^1 of the right-hand plug to the test ring a^1 of the spring jack of the line wanted. If the line be busy, the contact a^1 will have a potential different from that of the ground or common terminal of the battery e^4 and a flow of current will result from the said battery over conductor 5, through relay o^1 or p^1 of some cord circuit other than the one in use by the operator to secure the said busy test, over strand l of such cord circuit, through contact $h^2 a^1$ to the various testing contacts a^1 of the line tested, through the testing terminal i^1 of the particular plug now in use, strand k , listening-in key contact $n n^2$, through the tertiary winding s^5 of the operator's induction coil to the grounded terminal of the said battery e^4 . The flow of current through the said tertiary winding s^5 will cause a flow of current through the operator's telephone s and notify the said oper-

ator that the desired line is busy. Should, however, the desired line be idle, the said testing terminals a^1 will be at the potential of the earth or the common pole of the battery e^4 due to the normally closed contact between springs d^{12} and d^{13} , and no flow of current will result through the said tertiary winding s^5 when the tip of the testing plug is touched to any testing contact of the desired line. 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^{11} associated with the desired subscriber's line is maintained in an operated position by current which flows from battery e^4 over conductor 5, resistance coil t^4 , strand l and through the high energizing winding c^{13} of the said relay to the ground terminal of the said source of current e^4 . A path for the flow of ringing current is thus provided from the said generator t^2 over the limbs $a\ b$ of the subscriber's line and back to the grounded or common pole of said generator through the resistance coil t^4 , conductor 5 and circuits of the battery e^4 . The subscriber's bell is thus caused to ring to notify the subscriber that his attention is desired. Before the said subscriber responds to his call, but after the operator has released the ringing keys $t\ t$, a path for the flow of current is provided from battery e^4 over conductor 5, through relay p^1 , strand l of the cord circuit, plug and jack contact $i^2\ a^1$ and through the winding of high energizing capacity c^{13} of the relay associated with the desired subscriber, thus causing the operation of both the said relays in the manner previously described with reference to the calling subscriber.

The operation of relay p^1 closes its armature contact p^4 , p^5 and causes the illumination of the supervisory lamp p^6 to indicate to the operator that the desired subscriber has not as yet responded to his call. 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^4 is provided over conductor 5, through said relay p , strand k , plug and jack contact i^1 , b^1 , over the subscriber's line circuit and through winding c^{13} of the relay associated with the desired subscriber's line to the ground terminal of the said source of current. Relay p is thus energized, attracts its armature p^2 , and opens the circuit through the supervisory lamp p^6 to cause its extinction and to notify the operator of the response by 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^4 through relays o and p , over their respective line circuits and through windings c^{13} of the relays associated with their respective circuits. The relays o , p are of relatively low resistance compared with the resistances of the relays $o^1\ p^1$, thus providing for the proper distribution of the talking current. As soon as either subscriber replaces his telephone upon its 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.

In Fig. 2, the winding c^{14} , which is of low energizing capacity, is diagrammatically indicated on the end of the core distant from the armature and is included in circuit with the normally closed contact between springs d^{18} and d^{19} , said contact being adapted to be opened when the relay is completely energized, thus disconnecting the said winding c^{14} at all times when the cord circuit is united with the line circuit. In this case, the circuit through calling lamp g is normally closed between contact springs d^{20} , d^{19} and d^{18} , and is normally open between the spring contact $c^3\ c^4$, the armature c^1 being in this case connected directly to ground or to the common pole of the source of current e^4 . In other respects, the line circuit arrangement is the same as that described with reference to Fig. 1. I have also represented in connection with the line circuit of Fig. 2 a cord circuit which is the subject matter of my application for United States Letters Patent, Serial No. 219413, filed Aug. 4, 1904. Each cord circuit is provided with two relays, Q , R , each having two windings. The winding Q^2 is, when the line is open at the subscriber's station, capable of energizing the said relay to an extent sufficient to close contact between Q^3 and Q^4 but insufficient to open the contact between Q^4 and Q^5 . Similarly the energizing winding R^2 is, when the line is open at the subscriber's station, capable of energizing the relay R to an extent sufficient only to close the contact R^3 , R^4 , but not sufficient to cause the opening of the contact between R^4 and R^5 . The insertion of the plug into the jack causes a flow of current through the winding Q^2 or R^2 and through the energizing winding c^{13} of the relay associated with the line. This causes the complete energization of the said relay associated with the line and the incomplete energization of the relay associated with the cord circuit unless the subscriber's

telephone be then removed from its hook. In this latter case, an additional path for the flow of current is provided, through the said winding Q^2 or R^2 over the limbs a , b of the subscriber's line and back through the winding Q^1 or R^1 of the corresponding supervisory relay Q or R . This additional flow of current through both of said windings is sufficient to cause the complete energization of the supervisory relay, thus opening the contact between Q^4 and Q^5 or between R^4 and R^5 , resulting in the extinction of the corresponding supervisory lamp o^6 or p^6 .

