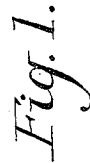


APPLICATION FILED NOV. 28, 1908.

Patented Jan. 21, 1913.

Fig. 2.



By

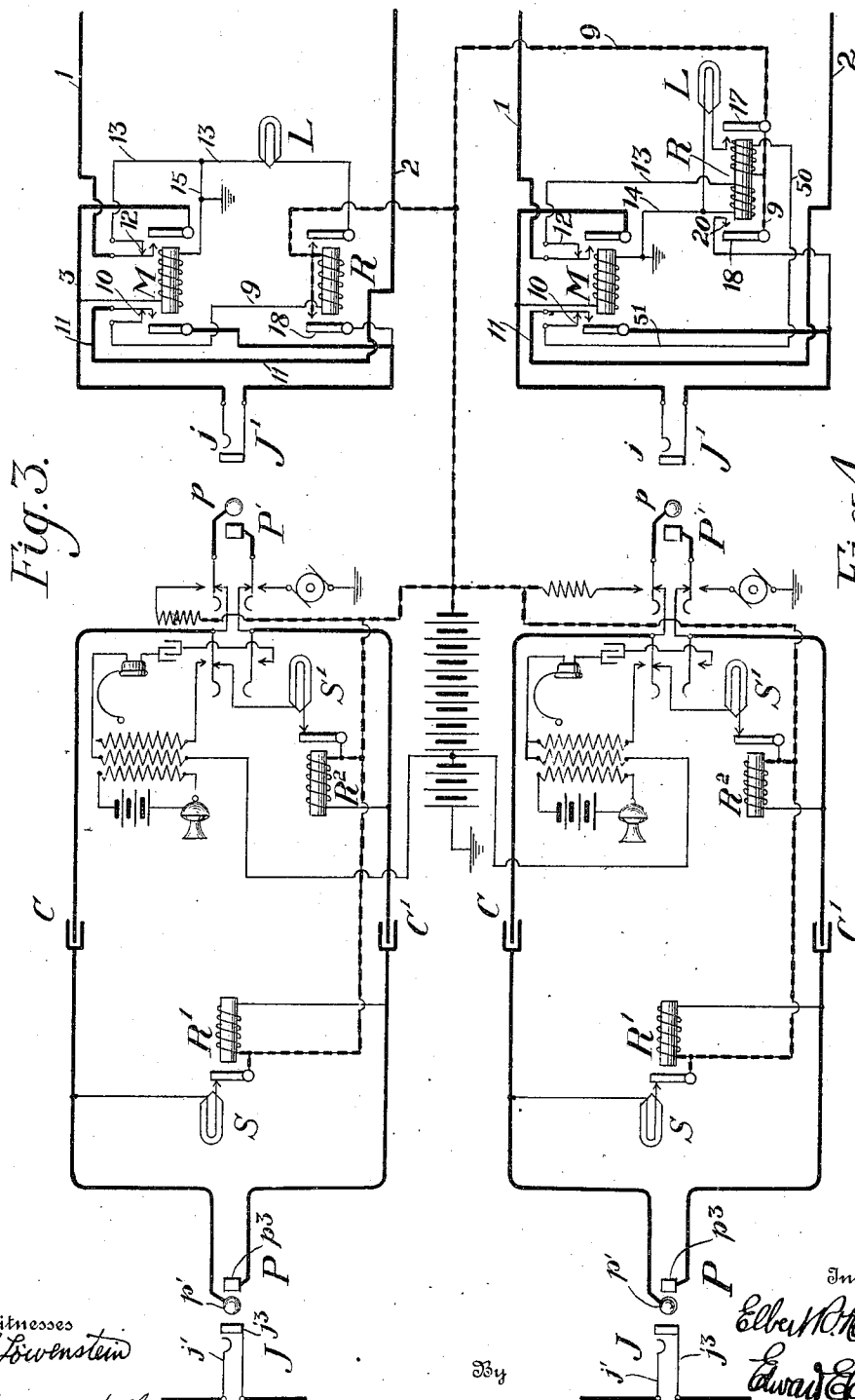
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1,051,109.

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TELEPHONE SYSTEM.
APPLICATION FILED NOV. 28, 1908.

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5 SHEETS—SHEET 2.



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Fig. 5.

