No. 824,980.

PATENTED JULY 3, 1906.

W. W. DEAN.

TELEPHONE SYSTEM.

APPLICATION FILED NOV. 9, 1903.

2 SHEETS—SHEET 1.

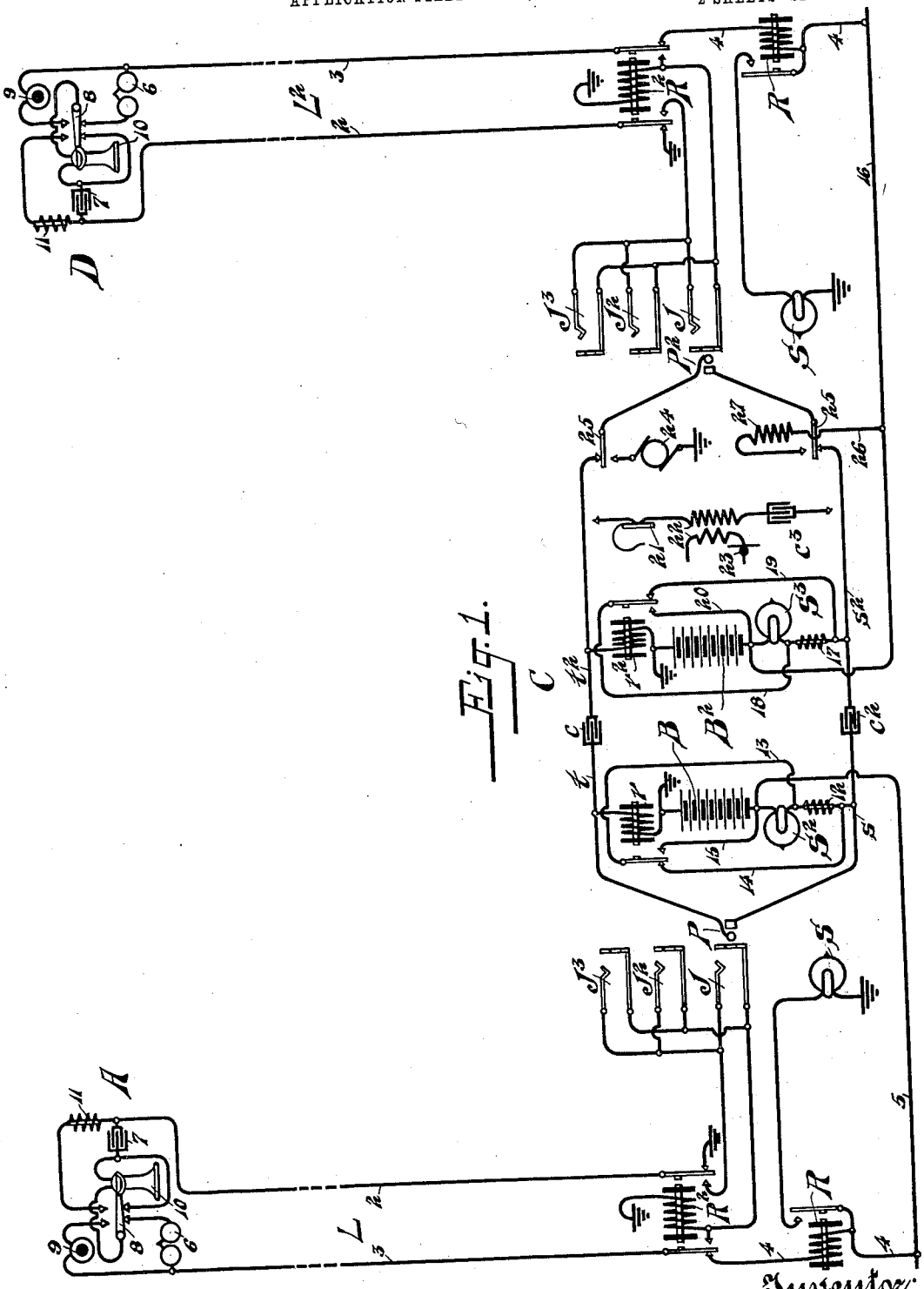

Fig. 1.

Witnesses.