It is apparent that the winding c^{13} of the relay associated with the line may in the circuit arrangement shown in Fig. 2, be made of high resistance as well as of high energizing capacity as the path for the talking current extends in said arrangement of Fig. 2 through the windings Q^1 Q^2 or R^1 R^2 of the supervisory relays. A resistance coil n^5 is shown in association with the listening-in keys of the cord circuit of Fig. 2, its use being to decrease the flow of current which would otherwise result from the testing contact a^1 through the winding R^1 of the relay R when the busy test was made on a busy line. In this case, the busy test is secured by the resulting change of potential which occurs through the condenser m^1 in the operator's telephone circuit when a busy line is tested. In other respects, the operation of the cord circuit shown in Fig. 2, is substantially the same as that described with reference to Fig. 1. Recapitulating, the winding c^{14} is made of low energizing capacity so as to secure the partial operation of the relay c^{11} under the control of the subscriber whereby the calling signal may be operated. The windings c^{12} and c^{13} are made of greater energizing capacity and the circuits in which they are included are under the control of the operator whereby the insertion of the plug into a jack will cause the complete energization of, and operation of, the said relay to cause the extinction of the line signal by a further movement of its armature. When the line is connected for conversation, the winding c^{12} is short circuited from the conversational circuit and the winding c^{13} is left legged to ground from one side thereof.

It is apparent that many alterations and modifications of the specific matter herein disclosed may be made without departing from the spirit and scope of the invention and that many ways will occur to those skilled in the art for securing a sufficient difference between the energization of the relay c^{11} when windings c^{12} or c^{13} are in circuit and when winding c^{14} alone is in circuit, whereby the relay magnet may control two definite movements of its associated switching apparatus. It will also be apparent 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 claim:—

1. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided thereat with a switching terminal, a signal receiving electro-magnet associated with said line having an energizing winding of low energizing capacity normally in circuit with said line and with a suitable source of current, whereby a limited energization only of said electro-magnet may be controlled from the sub-station to cause the display of a signal, two other windings for said electro-magnet of greater energizing capacities, a cord circuit adapted to make connection with said switching terminal and to complete a circuit through one of said windings of greater energizing capacity to cause a greater energization of said electro-magnet whereby the control of said signal from the sub-station is destroyed, switching mechanism associated with said electro-magnet adapted to be actuated by the greater energization thereof to remove the said winding of greater energizing capacity from the direct circuit extending between the sub-station and the switching terminal and to include in branch circuit the other of said windings of greater energizing capacity, 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, 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.

2. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided thereat with a switching terminal, a signal receiving electro-magnet associated with said line having an energizing winding of low energizing capacity normally in circuit with said line and with a suitable source of current, whereby a limited energization only of said electro-magnet may be controlled from the sub-station to cause the display of a signal, two other windings for said electro-magnet of greater energizing capacities, a cord circuit adapted to make connection with said switching terminal and to complete a circuit through one of said windings of greater energizing capacity to cause a greater energization of said electro-magnet whereby the control of said signal from the

sub-station is destroyed, switching mechanism associated with said electro-magnet adapted to be actuated by the greater energization thereof to remove the said winding of greater energizing capacity from the direct circuit extending between the sub-station and the switching terminal and to include in branch circuit the other of said windings of greater energizing capacity, 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, when the telephone line is switched for conversation.

3. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided thereat with a switching terminal, a signal receiving electro-magnet associated with said line having an energizing winding of low energizing capacity normally in circuit with said line and with a suitable source of current, whereby a limited energization only of said electro-magnet may be controlled from the sub-station to cause the display of a signal, two other windings for said electro-magnet of greater energizing capacities, a cord circuit adapted to make connection with said switching terminal and to complete a circuit through one of said windings of greater energizing capacity to cause a greater energization of said electro-magnet whereby the control of said signal from the sub-station is destroyed, switching mechanism associated with said electro-magnet adapted to be actuated by the greater energization thereof to remove the said winding of greater energizing capacity from the direct circuit extending between the sub-station and the switching terminal and to include in branch circuit the other of said windings of greater energizing capacity, and a signal controlling electro-magnet associated with said cord circuit and under the control of the sub-station, when the telephone line is switched for conversation.

4. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided thereat with a switching terminal, a signal receiving electro-magnet associated with said line having an energizing winding of low energizing capacity normally in circuit with said line and with a suitable source of current, whereby a limited energization only of said electro-magnet may be controlled from the sub-station to cause the display of a signal, two other windings for said electro-magnet of greater energizing capacities, a cord circuit adapted to make connection with said switching terminal and to complete a circuit through one of said windings of greater energizing capacity to cause a greater energization of said electro-magnet whereby

the control of said signal from the sub-station is destroyed, switching mechanism associated with said electro-magnet adapted to be actuated by the greater energization thereof to remove the said winding of greater energizing capacity from the direct circuit extending between the sub-station and the switching terminal and to include in branch circuit the other of said windings of greater energizing capacity, a signal controlling electro-magnet associated with said cord circuit and under the control of the sub-station, 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.

5. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided thereat with a switching terminal, a signal receiving electro-magnet associated with said line having an energizing winding of low energizing capacity normally in circuit with said line and with a suitable source of current, whereby a limited energization only of said electro-magnet may be controlled from the sub-station to cause the display of a signal, two other windings for said electro-magnet of greater energizing capacities, a cord circuit adapted to make connection with said switching terminal and to complete a circuit through one of said windings of greater energizing capacity to cause a greater energization of said electro-magnet whereby the control of said signal from the sub-station is destroyed, and switching mechanism associated with said electro-magnet adapted to be actuated by the greater energization thereof to remove the said winding of greater energizing capacity from the direct circuit extending between the sub-station and the switching terminal and to include in branch circuit the other of said windings of greater energizing capacity.

6. In a telephone exchange system, the combination with a telephone line connecting a sub-station with the central office and provided thereat with a switching terminal, a signal receiving electro-magnet associated with said line having an energizing winding of low energizing capacity normally in circuit with said line and with a suitable source of current, whereby a limited energization only of said electro-magnet may be controlled from the sub-station to cause the display of a signal, two other windings for said electro-magnet of greater energizing capacities, a cord circuit adapted to make connection with said switching terminal and to complete a circuit through one of said windings of greater energizing capacity to cause a greater energization of said electro-magnet

whereby the control of said signal from the sub-station is destroyed, switching mechanism associated with said electro-magnet adapted to be actuated by the greater energization thereof to remove the said winding of greater energizing capacity from the direct circuit extending between the sub-station and the switching terminal and to include in branch circuit the other of said windings of greater energizing capacity, and 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.

7. 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 three energizing windings, two of greater energizing capacity than the third, the said third winding of relatively low energizing capacity being normally connected in circuit with said line and a suitable source of current whereby the sub-station switch may control a limited energization only of said electro-magnet 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 windings of greater energizing capacity when the cord circuit is connected to the line whereby the control of said signal by the sub-station is destroyed, switching mechanism controlled by the greater energization of said electro-magnet for excluding said winding of greater energizing capacity from the talking circuit when the line is switched for conversation, and for including the other of said windings of greater energizing capacity in branch circuit of the said line, whereby the said greater energization of said electro-magnet is continued and the talking circuit freed from non-inductive branch circuits, 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.

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-sta-

tion 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 there-
 through over said telephone line, a signal receiving electro-magnet having three energizing windings, two of greater energizing capacity than the third, the said third winding of relatively low energizing capacity being normally connected in circuit with said line and a suitable source of current whereby the sub-station switch may control a limited energization only of said electro-magnet 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 windings of greater energizing capacity when the cord circuit is connected to the line, whereby the control of said signal by the sub-station is destroyed, switching mechanism controlled by the greater energization of said electro-magnet for excluding said winding of greater energizing capacity from the talking circuit when the line is switched for conversation and for including the other of said windings of greater energizing capacity in branch circuit of the said line whereby the said greater energization of said electro-magnet is continued and the talking circuit freed from non-inductive branch circuits, 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.