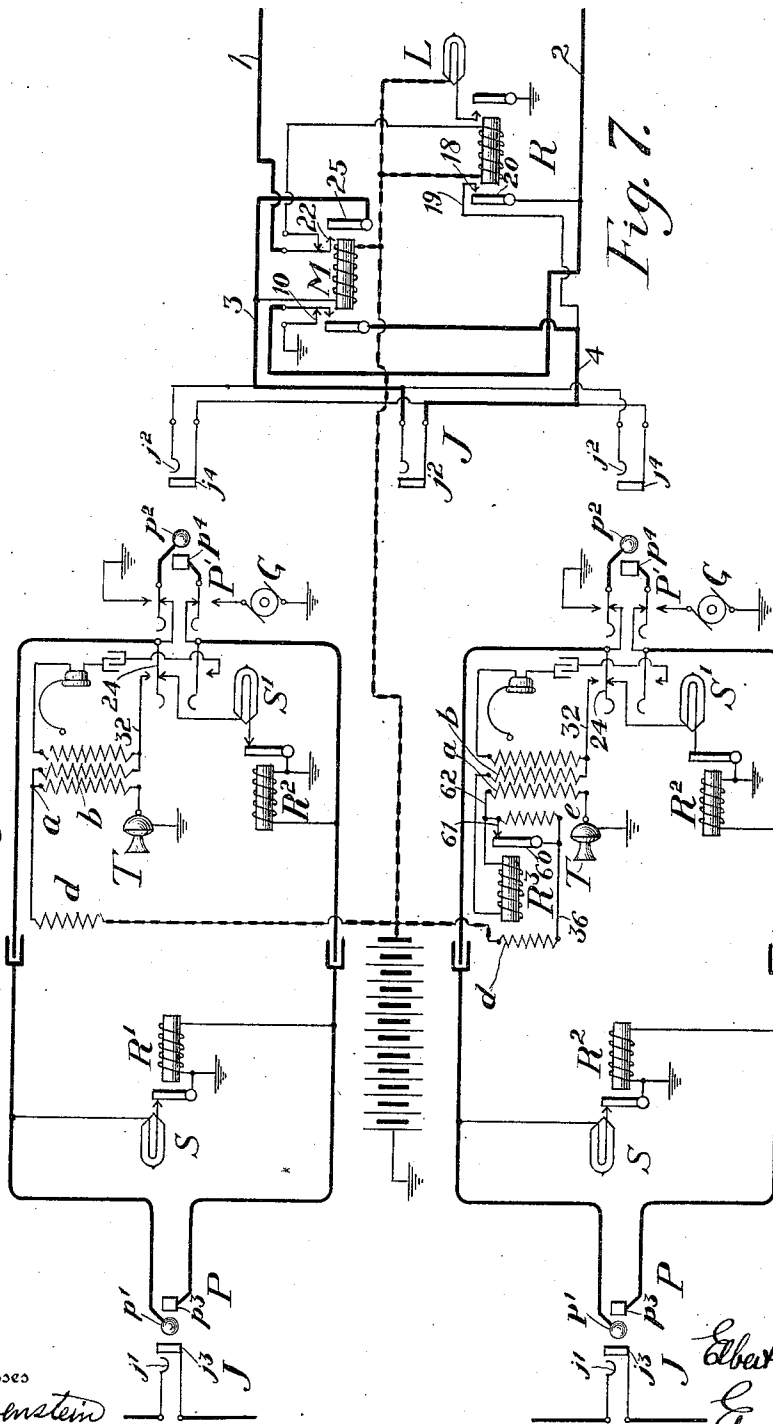


Fig. 6.

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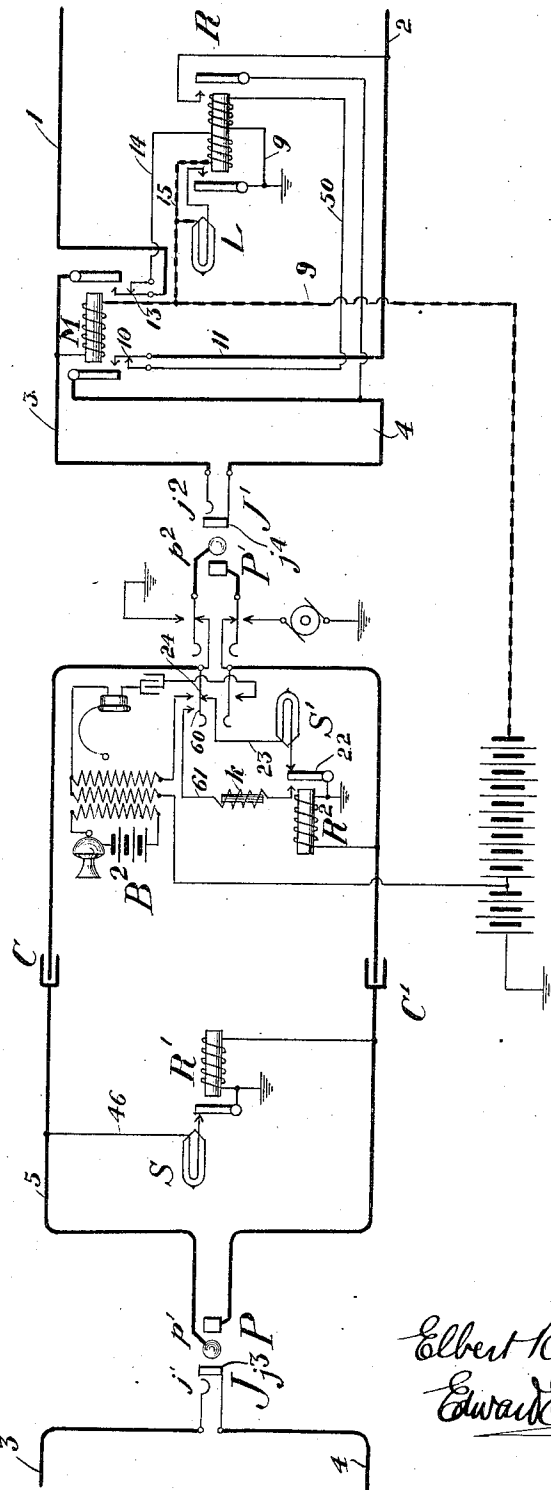
1,051,109.

