A. H. WEISS.

TELEPHONE SYSTEM.

APPLICATION FILED MAR. 30, 1907.

986,787.

Patented Mar. 14, 1911.

2 SHEETS—SHEET 1.

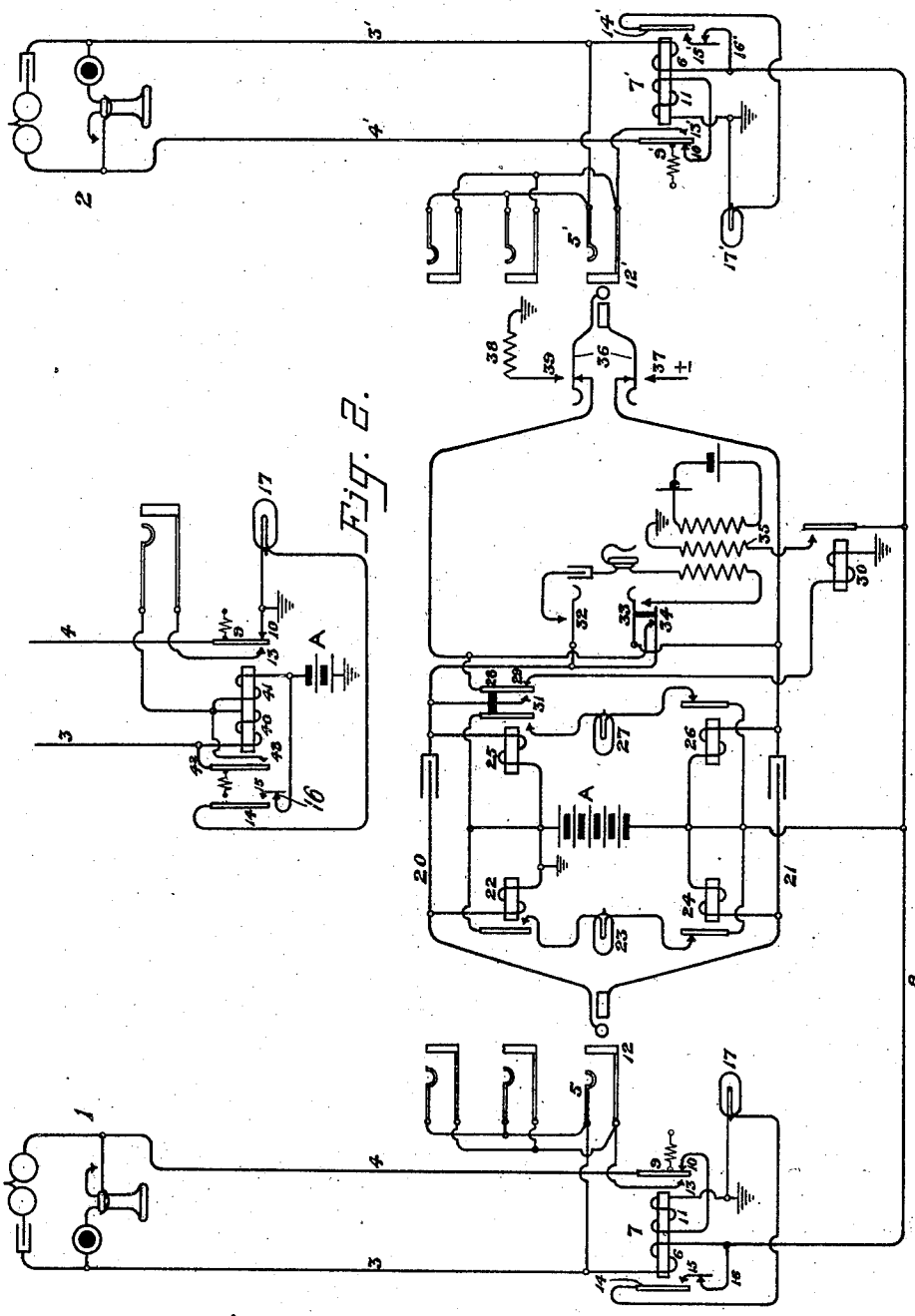

Fig. 1.