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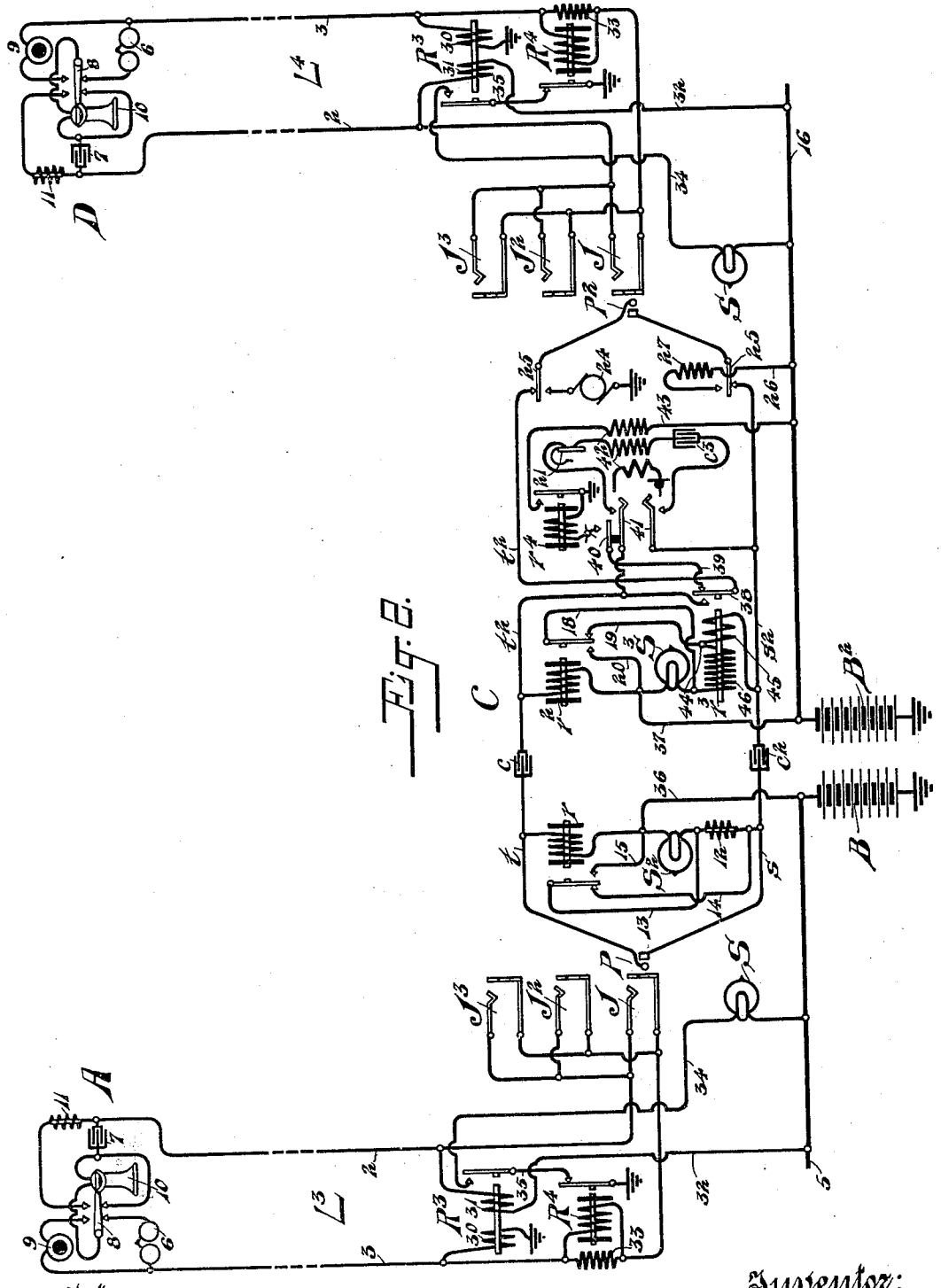

Fig. 2.

Witnesses.

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TELEPHONE SYSTEM.

No. 824,980. Specification of Letters Patent. Patented July 3, 1906.

Application filed November 9, 1903. Serial No. 180,317.

To all whom it may concern:

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

My invention relates to supervisory systems for telephone-lines, and has for its object generally to provide a system in which complete supervision in the most improved manner is carried out and in which at the same time the number of relays required for the operation of the supervisory system is reduced.