E. R. HOBBS.
TELEPHONE SYSTEM.
APPLICATION FILED NOV. 28, 1908.

Patented Jan. 21, 1913.

5 SHEETS—SHEET 4.

Fig. 8.



Witnesses
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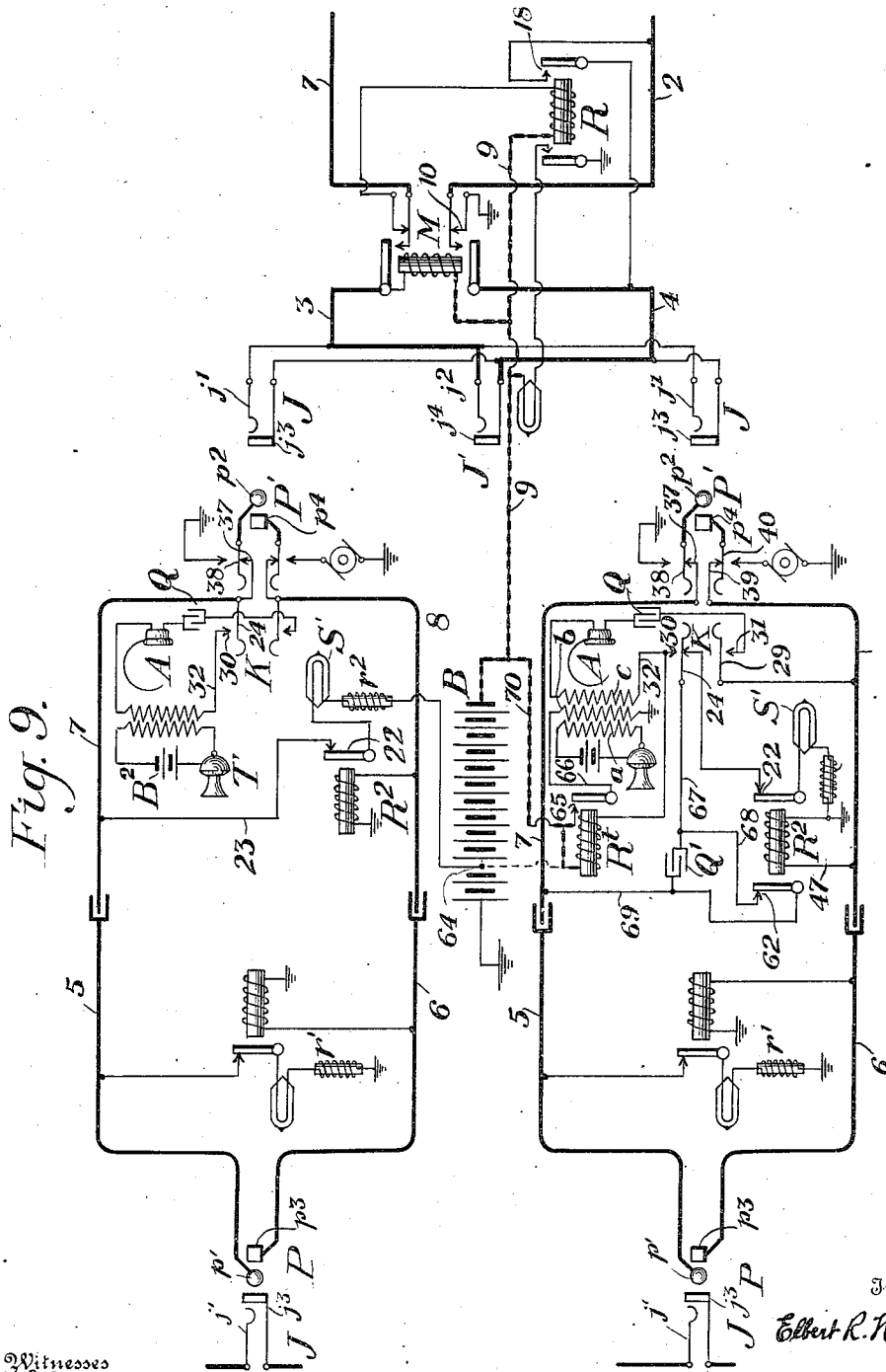
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5 SHEETS—SHEET 5.



