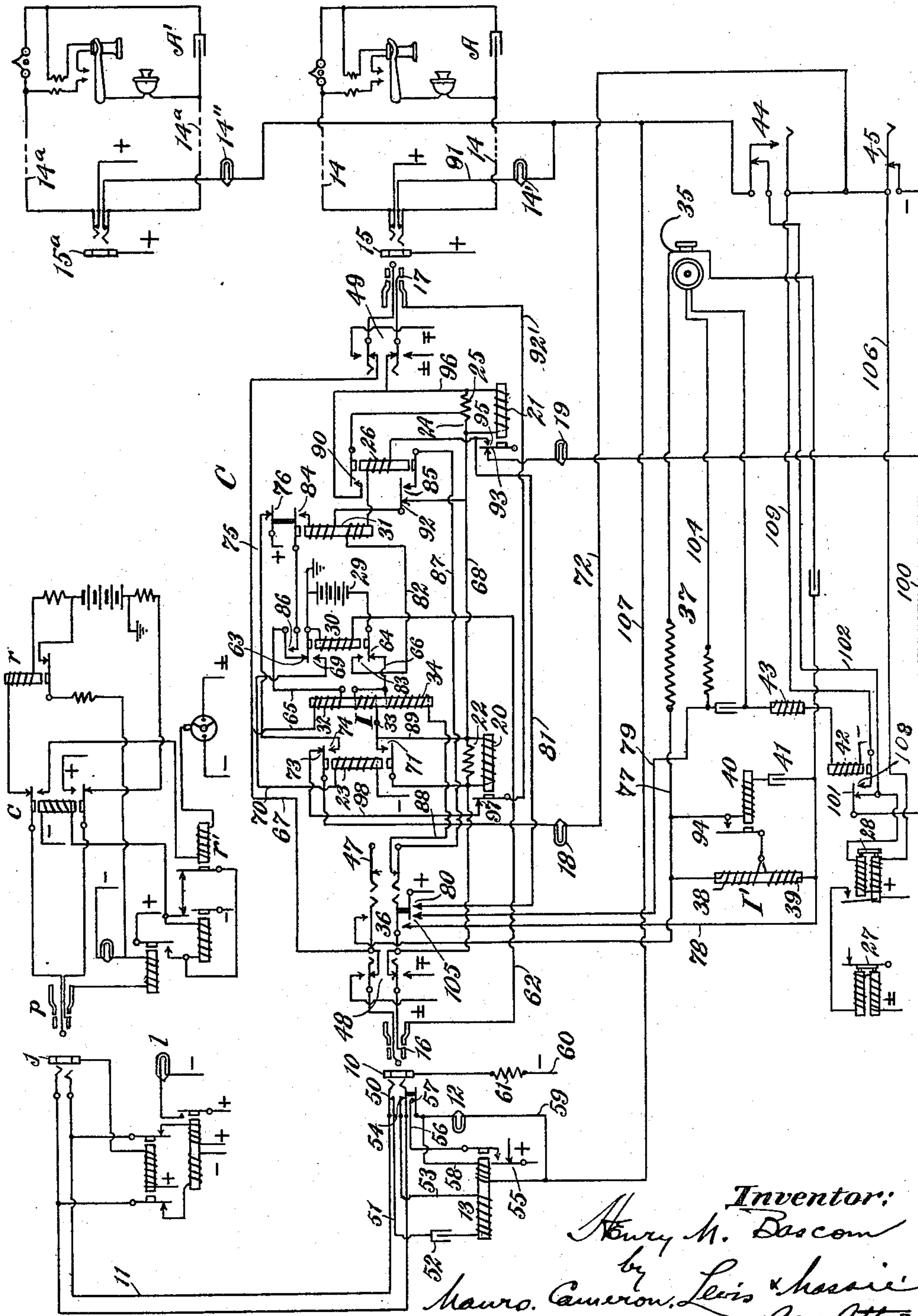


H. M. BASCOM.  
TELEPHONE SYSTEM.  
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1,175,112.

Patented Mar. 14, 1916.



Inventor:  
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# UNITED STATES PATENT OFFICE.

HENRY M. BASCOM, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

## TELEPHONE SYSTEM.

1,175,112.

Specification of Letters Patent. Patented Mar. 14, 1916.

Application filed July 1, 1915. Serial No. 37,561.

*To all whom it may concern:*

Be it known that I, HENRY M. BASCOM, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Telephone Systems, of which the following is a specification.

This invention relates to telephone systems and particularly to private branch exchanges. It specially concerns arrangements of the circuit whereby the transmission efficiency is increased; an organization for signaling the private branch exchange operator and subscriber when the central station operator rerings; and means for disconnecting the auxiliary signal.

The accompanying drawing illustrates diagrammatically portions of central station and private branch exchange circuits embodying my invention in one of its forms.