In the most improved supervisory systems the signal-lamp is lighted whenever a connection is established and the subscriber's telephone is upon its hook, but is extinguished during such connection when the subscriber's telephone is off its hook. It must also be extinguished under normal conditions—that is, when the connection is taken down from the subscriber's line. With this arrangement of supervisory signals the operator is informed at all times of the condition of each subscriber's telephone.

It has been common heretofore in two-wire telephone systems, and particularly those systems in which the cord-circuits are provided with only two strands, to provide a pair of relays for each end of the cord-circuit, one being energized as long as the cord-circuit plug is connected with the telephone-line and serving when so energized to cause the operation of the associated supervisory signal and the other relay being actuated only when the subscriber's telephone is off its hook and serving when so energized to prevent the operation of the lamp. Thus under normal conditions and before the operator establishes a connection the supervisory signal is inert, since the first of said relays is unenergized; but when a connection is established and the said first relay is energized the lamp is lighted, but it is again extinguished when the said second relay is actuated by current over the telephone-line. In my invention I provide in connection with said two-strand cord-circuits a single relay for each end thereof, and the signal is associated with the corresponding end of the cord-circuit in such manner that it is lighted as soon as the connection is established, but is rendered inert when the subscriber responds. Thus with the one relay I am enabled to do the work of the pair of relays before mentioned and without the addition of extra strands to the cord-circuit.

While various arrangements are possible and which involve the principle of my invention, I prefer to arrange the said relay and supervisory signal and a suitable retardation-coil in series therewith in a bridge of each end of the cord-circuit. I then arrange the relay so that when deënergized the said signal is in circuit, but the retardation-coil is out of circuit; but when the said relay is energized the reverse condition exists—that is, the lamp is cut out of circuit and the coil is cut into circuit.

My invention will be more particularly described in connection with the accompanying drawings, which illustrate my invention, and in which—

Figure 1 is a diagram showing the invention applied to one type of line-circuit, and Fig. 2 is a similar view showing the invention applied to a circuit of a different type.

Referring to Fig. 1, L and L^2 indicate subscribers' lines extending in two limbs 2 and 3 from their respective substations A and D to the central office C, where the lines are fitted, as is usual, with a line-signal S and an answering-jack J and with a plurality of multiple jacks J^2 and J^3 in any desired number. The line-relay R is included in the extension 4 of said line conductor 3 to the battery-lead 5, connected with the live pole of the central common battery B, and serves to control the local circuit of said line-signal S. The cut-off relay R^2, which is legged to ground from the sleeve side of the jack-section of the line, serves when actuated to disconnect the line conductor 3 from said conductor 4 and connect it with the sleeve side of the jack-section of the line and to disconnect the line conductor 2 from its normal ground connection and connect it with the tip side of said jack-section. At the substation each line is fitted with a common battery outfit of any desired or usual type, that shown including a signaling-bell 6 and a condenser 7 in a bridge of the line conductors normally closed at the switch-hook 8, while a transmitter 9, receiver 10, and a retardation-coil 11 are suitably connected

in circuit by said switch-hook 8 when the receiver 10 is removed therefrom.

The operator's connecting apparatus includes a number of cord-circuits, each of which is provided with an answering-plug P and a calling-plug P^2, having tip and sleeve contacts adapted to register with the corresponding contact-surfaces of the spring-jacks of the line when inserted therein. The tip-contacts of said plugs are electrically united by the flexible conductive strands t and t^2 and the interposed condenser c, while the sleeve-contacts thereof are similarly joined by the strands s and s^2 and the interposed condenser c^2. Between the grounded pole of the battery B and the strand t is located the supervisory relay r, and between the opposite pole of the said battery and the strand s are placed the supervisory lamp S^2 and the retardation-coil 12. Under normal conditions—that is, when the said relay r is deënergized—the retardation-coil 12 is shunted through branch conductors 13 and 14 and the normal contacts of said relay; but when the relay is energized said retardation-coil is cut into circuit and the lamp S^2 is shunted through said conductor 13, the forward contacts of said relay, and the branch conductor 15.