Fig. 2.

Witnesses
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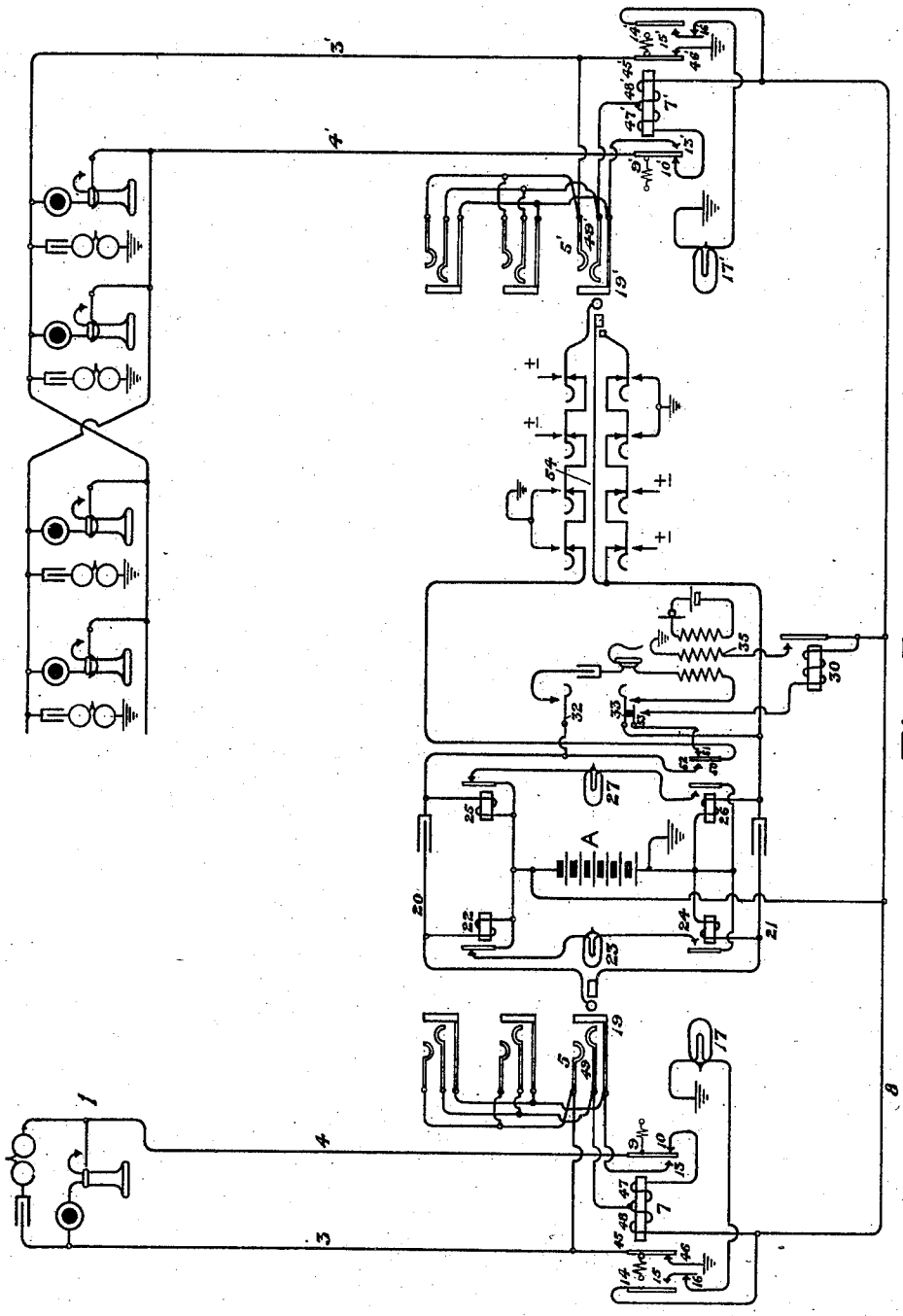

Fig. 2.