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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

1,051,109.

Specification of Letters Patent.

Patented Jan. 21, 1913.

Application filed November 28, 1908. Serial No. 464,860.

To all whom it may concern:

Be it known that I, ELBERT R. HOBBS, a natural-born citizen of the United States, residing at Buhl, in the county of Twin Falls and State of Idaho, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification, reference being had therein to the accompanying drawing.

My invention relates to telephone systems and has for its object the improvement of the two-wire multiple circuit systems used in connection with a common battery at the central station. In ordinary circuits of this kind there are numerous objections and it is my object to overcome these by a novel arrangement of the apparatus comprising the operator's cord circuit and the parts constituting the subscriber's line terminal apparatus. It often happens that after a subscriber has removed his receiver to call the central office he will be called himself by another operator before his own operator can answer his call. To obviate this difficulty I have devised a novel arrangement for testing the calling subscriber's line which at once notifies all operators that he is busy as soon as he takes his receiver from the hook and before his own operator has plugged in to answer his call. Moreover, I have so arranged these circuits that a false test cannot be caused by a faulty line.

A further object of my invention is to provide a system in which the usual noises occasioned by the making and breaking of circuits are done away with. For this purpose I make use of contacts on the cut-off relay of the make and break type which renders the system clickless.

A further object of my invention is to reduce the cost of the apparatus necessary in a common battery system by doing away with certain parts ordinarily used. Thus, in my improved system, there is only one relay on each side of the cord circuit. This adds to the simplicity of the cord circuit, and at the same time the reliability is enhanced since there are no marginal relays or lamp circuits and no differentially wound relays.

Besides the objects mentioned above there are several advantages flowing from the novel features of my invention. In my im-

proved system there is no chattering of the cut-off relay during ringing; there is no waste of talking current during conversation, and efficiency of transmission is thereby increased.

Other objects and advantages will appear in the detailed description of the system as hereinafter set forth.

My invention is illustrated in the accompanying drawings in which:

Figure 1 shows an operator's cord circuit and the terminal apparatus of two subscribers' lines adapted to cooperate with it. Fig. 2 shows a modified form of operator's cord circuit and also a modified arrangement of the subscribers' terminal apparatus. Figs. 3 and 4 are modified arrangements of the same. Figs. 5 and 6 are modified arrangements of the operator's cord circuit. Fig. 7 shows a subscriber's line terminal apparatus arranged for cooperation with the cord circuits of Figs. 5 and 6. Fig. 8 shows a modified arrangement of operator's cord circuit and line terminal apparatus. Figs. 9 and 10 are modifications of an operator's cord circuit and a subscriber's terminal apparatus adapted to cooperate therewith.

Referring to Fig. 1, I have shown therein, as above stated an operator's cord circuit and the terminals of two subscribers' lines. In order to have room on the drawing to illustrate the cord circuits in their proper relation to the terminals, I have shown merely the terminal jacks of the calling subscriber's line. It will be understood, however, that the terminal apparatus of the calling and the called subscriber are identical in every particular in this figure and in the modified forms shown in the remaining figures, and therefore the description of the called subscriber's terminal apparatus will suffice for both. The line wires 1 and 2 lead from a subscriber's sub-station (not shown) both of said lines terminating in contacts of the cut-off relay M, which are of the make before break type as will be seen from the drawing. The line relay R controls the circuit of the signal lamp L, the pulling up of its armature completing the lamp circuit from the battery B. The resistance coil r is normally connected with the line wire 2 through the closed contacts of the relay M. The energization of the cut-

off relay M puts the line wires 1 and 2 onto their respective extensions 3 and 4 leading to the jack J'. The operator's cord circuit is provided with the usual plugs P and P' 5 connected on the tip side by the conductors 5 and 7 and on the sleeve side by the conductors 6 and 8. The condensers C and C' are interposed on the tip and sleeve sides of the cord circuit to permit the passage of 10 voice currents while cutting off battery currents. The answering supervisory relay R' controls the supervisory lamp S while the relay R² on the calling end of the cord circuit controls the lamp S'. The operator's 15 set consists of the usual parts and includes the transmitter T in circuit with the battery B² and the primary winding *a* of an induction coil. The receiver A is in circuit with the secondary winding *c* of the induction 20 coil together with a condenser Q. A tertiary winding *b* is provided on the induction coil for test purposes. This coil is in series with the secondary winding *c* and about six volts of battery. A listening key 25 K is provided by means of which the operator can listen in to get the number wanted when a connection is desired, the operation of this key serving to break the circuit of the calling supervisory lamp and to 30 connect the operator's set with the tip and sleeve sides of the cord. The ringing generator G is connected on one side to ground and on the other to a contact adapted to be closed by the ringing key K^r.