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 three energizing windings, two of greater energizing capacity than the third, the said third winding of relatively low energizing capacity being normally connected in circuit with said line and a suitable source of current whereby the sub-station switch may control a limited energization only of said electro-magnet 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 windings of greater energizing capacity when the cord circuit is connected to the line whereby the control of said signal by the sub-station is destroyed, switching mechanism controlled by the greater energization of said electro-

magnet for excluding said winding of greater energizing capacity from the talking circuit when the line is switched for conversation and for including the other of said windings of greater energizing capacity in branch circuit of the said line whereby the said greater energization of said electro-magnet is continued and the talking circuit freed from non-inductive branch circuits, 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 three energizing windings, two of greater energizing capacity than the third, the said third winding of relatively low energizing capacity being normally connected in circuit with said line and a suitable source of current whereby the sub-station switch may control a limited energization only of said electro-magnet 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 windings of greater energizing capacity when the cord circuit is connected to the line whereby the control of said signal by the sub-station is destroyed, switching mechanism controlled by the greater energization of said electro-magnet for excluding said winding of greater energizing capacity from the talking circuit when the line is switched for conversation and for including the other of said windings of greater energizing capacity in branch circuit of the said line whereby the said greater energization of said electro-magnet is continued and the talking circuit freed from non-inductive branch circuits, 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 three energizing windings, two of greater energizing capacity than the third, the said third winding of relatively low energizing capacity being normally connected in circuit with said line and a suitable source of current whereby the sub-station switch may control a limited energization only of said electro-magnet 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 windings of greater energizing capacity when the cord circuit is connected to the line whereby the control of said signal by the sub-station is destroyed, and switching mechanism controlled by the greater energization of said electro-magnet for excluding said winding of greater energizing capacity from the talking circuit when the line is switched for conversation and for including the other of said windings of greater energizing capacity in branch circuit of the said line whereby the said greater energization of said electro-magnet is continued and the talking circuit freed from non-inductive branch circuits.

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 three energizing windings, two of greater energizing capacity than the third, the said third winding of relatively low energizing capacity being normally connected in circuit with said line and a suitable source of current whereby the sub-station switch may control a limited energization only of said electro-magnet 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 windings of greater energizing capacity when the cord circuit is connected to the line whereby the control of said signal by the sub-station is destroyed, switching mechanism controlled by the greater energization of said electro-magnet for excluding said winding of greater energizing capacity from the talking circuit when the line is switched for conversation and for including the other of said windings of greater energizing capacity in branch circuit of the said line whereby the said greater energization of said electro-magnet is continued and the talking circuit freed from non-inductive branch circuits,

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 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 three energizing windings, two of greater energizing capacity than the third, a connection to a source of current extending from one side of said line adapted to complete the circuit through the said winding of low energizing capacity 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 a winding of said electro-magnet of greater energizing capacity whereby a greater energization of said electro-magnet is caused to efface said signal, switching mechanism controlled by the greater energization of said electro-magnet adapted to remove the impedance of its said winding of greater energizing capacity from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation, switching mechanism also controlled by the greater energization of said electro-magnet adapted to include in branch circuit the second winding of said electro-magnet of relatively high energizing capacity, whereby the said electro-magnet is maintained in a condition of greater energization, 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 circuit and under the control of the sub-station, 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.

14. 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 three energizing windings, two of greater energizing capacity than the third, a connection to a source of current extending from one side of said line adapted to complete the circuit through the said winding of low energizing capacity 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 a winding of said electro-magnet of greater energizing capacity whereby a greater energization of said electro-magnet is caused to efface said signal, switching mechanism controlled by the greater energization of said electro-magnet adapted to remove the impedance of its said winding of greater energizing capacity from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation, switching mechanism also controlled by the greater energization of said electro-magnet adapted to include in branch circuit the second winding of said electro-magnet of relatively high energizing capacity whereby the said electro-magnet is maintained in a condition of greater energization 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, when the telephone line is switched for conversation.

15. 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 three energizing windings, two of greater energizing capacity than the third, a connection to a source of current extending from one side of said line adapted to complete the circuit through the said winding of low energizing capacity 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 a winding of said electro-magnet of greater energizing capacity whereby a greater energization of said electro-magnet is caused to efface said signal, switching mechanism controlled by the greater energization of said electro-magnet adapted to remove the impedance of its said winding of greater energizing capacity from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation, switching mechanism also controlled by the greater energization of said electro-magnet adapted to include in branch circuit the second winding of said electro-magnet of relatively high energizing capacity whereby the said electro-magnet is maintained in a condition of greater energization when the line is switched for conversation, and means whereby the operator may determine the idle or busy condition of a tested line.