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UNITED STATES PATENT OFFICE.

ALFRED H. WEISS, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD & SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

986,787. Specification of Letters Patent. **Patented Mar. 14, 1911.**

Application filed March 30, 1907. Serial No. 365,566.

To all whom it may concern:

Be it known that I, ALFRED H. WEISS, a citizen of the United States, residing in Chicago, county of Cook, and State of Illinois, have invented a certain new and useful Improvement in Telephone Systems, of which the following is a specification.

My invention relates to telephone systems, and particularly to the arrangement of so called line circuits and apparatus therefor.

My invention has for an object the simplification of the circuits and apparatus necessary in the control of a central office signal for telephone lines.

In carrying out my invention I perform all of the functions usually performed by a line and a cut-off relay by means of a single relay in the line, this relay having two degrees of actuation, and being adapted to assume an intermediate degree of actuation to display a signal when the telephone subscriber removes his receiver in the act of calling the central office and to be completely actuated to efface this signal when the cord circuit is connected with the line.

A further object of my invention is to arrange a system as above described such that the testing contact of the line jack will be normally disconnected from the line and will remain disconnected until a cord circuit is connected with one of the jacks of the line.

A still further object of my invention is to arrange the circuits of my line relay in such a manner that a complete ground upon the battery side of the telephone line will actuate the relay only to its intermediate degree of actuation, whereby the line lamp will be displayed.

Still further objects of my invention will appear from the following description and claims.

My invention is illustrated in the accompanying drawings, in which,

Figure 1 shows my invention as applied to a system equipped with two-wire line and two strand cord circuits; Fig. 2 is a modification of the line circuit of Fig. 1, by means of which the entire resistance of both coils of the relay is included in one side of the line, and Fig. 3 is a modification of my invention in which three conductors are carried through the multiple, whereby ringing may be done upon either side of the telephone line, such that so called bias bells may be used, or whereby other forms of selective signals may be connected between each of the limbs of the telephone line, and a third conductor.

Referring to Fig. 1 the usual subscribers' stations 1 and 2 are connected to the central office by the limbs 3 and 4, the line wire 3 connecting with the tip contact 5 of the answering and multiple jacks and extending through the coil 6 of the relay 7, over conductor 8 to the live pole of battery A. Line wire 4 terminates at the central office in the spring 9 of relay 7, such spring being normally connected through contact 10 with the coil 11 of relay 7, this coil being connected to the ground terminal of battery A. Sleeve contacts 12 of the answering and multiple jacks are connected to normally open contact 13 of relay 7, said contact being adapted to be connected with the spring 9 when the relay 7 is fully actuated. The coil 6 of relay 7 is preferably of copper and has been found to work satisfactorily when wound to one-thousand ohms resistance, while coil 11 is preferably of German silver and may be also wound to one-thousand ohms resistance. This relay 7 also carries spring 14, which connects with the spring 15 when the relay is actuated. Spring 15 is normally in contact with spring 16 but said contacts are adapted to be severed by the complete actuation of relay 7. The spring 14 is constructed with light tension such that it will be actuated to make contact with spring 15 when the German silver coil 11 is in series with the copper coil 6. When in this condition the circuit of line lamp 17 is closed, this circuit being opened again at contacts 15 and 16 of relay 7 when this relay is completely actuated.