A second battery B^2 is connected across the calling end of the cord-circuit and has its live pole connected by a suitable conductor 16 with a certain number of the telephone-lines, a second supervisory relay r^2 being included between the other pole of the said source and the cord-circuit, while a supervisory signal S^3 is connected with a second retardation-coil 17 between the said live pole of said battery and the strand s^2 of said circuit. Said relay r^2 serves, as before, to normally control a shunt of the retardation-coil 17 through conductors 18 and 19 and the normal contacts of said relay, while when said relay is energized it closes a shunt of the supervisory signal S^3, including conductor 18, the forward contacts of said relay, and the branch conductor 20.

The operator's set, including her head-receiver 21, the secondary of her induction-coil 22, and a suitable condenser c^3, is adapted to be connected in a bridge of the calling end of the cord-circuit through the medium of any suitable listening-key, her transmitter 23 and the primary of her induction-coil being charged from any suitable source of current, which may be either the battery B or B^2. A ringing-generator 24 is adapted to be connected with the tip side of the line upon the depression of the springs of the ringing-key 25, the sleeve-strand at the same time being connected through the auxiliary conductor 26, including a suitable resistance 27, with the said conductor 16.

In the operation of the system thus far described the subscriber A, for example, takes up his receiver and thereby completes a path for current over his metallic line from the battery B, said path including the conductors 5, 4, and 3, thence through the substation devices and back to the central office over line conductor 2 and ground. The current in this path actuates the line-relay R, which closes the local circuit of the line-signal S, which is lighted to attract the attention of the operator. Upon seeing the signal the operator inserts the answering-plug P of her cord-circuit in the answering-jack J of the line, thereby completing a path for current from the live pole of battery B through the lamp S^2, the shunt of retardation-coil 12, which includes the conductors 13 and 14, the strand s of the cord-circuit, the sleeve side of the jack-section of the line, and through the winding of the cut-off relay R^2 to ground. The cut-off relay responds to current in this path and connects the external section of the line to the jack-section of the line, thus cutting off the line-relay R and retiring the signal S. Owing to the fact that the subscriber's telephone is off its hook, current now flows over the metallic telephone-line and through the strand t of the cord-circuit and the supervisory relay r, which is energized to break the shunt about the retardation-coil 12 and to complete the short circuit about the supervisory lamp S^2, which is accordingly retired. Under these conditions the battery B is connected across the metallic talking-circuit with the relay r upon one side thereof and the retardation-coil 12 upon the other. Having connected her head set with the cord-circuit now in use and learning the order of the calling subscriber, the operator proceeds to test the condition of the wanted line, which is done in the usual manner by touching the tip of the calling-plug to one of the test-rings of the jacks of the said line. It will be observed that normally said test-rings are grounded through the cut-off relay, and since the tip of the plug is likewise grounded through the supervisory relay r^2 no flow of current takes place over the strand t^2 when an idle line is tested. When a connection exists with the line, however, the test-rings are connected with the live pole of either the battery B or B^2 through the sleeve-strand of the cord-circuit used for that connection, whereby the application of the grounded tip of the testing-plug results in a flow of current over the testing-circuit thus completed and causes a surge of current through the operator's bridge from said condenser c^3 and a click in her receiver to notify her that the line is busy. Assuming that the line is found idle, the calling-plug P^2 is inserted in one of the multiple jacks of the line and the ringing-key 25 is depressed. The initial insertion of the plug P^2 completes a path for current over the sleeve-strand of the cord-circuit from said battery B^2 and through the cut-off relay R^2, which is energized to prevent the operation of the line-