35 The arrangement shown in Fig. 2 is very similar to that shown in Fig. 1. There are, however, some differences which will be mentioned now and more particularly pointed out in the detailed explanation of the operation of the system. In this figure the line 40 wires 1 and 2 terminate as in Fig. 1 in contacts of the cut-off relay M. The battery connections however, are reversed and the resistance *r* shown in Fig. 1 is omitted. The 45 line relay R controls the circuit of the lamp L and the operation of the cut-off relay M as in the previous figure, places the line wires 1 and 2 upon the extensions 3 and 4 leading to the jack J'. In the cord circuit 50 shown in Fig. 2 one terminal of the windings of each relay R' and R² is grounded, the other being connected with the sleeve side of the cord. The operator's set is similarly arranged to that shown in Fig. 1 except that the tertiary winding *b* is connected 55 at 63 to about eighteen volts of battery, counting from the grounded side. The operation of the ringing and listening keys is precisely similar to that shown in Fig. 1.

60 The arrangement in Fig. 3 is similar to that shown in Fig. 1, the relay R, however, being shown in the place of the resistance *r* in Fig. 1. The operation of the cut-off relay in this figure is the same as that in Fig. 1.

65 The line relay R in Fig. 4 has a double

winding, otherwise the arrangement in this figure is the same as that in Fig. 3.

In Fig. 5 I have shown a similar arrangement to that shown in Fig. 2. It will be noticed, however, that the battery B² is 70 omitted in this figure and that the transmitter derives current from battery B, one side of the transmitter being grounded.

Fig. 6 is similar to Fig. 5. There is, however, a relay R³ interposed in the test circuit, which when actuated, causes the resistance *c* to be interposed in the transmitter 75 circuit, the normal circuit of the transmitter being through the contacts 60, 61. The other parts of the operator's cord circuit are the same as shown in Figs. 5 and 2.

Fig. 7 shows the same arrangement of the subscriber's line terminal apparatus as 80 in Fig. 2.

In Fig. 8 the arrangement of the cord circuit is similar to that in Fig. 2. A choke coil 85 *h* is added, however, and is arranged to be connected with ground on one side when the relay R² is energized and to the tip side of the cord when the listening key is down. 90 The line relay R is double wound.

Fig. 9 is similar to Fig. 2, the subscriber's terminal apparatus being identical with that of Figs. 2 and 7. However the resistance coils *r'* and *r''* are interposed in the circuit of the supervisory lamps, the tertiary 95 winding *b* of the induction coil is omitted and the test made by a discharge from the condenser Q.

Fig. 10 makes use of the usual tertiary 100 winding *b*, and a test relay R^t controlled by a contact 62 on the supervisory relay. Otherwise it is similar to Fig. 9.

The operation of the system will be readily understood from the foregoing explanation 105 of the apparatus used. When a subscriber desires a connection he removes his receiver from the hook, thereby closing the circuit through the line wires 1 and 2. The line relay R is energized, the energizing 110 current flowing from battery B through 9, *r*, contact 10, 11, 2, through the subscriber's instrument, 1, 12, 13, R, 14, 15, to ground. The actuation of the line relay R closes the circuit of the line lamp L at 16 and the 115 lamp is lighted, current flowing from battery, 9, contact 17, 16, L, 15, to ground. At the same time, through the pulling up of the armature 18 on the opposite end of the relay R, the sleeve *j'*, of the jack J is connected 120 to battery by means of the conductors 4, 19, contacts 20 and 18 and conductor 9. The potential of the sleeve is therefore raised, thus providing for a busy test even before the operator plugs in. On seeing the 125 lighting of the signal lamp L, the operator places the answering plug P in the jack J. If, however, before she has had time to insert the plug in its jack, another subscriber should desire to communicate with the call- 130