The cord circuit adapted to operate with the line circuit just described is provided with tip strand 20, and sleeve strand 21, each of said strands containing a condenser to divide the cord circuit into answering and calling ends as is well known in the art. The answering end of this cord circuit is provided with a relay 22 having its coil connected between the tip strand 20 and the ground pole of battery A, said relay controlling normally open contacts in the circuit of supervisory signal 23. This end is

also provided with a relay 24 connected between the sleeve strand 21 and the live pole of battery A, said relay controlling normally closed contacts in the circuit of supervisory signal 23. The calling end of the cord circuit is similarly provided with relays 25 and 26, similarly controlling the circuit of supervisory lamp 27. Relay 25 in addition to the contacts of the signal circuit has also the normally closed contacts 28 and 29 connecting the tip strand of the calling end of the cord circuit with the coil of the test relay 30, and normally open contact 31 connecting with the coil of relay 25 and adapted to make connection with spring 28 by the actuation of relay 25.

The cord circuit is provided with the usual listening key having the spring 32 connecting with the tip strand of the cord circuit and the spring 33 connecting with the sleeve strand of the cord circuit. This key also controls normally closed auxiliary contacts 34 which maintain the continuity of the tip strand of the cord circuit, such contacts being open during testing to disconnect the coil of supervisory relay 25 from the tip strand to prevent a portion of the testing current from being shunted by the comparatively low resistance path through the coil of the relay 25. Springs 32 and 33 of the listening key when actuated connect the operator's receiver and condenser and the secondary of the operator's induction coil in a bridge of the cord circuit in the customary manner. The operator's induction coil, in addition to its primary and secondary windings, is provided with a tertiary winding 35 having one terminal connected with ground and the other terminal connected with the normally open contact of the test relay 30, the other contact of relay 30 being connected with the live pole of battery A. The cord circuit is also provided with the usual ringing key 36 having normally closed series contacts opened by the actuation of the key to prevent ringing current from flowing into the cord circuit, the tip spring of said key being adapted when actuated to connect with contact 39 which is connected through the non-inductive resistance 38 with the ground pole of battery A. The sleeve contact of the key 36 is adapted to be connected with the signaling contact 37.

In the operation of the system so far described the receiver at station 1 is removed from the hook closing the circuit of line conductors 3 and 4 at the substation. Current then flows from the live pole of battery A through conductor 8, coil 6 of relay 7, line conductors 3 and 4, contacts 9 and 10 and the coil 11 of relay 7. The coil 11 being of high resistance and having very few actuating turns, the current in this path is not sufficient to fully actuate relay 7 but only actuates the spring 14 sufficiently to close the circuit of the line lamp 17 at contacts 14 and 15. The line lamp 17 being displayed, the operator inserts her calling plug, whereupon an increased flow of current passes from the live pole of battery A over conductor 8 through the coil 6 of relay 7, over the tip 5 of the answering jack, through the coil of relay 22 to the ground pole of battery A. Current in this path is sufficient to completely actuate relay 7 and to actuate relay 22 to close its contacts in the circuit of supervisory signal 23. Relay 7 being completely actuated springs 15 and 16 are severed to efface signal 17 and the spring 9 is brought in contact with the normally disconnected contact 13 and the sleeve 12 of the jack is thereby connected with the limb 4 of the telephone line. Current therefore flows from the live pole of battery A through the coil of relay 24, the sleeves of the answering plug and jack, contacts 13 and 9 of the relay 7 and over the telephone line, returning to the ground pole of battery over the tip of the cord circuit and through the coil of relay 22. Relay 24 is thereby actuated and prevents the display of the supervisory signal 23. The operator now throws her listening key and inquires the desired number of the calling subscriber. Finding this number to be that of substation number 2 the multiple jack of that station is tested to obtain the idle or busy condition of the line. If the line is busy another cord circuit will be connected with one of the multiple contacts of that line and the test contact instead of being disconnected entirely will be connected through the sleeve supervisory relay of the cord circuit, connected therewith to the live pole of battery, and will therefore be at a potential above that of ground. When the tip of the cord is connected with this testing contact of a busy line current flows over the tip strand of the cord circuit through contacts 28 and 29 of relay 25 and through the coil of relay 30, actuating such relay to close the circuit through the tertiary winding 35 of the operator's induction coil. Assuming that the line was found to be idle the operator inserts her calling plug into one of the multiple jacks and thereby completes the circuit through the coil 6′ of relay 7′ associated with the line of substation 2. Current now flows from the live pole of battery through the coil 6′ over the tip 5′ of the multiple jack, the tip strand of the cord circuit, through contacts 34 of the operator's listening key and through the coil of supervisory relay 25 to the ground pole of battery A, the operator's listening key now being in its normal condition. Current in this path completely actuates the line relay 7′, thereby connecting the sleeve contact of