signal of said line. During ringing the path for current from the battery B^2 is preferably maintained through the auxiliary conductor 26, including the resistance 27, although it is obvious that this feature is not absolutely necessary. The path for ringing-current when the bell at the substation is connected as shown in the drawings is out on the tip side of the telephone-line, through the bell at the substation, thence back to the central office, and through said conductors 26 and 16 and the battery B^2 to ground. After the subscriber has been called, but before his response-current is flowing from the live pole of the battery B, through the lamp S^3, the shunt of the retardation-coil 17, including conductors 18 and 19, and thence over the strand s^2 and through the cut-off relay of the called line, as stated, the current in this path is sufficient to light the supervisory lamp S^3, the resistance of the said supervisory lamps and the cut-off relays being suitably adjusted, as is well understood in the art, to permit of the lamps lighting in series with these relays, as described. When the subscriber responds, however, the current flows from the battery B^2 over the metallic telephone-line and back to the central office over the tip-strand and through the supervisory relay r^2, which responds to such current and opens the shunt about the retardation-coil 17 and completes the shunt consisting of conductors 18 and 20 around the supervisory lamp S^3, thereby retiring the same to indicate to the operator the fact of the called subscriber's response. The subscribers are now in conversation, during which time the batteries B and B^2 are independently supplying current to the lines L and L^2, respectively, for the operation of the transmitters. The supervisory lamps S^2 and S^3 are extinguished by reason of the shunts completed about them by the relays r and r^2. At the termination of the conversation the return of the subscribers' receivers to their hooks opens the line-circuits to steady currents from the said central batteries and deënergizes the supervisory relays r and r^2, which restore the conditions before described—namely, that the supervisory lamps are included in local circuits with the cut-off relays, from which circuits the retardation-coils 12 are excluded. Upon observing these signals the operator takes down the connection and restores all parts to normal condition. The retardation-coils 12 and 17 are preferably of one thousand ohms resistance, while the supervisory relays may be of one hunderd ohms resistance.

In Fig. 2 the line-circuits are slightly different in type, two only—namely, L^3 and L^4—being shown, and the substation arrangement being the same as in the former figure. In this instance the line-relays R^3 are provided with split windings 30 and 31, winding 30 being legged to ground from the sleeve conductor of the telephone-line and winding 31 being connected between the line conductor 2 and the battery-lead 5 by conductor 32. The cut-off relay R^4 has its windings included in the line conductor 3 between the line-relay R^3 and the spring-jacks of the line, said relay being shunted by an ordinary non-inductive resistance 33 in the usual manner. The line-signal S has its circuit completed from the battery-lead 5 by means of conductor 34 to the front contact of the line-relay R^3, thence by the spring of said relay and conductor 35 with the normal contact of said cut-off relay R^4, the armature of which is grounded. In the cord-circuit the supervisory relay r, the supervisory signal S^2, and the retardation-coil 12 are included in a bridge of the answering end of the cord-circuit, while said bridge intermediate the relay and lamp is joined by a conductor 36 with the live pole of said central and common battery B. As in the former instance, the retardation-coil is normally shunted by conductors 13 and 14 through the normal contacts of the supervisory relay r^4, which shunt is adapted to be opened and another one established about the supervisory signal S^2 by said conductor 13 and the conductor 15. The same arrangement exists in connection with the calling end of the cord-circuit, except that to facilitate making the busy test the retardation-coil 17 of the prior figure is now replaced by a retardation coil or relay r^3, which in addition to performing the function of the retardation-coil serves to control the circuit of the test-relay r^4. The bridge containing these parts is joined by conductor 37 with the live pole of the battery B^2. The spring 38 of the relay r^3 serves to normally open the tip-strand t^2 of the cord-circuit and to complete the forward portion thereof through a conductor 39, connected with the auxiliary spring 40 upon the listening-key 41. When the listening-key 41 is operated, said spring 40 connects with the winding of the high resistance and high impedance test-relay r^4. The operator's head-telephone 21 and the condenser c^3 are now included in a bridge of the cord-circuit with the secondary winding of an induction-coil 42, that is provided with a tertiary winding included in the conductor 43, which is connected at one end with the conductor 16 and is adapted to be grounded at its opposite end by the test-relay r^4. The same ringing outfit is provided as in the former instance. Now when the subscriber L^3 takes up his telephone current from the battery B flows over conductors 5, 32, and 2, thence through the substation devices and back to the central office through line conductor 3, and through the winding 30 of the line-relay R^3. The current thus flowing through both windings of the line-relay R^3 actuates the same to close the local circuit of the line-signal S. The insertion of