ing subscriber, a second operator before whom the line of the second subscriber terminates, on testing the first subscriber's line in the ordinary way will find it busy even before the first operator has plugged in. The second operator will get a click in the ear due to a momentary induced current in the coil *a*, caused by a flow of current from the sleeve *j^a* of the calling subscriber's multiple jack *J^a* (which is connected to battery through the contacts 18 and 20) through the tip side of the cord plug (the cord of the second operator) 24, 32, *c*, *b*, 36 and to battery at 64, this including about eighteen volts of battery. When the first operator plugs into the answering jack *J* the cut-off relay *M* is energized, the energizing current being from battery *B*, conductor 21, 44, contact 45 of the relay *R'*, *S*, 46, 5, *p'*, *j'*, 3, *M*, 15, and to ground. It will be noticed that there is no flow of current over the sleeve side of the cord and the line at this time because the live side of battery is connected to both the sleeve sides of the answering plug and the answering jack, which are therefore at the same potential. The actuation of the cut-off relay *M* through the pulling up of its armatures 25 and 26 puts the line wires 1 and 2 onto their respective extensions 3 and 4 through the engagement of these armatures with the contacts 27 and 28. At the same time the contacts at 10 and 12 are broken, thereby deenergizing the line relay *R*, breaking the circuit of the line lamp *L*, and at the same time cutting off the sleeve *j^s* from the battery *B* through the breaking of the circuit at the contacts 18 and 20. Lamp *S* is extinguished by the pulling up of the relay *R'*, current flowing from battery *B* through 21, 44, *R'*, 44^a, 6, *p^s*, *j^s*, 4, 43, 28, 11, 2, through calling subscriber's telephone 1, 27, 25, 3, through his cut-off relay *M* to ground, which constitutes the battery supply circuit of the calling subscriber. Having obtained the number the operator tests the line wanted and if it is idle inserts the calling plug *P'* in jack *J'*, supervisory lamp *S'* glows, the current flowing from the battery through 21, 22, *S'*, 23, 24, *p^s*, *j^s*, 3, through the called subscriber's relay *M* and to ground. She then presses the ringing key *K* thereby breaking the cord circuit at the terminals 37—38 and 39—40 and connecting the ringing generator to the line through the closing of the contacts 38—41 and 40—42, (relay *M* being held up through protection coil *F*). Ringing current is then supplied to the line from the generator *G* through 40, *p^s*, *j^s*, 4, 43, 11, 2, subscriber's ringer, 1, 27, 25, 3, *j^s*, *p^s*, 38, 41, protection coil *F*, and to ground through the battery. This prevents the chattering of the cut-off relay *M*. When the called subscriber answers, his battery supply circuit is from battery *B* through 21, *R^s*, 8, *p^s*, *j^s*, 4, 43, 26, 11, 2,

through the called subscriber's telephone, back on the tip side 1 of line and through his cut-off relay *M* to ground. The supervisory relay *R^s* pulls up breaking the circuit of lamp *S'*.

Referring now to Fig. 2, the removal of the calling subscriber's receiver actuates the line relay *R* and operates the signal lamp *L* and puts the ring of the jack *J* in connection with ground in the same manner as in Fig. 1. The operation of the cut-off relay is the same as that in the previous figure. When the operator plugs into the answering jack *J* current flows from the battery *B*, through the relay *M*, conductor 3, *j'*, *p'* 5, 46, lamp *S*, 45 and ground. With the circuits arranged as shown in this figure the supervisory lamp cannot burn out. A ground on the line 1 would prevent it from burning to its full brilliancy but any such ground if of any consequence, would be immediately detected by means of the line relay. The operation of the cut-off relay places the line wires 1 and 2 on their extensions 3 and 4 and cuts off the circuit of the line relay *R*. The current in the test circuit flows in an opposite direction from that in Fig. 1, the path being tapped from battery *B* at 63, through *b*, *c*, 32, 24, *p^s*, *j'*, 4, 19, 18, 20, 2, 10, 9, and ground, including about eighteen volts of battery. After having learned the number wanted the operator inserts the calling plug *p'* in the jack of the wanted subscriber. Thereupon the supervisory lamp *S'* lights up, current flowing from battery *B*, through the called subscriber's cut-off relay *M*, and over the tip side of his line 3, *j^s*, through the tip side *p^s* of the plug *P'*, conductor 24, 23, lamp *S'*, contact 22 and to ground. The ringing is accomplished in the same manner as in Fig. 1, the ground which is placed on the tip of the plug during ringing effectually handling all the ringing current and that from the cut-off relay, and positively preventing the latter from chattering. When the called subscriber answers battery current is supplied to the supervisory relay *R^s* through the cut-off relay *M*, and over the line 1, through the instrument, back on the sleeve side of his line, 2, conductor 8 of the cord circuit, *R^s* and ground. Thereupon the lamp *S'* is extinguished. When conversation is ended and the subscribers have hung up their receivers the relays *R'* and *R^s* retract and the supervisory lamps *S* and *S'* light up; the operator withdraws the plugs and the system is restored to normal.