the multiple jacks with the line conductor 4′ and separating contacts 15′ and 16′ of relay 7′ to prevent the display of the line signal 17′. Current in this path also actuates the supervisory relay 25, closing the circuit of the supervisory signal 27 to display said signal. The actuation of relay 25 also connects contacts 28 and 31 of said relay, thereby closing a shunt about the contact 34 of the listening key, whereby the listening key may be afterward actuated without interrupting the circuit of relay 25. The operator now actuates her ringing key connecting the tip strand with ground through the non-inductive resistance 38, and connecting the sleeve strand with the source of signaling current. The line relay 7′ is thereby maintained actuated by the current from the live pole of battery through the coil 6′, over the tip of the jack and plug to ground through the resistance 38. The called subscriber hearing his signal removes his receiver from its hook and thereby closes the circuit of line conductors 3′ and 4′ and completes the circuit from the live pole of battery A through the supervisory relay 26, the sleeve strand of the cord circuit, the sleeve 12′ of the multiple jack, contacts 13′ and 9′ of relay 7′, conductors 4′ and 3′ of the line, the tip of the jack and plug, and the coil of relay 25 to ground. Current in this path actuates relay 26 and severs the circuit of the supervisory signal 27. The circuit of substations 1 and 2 are now completed for conversation and the signals at the central office are effaced. When the conversation is terminated and the subscribers again hang up their receivers the circuits of the sleeve supervisory relays 24 and 26 will be severed and such relays will fall back to again close the circuits of supervisory signals 23 and 27. Upon the display of these signals the operator removes her plugs from the jacks and the apparatus again assumes its normal condition.

In Fig. 2 I have shown a line relay similarly adapted for two degrees of actuation. This relay is provided with the coils 40 and 41, the coil 40 being of German silver and 41 being preferably of copper. When the circuit of the line conductors 3 and 4 is closed at the substation current flows from the live pole of battery A through the copper winding 41 and thence through the German silver winding 40 over the line conductors and back to ground through contacts 9 and 10 of this relay. The relay is thereby partially actuated, the first actuation being adapted to close contacts 14 and 15 to complete the circuit of the line lamp 17. When a cord is connected with the jack a circuit of decreased resistance is completed through the coil 41 of the line relay and over the tip of the jack and the tip strand of the cord circuit. The line relay is thereby completely actuated closing contacts 42 and 43 which are connected in shunt of the high resistance coil of said relay. The complete actuation of the relay also severs contacts 15 and 16 of the lamp circuit and closes contacts 9 and 13 to connect the sleeve of the jack with the line conductor 4. With this arrangement of the copper and German silver coils of the line relay it will be seen that if line conductor 3 becomes accidentally grounded, both the high and low resistance coils of the relay being in the circuit of that limb of the line, the relay will only be actuated to its intermediate position and the line lamp will be displayed to indicate to the operator that the line is out of order.