the answering-plug P in response to the line-signal completes a path for current from the battery B over conductor 36, through lamp S^2, conductors 13 and 14, the sleeve-strand *s* of the cord-circuit to the line conductor 3, including the winding of the cut-off relay R^4, and through the winding 30 of the line-relay R^3. The cut-off relay responds to this current and opens the local circuit of the line-signal S, which is retired. At the same time and owing to the fact that the subscriber has his telephone off the hook the supervisory relay *r* receives sufficient current over the tip side of the cord-circuit to open the short circuit about the retardation-coil 12 and close it about the lamp S^2, which is thereby prevented from operating. In testing the condition of the wanted line the test-relay is connected with the tip-contact of the plug P^2 through the medium of the normal contacts of the relay r^3 and the spring 40 of the listening-key, the test being carried out in the usual manner. When it is found that the line is idle, the calling-plug is inserted and the ringing-key depressed. The insertion of the calling-plug completes a path for current from the live pole of the battery B^2 over conductor 37, through the supervisory lamp S^3, conductors 18 and 19, and through the portion 45 of the winding of the impedance-coil or relay r^3, the sleeve-strand s^2 of the cord-circuit, the sleeve conductor 3 of the telephone-line, including the winding of the cut-off relay R^4, and through the winding 30 of the line-relay R^3 to ground. The cut-off relay is thus actuated to prevent the line-signal operating, and the depression of the ringing-key maintains the said cut-off relay actuated by current over the conductors 16 and 26. After the subscriber has been called and before his response the current flowing in the path just traced serves to light the supervisory lamp S^3 and to energize the relay r^3 through the winding 45, thus causing it to attract its armature to disconnect the conductor 39 leading to the test-relay and to complete the tip-strand t^2 for conversation. Upon the response of the called subscriber the supervisory relay r^2 receives sufficient current from the battery B^2 flowing over the metallic telephone-line to actuate the same, thereby severing the short circuit about the main portion 46 of the winding of the relay r^3 and completing the short circuit about the lamp S^3, said short circuit including the conductors 18 and 20. This retires the signal S^3 and connects the impedance-coil or relay r^3 in the bridge of the calling end of the cord-circuit. The resistance of the winding 45 may vary between rather wide limits and may be as low as ten ohms and still work satisfactorily, while the combined resistances of both coils is preferably of one thousand ohms, the same as the retardation-coils 12, connected with the other end of the cord-circuit. During conversation the batteries B and B^2 are feeding current out to the lines L^3 and L^4 and the supervisory relays and retardation-coils are connected in bridges of the cord-circuits.

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

1. In a telephone system, the combination with a telephone-line, of a cord-circuit to establish connections therewith for conversation; a supervisory relay, a supervisory signal-lamp and a retardation-coil in series in a bridge of said cord-circuit; a central source of current, the said relay being in the path of current from said source over the telephone-line during conversation, and a local circuit established with a portion of the line when connection is made therewith, said relay serving when deënergized to include said lamp in said local circuit and to exclude said coil therefrom and when energized to establish the reverse conditions, substantially as described.

2. In a telephone system, the combination with a telephone-line, of a cord-circuit to establish connections therewith for conversation; a supervisory relay, a supervisory signal-lamp and a retardation-coil in series in a bridge of said cord-circuit; said relay being in the path of current to one side of the cord-circuit and over the telephone-line and therefore controlled by the subscriber after a connection is established, said lamp and retardation-coil being connected between the source of current and the other side of the cord-circuit, said relay controlling shunt-circuits of said lamp and coil whereby when the relay is deënergized the retardation-coil is shunted and the lamp is in circuit and when energized the lamp is shunted and the retardation-coil is in circuit, substantially as described.

3. In a telephone system, the combination with a plurality of telephone-lines, of a cord-circuit to establish connections therewith for conversation, a condenser in each limb of said cord-circuit to conductively separate its two ends, a supervisory relay for each end of said cord-circuit with its coil in the path of current completed over the subscriber's line when the cord-circuit is connected therewith and the subscriber's receiver is off his hook, a supervisory signal and a retardation-coil associated with the cord-circuit and means controlled by the actuation of said relay whereby either said signal or said coil may be included in a path for current completed by the connection of its end of the cord-circuit with a telephone-line, substantially as described.

4. In a telephone system, the combination with a plurality of telephone-lines, of a cord-circuit adapted to establish connections therewith for conversation, of a retardation-coil and a supervisory signal associated with said cord-circuit, a path of current completed

by the connection of said cord-circuit with a line, and means to include said signal in and exclude said coil from said path before a called subscriber has responded to his call and to include said coil in and exclude said signal from said path after the called subscriber has answered his call, substantially as described.

Signed by me at Chicago, county of Cook, and State of Illinois, this 5th day of November, 1903.

WILLIAM W. DEAN.

Witnesses:

GAZELLE BEDER,

ROBERT LEWIS AMES.