The arrangement of the circuits as described in Fig. 2 admits of the following advantages: First, no protection coil is needed at the ringing key; second, the line relay connects the extension 4 direct to the line wire 2 and thus the line is ready for use at once when the cut-off relay operates without waiting for the line relay to fall back, thus

avoiding the necessity of a protection coil; third, there is no need of a double wound line relay. As compared with other well known systems it has the following advantages: First, more efficient transmission, because there is no special cut-off relay to ground and the supply relay consequently can be higher wound and yet afford the same current for talking, thus making the circuit less noisy and allowing less loss; second, it provides a better test as the click is heard as long as the line relay operates and yet cannot give a false test; third, there is absolutely no current wasted while talking; fourth, the system is clickless because of the make before break contacts on the cut-off relay; fifth, there is positively no chattering of the cut-off relay during ringing for the reason heretofore explained; sixth, there is no battery or relay resistance to the ringing current; seventh, it is more simple as there is only one relay for each half of the cord circuit; eighth, no insulated metal ring is needed between the tip and the sleeve of plug; ninth, there is no apparatus bridged across the talking circuit.

In Fig. 3 the removal of the receiver by the calling subscriber energizes the relay R, the energizing current flowing over the following path: from battery B through R, 9, 10, 11, 2, subscriber's telephone, 1, 12, 13, 15 and ground. The actuation of the relay R lights the signal lamp L and places the ring of the jack J in connection with battery through the pulling up of its armature 18. It will be observed that the disposition of the line relay so that it is actuated over the line wire 2 has this advantage over the arrangement shown in Fig. 1: If there should be a ground on the line wire 2 it would be at once noticed through the energization of the line relay, while in Fig. 1 no signal would be displayed, current flowing from battery through the resistance r , over the line 2 and to ground. The talking circuits, test circuits and ringing circuits are the same as those shown in Fig. 1.

In Fig. 4 I have shown the subscriber's line circuit equipped with a double wound line relay R. With this arrangement when the receiver is lifted from the hook the line relay is energized, the energizing current being from battery B, through 9, R, 50, 51, 10, 11, 2, subscriber's telephone, 1, 12, 13, R, 14 and ground. The pulling up of the armature 17 causes the glowing of the lamp L while the ring j^3 of jack J is connected to battery through the closing of the contacts 18 and 20. The remaining circuits are practically the same as those shown in Figs. 3 and 1. The provision of an extra winding on the relay R insures the positive operation of the cut-off relay M and at the same time gives additional strength to the line relay.

In Fig. 5 the operation of the line and cut-

off relays is the same as in Fig. 2. In this figure there is another path provided by which current through the cut-off relay can be maintained when the listening key is operated and the lamp circuit L broken thereby. I accomplish this by grounding one side of the transmitter T and providing a resistance d between the battery B and the joined ends of the primary and tertiary windings a and b respectively. Current may then flow from battery B through the cut-off relay M and through 3, j^2 , p^2 , 24, 32, b , a , T and ground. This arrangement provides for the time-being two sources of current for the transmitter, one source being from the battery B through the resistance d , the primary winding a , the transmitter T; and the other being the circuit already traced through the cut-off relay M and the test coil in series. In order to guard against any possible overloading of the transmitter with current, I may provide a relay for interposing a resistance in the primary circuit of the coil when the extra current, *i. e.* the current through the cut-off relay and the test coil, is flowing.

In Fig. 6 I have shown a relay R^3 which effectually prevents the overloading of the transmitter. In the ordinary operation of listening in, to obtain the number wanted by the calling subscriber, the test coil b is cut out by virtue of the calling plug not being in. At such times the current through the transmitter T flows from battery B through the resistance d , 36, armature 60 of the relay R^3 , contact 61, 62, a , T, to ground, this current being the normal current of the transmitter. When current flows over the tertiary winding b in series with the cut-off relay M, however, this would tend to cause a greater current in the transmitter as before described. The flow of current through the cut-off relay and the tertiary winding b actuates the relay R^3 which pulls up thereby breaking the contacts 60, 61 which formed a short circuit, and interposing the resistance e which cuts down the current through the transmitter T to its normal intensity.

In Fig. 8, when a subscriber calls up, the line relay R is actuated, current flowing from battery through 15, R, 14, 13, 1, through subscriber's telephone, back upon the sleeve side 2, 11, 10, 50, R, 9, to ground. The actuation of the line relay R connects the line wire 2 direct to the sleeve j^3 of the jack J and closes the lamp circuit. When the operator plugs into the calling jack J' current flows from battery through the cut-off relay M, 3, j^2 , p^2 , 24, 23, S', 22 and to ground. The cut-off relay is actuated and the line relay is cut out. When the operator presses her listening key the calling supervisory lamp circuit is broken. The current from the called subscriber's cut-off relay now flows over the line 1 (the called subscriber

having answered) and back to the line 2 and through the supervisory relay R^2 which pulls up. Since the listening key is down, a path to ground is provided for current through the cut-off relay, through the closed contacts at 60, the conductor 61, k , 22, to ground.