In Fig. 3 the circuit of substation 1 is connected with the central office by limbs 3 and 4, the limb 3 connecting with the tip contact 5 of the line jack, and also through contacts 45 and 46 of the line relay 7 to ground. The conductor 4 terminates at the central office in the spring 9 of relay 7, this spring being normally connected through contact 10 with the high resistance coil 47 of relay 7, the other terminal of said coil being connected with one terminal of the operating coil 48 of relay 7 and thence through conductor 8 to the live pole of battery A. The inner terminals of coils 47 and 48 are connected with the ring contact 49 of the line jacks. Sleeve contacts 19 of the line jacks are connected to the normally free contact 13 of relay 7, such contact being adapted to make connection with the spring 9 of that relay by the complete actuation of the relay. Relay 7 also has the contact 14 adapted when actuated to be connected with the spring 15, spring 15 being normally connected with contact 16, said contacts being in the circuit of the line lamp 17. The cord circuit shown in connection with this line is provided with tip and sleeve strands 20 and 21, each of these strands being divided into answering and calling ends by condensers, as is well known in the art. The anwering end of the cord circuit is provided with the supervisory relay 22 connected between the tip strand 20 and the live pole of battery A and controlling normally closed contacts in the circuit of the supervisory signal 23. This end is also provided with the supervisory relay 24 having its coil connected between the sleeve conductor 21 and the ground pole of battery A and controlling normally open contacts of the circuit of supervisory signal 23. The calling end of this cord circuit is similarly provided with supervisory relays 25 and 26 controlling the circuit of the signal 27. The relay 26 has in addition to its signal controlling contacts, the normally

closed contacts 50 and 51 and the normally disconnected contact 52, contact 50 being connected with the tip of the calling plug, and contact 51 connecting through the normally open contacts 53 of the operator's ringing key with the coil of the test relay 30. Contact 52 of relay 26 connects with the coil of supervisory relay 25 and with the answering end of the cord circuit.

The operator's listening key has the springs 32 and 33 connected to the tip and sleeve strands of the cord circuit in the usual way and adapted when actuated to bridge the condenser, receiver and secondary of the induction coil across the talking strands of the cord circuit. The operator's induction coil is provided with the testing winding 35, one terminal of said winding being grounded, and the other terminal being adapted to be connected with the live pole of battery through contacts of the test relay 30. The flexible cord at the calling end of this cord circuit is provided with three contacts, the ring contact being permanently connected with the talking strand of the cord circuit and the sleeve contact being connected through series contacts of the operator's ringing key 54 with the same strand of the cord circuit. The tip contact is connected through the series contacts of said key with the tip strand of the cord circuit.

The telephone line is shown provided with four subscribers' stations, each station being provided with an annunciator connected between one of the line conductors and earth. This line is otherwise equipped the same as the line extending to substation number 1, and the apparatus associated with this line is designated by like numerals with the suffix "′".