16. 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
 5 connection with the said line, a signal receiving electro-magnet associated with said line having three energizing windings, two of greater energizing capacity than the third, a
 10 connection to a source of current extending from one side of said line adapted to complete the circuit through the said winding of low energizing capacity when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet
 15 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 a winding of said electro-magnet of greater energizing capacity whereby a greater energization of said
 20 electro-magnet is caused to efface said signal, switching mechanism controlled by the greater energization of said electro-magnet adapted to remove the impedance of its said
 25 winding of greater energizing capacity from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation, switching mechanism also controlled by the greater en-
 30 ergization of said electro-magnet adapted to include in branch circuit the second winding of said electro-magnet of relatively high energizing capacity whereby the said electro-magnet is maintained in a condition of
 35 greater energization 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, when the telephone line is switched for con-
 40 versation.

17. 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
 45 connection with the said line, a signal receiving electro-magnet associated with said line having three energizing windings, two of greater energizing capacity than the third, a connection to a source of current extending
 50 from one side of said line adapted to complete the circuit through the said winding of low energizing capacity when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet
 55 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 a winding of said electro-magnet of greater energizing capacity
 60 whereby a greater energization of said electro-magnet is caused to efface said signal, switching mechanism controlled by the greater energization of said electro-magnet adapted to remove the impedance of its
 65 said winding of greater energizing capacity

from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation, and switching mechanism also controlled by the greater energization of said electro-magnet
 70 adapted to include in branch circuit the second winding of said electro-magnet of relatively high energizing capacity whereby the said electro-magnet is maintained in a condition of greater energization when the line
 75 is switched for conversation.

18. 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
 80 connection with said line, a signal receiving electro-magnet associated with said line having three energizing windings, two of greater energizing capacity than the third, a connection to a source of current extending from
 85 one side of said line adapted to complete the circuit through the said winding of low energizing capacity when the circuit is closed at the sub-station to cause a limited energization only of said electro-magnet whereby the
 90 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 a winding of said electro-magnet of greater energizing capacity whereby a
 95 greater energization of said electro-magnet is caused to efface said signal, switching mechanism controlled by the greater energization of said electro-magnet adapted to remove the impedance of its said winding of
 100 greater energizing capacity from the circuit extending between the sub-station and the said switching terminal when the line is switched for conversation, switching mechanism also controlled by the greater energiza-
 105 tion of said electro-magnet adapted to include in branch circuit the second winding of said electro-magnet of relatively high energizing capacity whereby the said electro-magnet is maintained in a condition of greater ener-
 110 gization, when the line is switched for conversation, a signal controlling electro-magnet associated with said cord circuit and under the control of the sub-station when the telephone line is switched for conversation, a
 115 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
 120 the said two electro-magnets.

19. A telephone system comprising a telephone line extending from a substation to a central office, a cord-circuit for making con-
 125 nection 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
 130 windings, means under the control of the

subscriber for energizing said electromagnet by supplying current over a path through one of said windings, means under the control of the operator for modifying the said energization by supplying current first to a plurality of said windings and then to a less number, and means responsive to the initial energization to display said signal and to the modified energization to efface said signal.

20. 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 one of said windings, means under the control of the operator for increasing the said energization by supplying current first to a plurality of said windings and then to a less number, and means responsive to the initial energization to display said signal and to the increased energization to efface said signal.

21. 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 normally under the substation control, a signal controlling electromagnet for causing the display of said signal and removing said signal from the substation control, and means under the control of the operator for closing a circuit through an energizing winding of said electromagnet to cause it to destroy said substation control, and means actuated by said electromagnet for varying the resistance of said energizing circuit while maintaining said means in its final position.

22. 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 controlling electromagnet associated with said line at the central office, means controlled by said electro-magnet, means under the control of the subscriber for energizing said magnet, means under the control of the operator for modifying said energization by supplying current over a definite path, and means responsive to the latter energization to change said path.

23. 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 magnet for said signal, means under the control of the subscriber for energizing said electromagnet, means under the control of the operator for modifying said energization by supplying current over a definite path, and means responsive to the initial energization to display said signal and to the modified energization both to efface said signal and to change said path.

24. 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 controlling electromagnet associated with said line at the central office, means controlled by said electro-magnet, means under the control of the subscriber for energizing said magnet, means under the control of the operator for increasing said energization by supplying current over a definite path, and means responsive to the increased energization to change said path.

25. 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 magnet for said signal, means under the control of the subscriber for energizing said electromagnet, means under the control of the operator for increasing said energization by supplying current over a definite path, and means responsive to the initial energization to display said signal and to the increased energization both to efface said signal and to change said path.

26. 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 controlling electromagnet associated with said line at the central office, means controlled by said electro-magnet, means under the control of the subscriber for energizing said magnet, means under the control of the operator for varying said energization, and means actuated by said electromagnet to vary the path over which current is supplied by the operator to produce this varied energization.

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.