In Fig. 9 the operation of the subscriber's terminal apparatus is identical with that of Figs. 2 and 7. In this figure the cut-off relay is held up independently of the listening key by the following circuit: from battery B, through 9, M, 3, j' , p^3 , 38, 37, 7, 23, 22, S' , r^2 to battery at 64, thus including about twenty volts of battery. The operator's listening in circuit is very simple, the tertiary winding b being omitted and the listening key reduced to its simplest form. The tip side of operator's calling plug is connected to about three or four volts of battery at 64 which raises its potential above that of ground. In testing, the operator first operates her listening key K which charges the condenser Q and thus prepares her head set for a ground busy test. This test to ground is given if the subscriber has lifted his receiver and is waiting for an answering operator as the sleeve j^3 of this multiple jack J is grounded through the contact 18 of relay R. After an operator has plugged in the line is still prepared for a ground busy test, the sleeve j^3 being then grounded through the operator's supervisory relay.

Fig. 10 makes use of a test relay R^t which is connected to battery at one end and at the other to a make contact 30 of the listening key K, thence to the tip of calling plug through the condenser Q' which is short circuited through the contact 62 on the supervisory relay R^2 . The tertiary winding b is connected at one end to battery through the make contact 65 of the test relay and at the other end to ground. When the operator presses her listening key K preparatory to making a test the test relay R^t is connected to the tip of plug P'. Now if the called subscriber has lifted his receiver and is waiting for an answering operator the sleeve j^3 of his multiple jack is grounded through the contact 18 of relay R and the test circuit is as follows: from battery B through 70, R^t , 30, 24, 67, 68, 62, 69, 7, 37, 38, p^2 , J, 4, 18, 2, 10 and to ground. After the operator has plugged in and the cut-off relay M has pulled up the test circuit of a second operator will be from battery B through 70 R^t , 30, 24, 67, 62, 69, 7, 37, 38, p^2 , J, p^4 , 40, 39, 8, 47, R^2 and to ground. To avoid any possibility of the supervisory relay pulling up on this test circuit, the strength of the test circuit may be diminished by connecting the relay R^t to two or three volts of battery as shown in dotted lines on the drawing. On the pulling up of the test relay current flows from battery B through 70,

contact 65, 66, tertiary winding b and to ground causing a busy click in the operator's ear.

It can be seen that the cord circuits shown in Figs. 9 and 10 will operate with the terminal apparatus of Figs. 1, 3 and 4 by reversing the battery connections of the latter circuits. The ringing circuit will be the same as that of Figs. 2, 5, 6 and 8.

Having thus described my invention what I claim and desire to secure by Letters Patent of the United States is:

1. In a telephone exchange system, subscribers' lines, line relays and cut-off relays associated therewith, an operator's cord circuit provided with supervisory relays and signal lamps controlled thereby, one terminal of the winding of each supervisory relay being connected to one side of the cord and the other connected to battery so that the winding of the relay is removed from the direct path of talking current during operation, means directly controlled by the subscriber in calling to cause his line terminals to test busy, means acting directly through the cord circuit when a plug is fully inserted to maintain said busy test, and make and break contacts in said busy test circuit adapted to be made and other contacts adapted to be thereafter opened when the plug is inserted, said break contacts determining the subscriber's control of the test and the make contacts determining the cord circuit control of the test whereby the active test condition is maintained in absolute continuity from the time the subscriber initiates a call until the final disconnection of his line.

2. In a telephone exchange system, subscribers' lines provided with cut-off and line relays, an operator's cord circuit provided with a test set, supervisory relays, and supervisory lamps, means for initially energizing the cut-off relays by current through the supervisory lamps, and means for continuing the energization of the cut-off relays by current through the operator's testing set.

3. In a telephone exchange system, subscribers' lines, cut-off relays associated therewith, an operator's cord circuit provided with supervisory relays and associated lamps, means for initially energizing said cut-off relays by current through said lamps, means for subsequently energizing said cut-off relays by current through the operator's testing set and means associated with said testing set for maintaining the normal flow of current through the operator's transmitter.

4. In a telephone exchange system, subscribers' lines, cut-off and line relays associated therewith, said cut-off relays being provided with make before break contacts, an operator's cord circuit provided with

supervisory relays and signal lamps controlled thereby, one terminal of the winding of each supervisory relay being grounded and the other terminal being connected to one side of the cord, means for initially energizing the cut-off relay through the lamp circuit and to subsequently energize said cut-off relays through the windings of the supervisory relays, the make before break

contacts serving to provide a continuous energization of said cut-off relays. 10

In testimony whereof I affix my signature in presence of two witnesses.

ELBERT R. HOBBS.

Witnesses.

R. H. COST,

E. A. MILNER.

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