The operation of the system shown in Fig. 3 is as follows: The receiver at substation number 1 being removed from the hook, the circuit is completed from the live pole of battery A over conductor 8 through coils 48 and 47 and contacts 10 and 9 of relay 7, line conductors 4 and 3, and contacts 45 and 46 of relay 7. The coil 47 being of high resistance and few actuating turns, only sufficient current flows at this time to partially actuate the relay, closing contacts 14 and 15 to display the line lamp 17. The operator seeing the line signal displayed, inserts her plug into the answering jack, completing the circuit from the live pole of battery A over conductor 8 through the coil 48 of relay 7, the ring contact 49 of the line jack, the coöperating sleeve contact of the cord circuit, the coil of relay 24 to ground, thus actuating relay 24, and completing the actuation of line relay 7 to efface the line signal 17, disconnect the line conductor 3 from its connection with ground through contacts 45 and 46, and connect the sleeve contact 19 of the jack with the line conductor 4. A path is also now completed through the coil of relay 22, tip of the cord and jack, line conductors 3 and 4, contacts 9 and 13 of relay 7, and the sleeve of the jack and plug to ground through the coil of relay 24. Current in this path actuates relay 22 and prevents the display of the supervisory signal 23, which would otherwise be displayed by the actuation of relay 24. The operator now throws her listening key in the usual manner and inquires the desired number. The desired number being obtained the operator now touches the tip of her calling plug with the test contact of the desired line to obtain the idle or busy condition of the line. If the line is busy the test contact of that line will be at a potential less than the potential of the live pole of battery and current will therefore flow from the live pole of battery through the coil of the test relay, contacts 53 of the operator's listening key, contacts 51 and 50 of the supervisory relay 26 and the tip of the calling cord. This current will actuate the relay 30 and complete a circuit through the tertiary 35 of the operator's induction coil and thereby cause a click in the operator's receiver. Assuming, however, that the line is found idle the operator inserts her plug in one of the multiple jacks of the desired line and depresses the ringing key adapted for the distinctive actuation of the annunciator at the particular substation desired. When the calling plug is inserted a path for current is completed from the live pole of battery through the coil 48′ of the line relay associated with the desired line and thence over the ring contact 49′ of the multiple jack, the ring of the calling cord and through the coil of supervisory relay 26 to ground. Current in this path completely actuates the line relay 7′, preventing the display of the line signal 17′ and connecting line conductor 4′ with the sleeve contact of the jacks, and also disconnecting line conductor 3′ from ground through the contacts 45′ and 46′. The supervisory relay 26 is also actuated and completes the circuit of the supervisory signal 27, such signal being displayed to indicate that the called subscriber has not yet answered his call. It will be seen that alternating or pulsating ringing current may be sent upon either side of the telephone line without having any effect upon the line relay, inasmuch as both of the line conductors are maintained entirely free from any connection with the coil of the line relay 7′ during ringing. When the called subscriber answers his call the circuit of supervisory relay 25 is completed through the now closed contacts 52 and 50 of relay 26, tip of the calling cord, line conductors 3′ and 4′, sleeve

of the jack and plug and the coil of relay 26 to ground, thus actuating relay 25 to sever the circuit of the supervisory signal 27. The subscribers' circuits are thus completed for conversation and all of the signals at the central office are effaced. When either of the subscribers hangs up his receiver his supervisory signal is displayed, indicating to the operator that the connection may be severed from the line. When both signals are displayed the operator removes the entire connection and the apparatus assumes its normal condition.

The line circuit of the system just described is arranged with both of the coils of the relay 7 in series with the limb of the line normally extending to the live pole of the battery, such that a complete ground upon the line conductor 4 will only actuate the line relay to its intermediate position, and thereby will display the line lamp to indicate to the operator that there is trouble on the line. This is a distinct advantage over systems in which the line relay is completely actuated when a ground is accidentally formed with one of the line conductors, in that under such conditions the central office receives no notice of any trouble on the line until a test is made, or until the trouble is reported by the subscriber whose line is thereby thrown out of use.

While I have described my invention particularly with reference to the accompanying drawings, I do not wish to be unduly limited thereto, many variations being possible without departing from the spirit or scope of my invention.

What I claim is:

1. In a telephone system, the combination with a telephone line, of a relay for the line having two degrees of actuation, a signal for the line displayed by the partial actuation of said relay and effaced by the complete actuation of said relay, and connection terminals all of which are directly connected with the limbs of the telephone line during a conversational connection only, substantially as described.

2. In a telephone system, the combination with a telephone line, of a relay for the line having two degrees of actuation, an actuating coil for said relay and a resistance coil normally in series with the actuating coil and with the telephone line, whereby the current through the actuating coil is only sufficient to partially actuate the relay when the circuit is closed at the sub-station, and means to close a path of decreased resistance about the resistance coil when a conversational connection is established with the telephone line, whereby the relay is completely actuated, substantially as described.

3. In a telephone system, the combination with a telephone line, of a relay for the line having two degrees of actuation, a signal for the line displayed by the partial actuation of said relay and effaced by the complete actuation of said relay, testing contacts for the line, said contacts being normally free and free during the partial actuation of said relay and being connected with one of the limbs of the telephone line when the relay is fully actuated, substantially as described.

4. In a telephone system, the combination with a telephone line, of a central source of current, a relay for the line having two degrees of actuation, an actuating coil and a resistance coil for said relay, said coils being in series and being connected between the live pole of said source and one of the limbs of the telephone line, whereby a complete ground upon the telephone line will partially actuate the line relay, and a line signal displayed by the partial actuation of said relay, substantially as described.

5. In a telephone system, the combination with a telephone line, a source of current, a relay for the line having two degrees of actuation, an actuating coil for said relay, a resistance coil, said coils being connected in series between said source and one of the limbs of said telephone line, a cord circuit to connect with said line for conversation, the connection of said cord circuit with the line being adapted to complete a path of decreased resistance through said actuating coil, whereby the relay is completely actuated, and a line signal controlled by said relay, substantially as described.

6. In a telephone system, the combination with a telephone line having normally disconnected testing contacts, a central source of current, a signal for the line, a relay for the line adapted to be actuated by current from said source and over the telephone line, said relay being partially actuated when the circuit of the telephone line is closed at the substation, whereby the line signal is displayed, and being completely actuated when a conversational connection is established with the telephone line, whereby the line signal is effaced and the testing contact is connected with one of the limbs of the telephone line, substantially as described.

7. In a telephone system, the combination with a telephone line, of a relay for the line having different degrees of actuation, a cord circuit to connect with the line, a ringing key for the cord circuit, and means for separating both of the limbs of the telephone line from the coils of the line relay during ringing, whereby ringing current may be applied to limbs of the telephone line without any part being shunted through local paths, substantially as described.

8. In a telephone system, the combina-

tion with a telephone line, of a source of current normally connected with the line, a relay for the line having different degrees of actuation, a signal displayed by the partial actuation of said relay and effaced by the complete actuation of said relay, a cord circuit to connect with the line, a ringing key for the cord circuit, and means independent of the limbs of the telephone line for completely actuating said relay when the cord is connected with the line, the complete actuation of said relay being adapted to disconnect the limbs of the telephone line from their connection with said source, whereby ringing current may be applied to limbs of the telephone line without any part thereof being shunted through a local circuit, substantially as described.

9. In a telephone system, the combination with a telephone line, of a single relay permanently associated with the line, a normally disconnected test contact, a line signal, said relay being partially actuated to display said signal by current wholly over the telephone line, and being completely actuated to efface said signal when a conversational connection is established with the line, said relay avoiding the functions of a repeating coil, substantially as described.

10. In a telephone system, the combination with a telephone line, of a single relay permanently associated with the line, a line signal, said relay being partially actuated to display said signal by current wholly over the telephone line, and being completely actuated to efface said signal when a conversational connection is established with the line, a source of ringing current, the limb of the telephone line to which said source is connected for ringing being maintained free from other local connections during ringing, substantially as described.

11. In a telephone system, the combination with a telephone line, of a single relay permanently associated with the line, a line signal, said relay being partially actuated to display said signal by current wholly over the telephone line, and being completely actuated to efface said signal when a conversational connection is established with the line, said relay being adapted by its complete actuation to maintain a limb of the line free from local connections, and means to connect ringing current with said limb, substantially as described.

12. In a telephone system, the combination with a telephone line, of a normally disconnected test contact for said line, a single relay for the line having the usual functions of both line and cut-off relays, the partial actuation of said relay being under the control of the subscriber and the complete actuation of said relay being under the control of the operator, and a signal displayed by the partial actuation of said relay and effaced by the complete actuation thereof, substantially as described.

Signed by me at Chicago, county of Cook, and State of Illinois, in the presence of two witnesses.

ALFRED H. WEISS.

Witnesses:
CLIFFORD C. BRADBURY,
EDITH F. GRIER.

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