At 10 appears a jack at which terminates a trunk line 11 connecting a central station with a private branch exchange. At the central station end of the trunk is represented a jack *j*, with its line lamp *l*, to receive the plug *p* of an operator's cord circuit *c*. Associated with this cord circuit is the central battery *b*, a calling supervisory relay *r* and a portion of an automatic ringing apparatus, including the usual tripping relay *r'* which cuts off the ringing current. At the private branch exchange trunk jack 10 is a lamp or other visual signal 12 controlled by a relay 13. The lines local to the private branch exchange, or extension lines, of which two are shown at 14 and 14<sup>a</sup> extending from the substations A, A', are joined to jacks 15, 15<sup>a</sup> to which lamps 14', 14'' are respectively connected. For uniting the trunk and extension lines cord circuits, as C, are used, each provided with a plug 16 for coöperation with the jacks 10, 15, 15<sup>a</sup> and a plug 17 for coöperation with the jacks 15, 15<sup>a</sup>. These movable portions 16 and 17 of the line switches may conveniently be termed the front and back plugs. Each cord circuit includes corresponding front and back supervisory lamps or visual signals 18 and 19 governed by supervisory relays 20 and 21, respectively. The relay 20 is shown as normally shunted by a non-inductive resistance 22, which may be short circuited through a contact of a relay 23. Relay 21 has a similar shunt, of which a portion 24 is left permanently on the relay, while a portion 25 of greater resistance may be short circuited at the contact

of a relay 26. An audible signal, such as a buzzer 27, is operated under the control of a relay 28 whenever the lamps 12, 14', 14'' and 19 are illuminated, the circuit which includes the supervisory lamp 19 passing through the back contact of a relay 42. This signal 27 gives warning to an operator who is not paying close attention to the visual signals. Current is supplied from battery 29 through the contacts of a relay 30 for furnishing local talking current and for operating the switchboard signals at the private branch exchange. The relay 26 together with a relay 31 controls the impedance of a bridge of the cord consisting in part of low resistance windings 32 and 33 and high resistance winding 34 of coil I.

The private branch exchange operator connects her telephone set 35 with the cord circuit by means of a listening key 36. Associated with the operator's set is the usual repeating coil 37 and bridged retardation coil I' provided with high and low resistance windings 38 and 39, respectively. A high resistance relay 40 in series with a condenser 41 is bridged across the operator's set. In series with the operator's transmitter is the winding of the relay 42 and an impedance coil 43, the former when energized disconnecting the buzzer relay 28 from the supervisory lamp 19. The operator also has a key 44 which when actuated prevents the energization of relay 28 upon the illumination of the line lamps. Key 45 cuts off the signals when the trunk is connected through to an extension line for night service, while a key 47 at this time opens the bridge through the retardation coil I. Keys 48 and 49 enable the operator to send ringing current over the extension lines upon the connection of either end of the cord circuit C therewith.

The functions of the various pieces of apparatus, so far as they affect this invention, may be more clearly understood from the following statement of operation of the system.

Assuming there to be an incoming call on the trunk 11, the relay 13 is energized by ringing current from the central station flowing over one side of the trunk, normal contact 50 of jack 10, conductor 51, condenser 52, left-hand high resistance winding of relay 13, conductor 53, normal contact 54 of the jack and then back over the trunk to



the central station. Relay 13 is energized and locks itself to the private branch exchange battery through its front contact 55, conductor 56, contact 57 of the trunk jack, conductor 58, the right-hand low resistance winding, conductor 107, resting contact of key 44, conductor 102, winding of relay 28, conductor 106 and key 45. The trunk lamp 12 is in parallel with the locking circuit in the conductor 59 and is illuminated to indicate to the private branch exchange operator the existence of the call. Relay 28 attracts its armature closing the circuit of buzzer 27, which gives the operator an audible signal.

The front plug 16 is inserted in the jack 10 connecting the cord or link circuit C to the trunk 11, opening at the jack contacts the circuits of relays 13 and 28 and lamp 12, releasing the former and extinguishing the latter. Relay 30 is energized by current over conductor 60, resistance 61, sleeve contacts of jack 10 and plug 16 and conductor 62. At its back contacts 63 and 64 relay 30 disconnects the private branch exchange battery 29 from conductors 65 and 66 which lead through the windings 32 and 33 of the retardation coil I to the cord strands 67 and 68. Current for talking purposes is now obtained from the central station battery *b*. Primary relay 30 at front contact 69 causes the operation of the secondary relay 23 by way of conductor 70. At contact 71 relay 23 now short circuits the winding of the supervisory relay 20 and its shunt 22, thus removing its impedance from the talking circuit. The supervisory signal 18, which is controlled by this relay for calls local to the private branch exchange through conductor 72 and back contact 73 of relay 23, is now transferred at front contact 74 to conductor 75 and the back contact 76 of relay 31. Supervision at the private branch exchange is now dependent upon the lamp 19, supervisory lamp 18 being used to signal a ringing from the central station to the private branch exchange operator, as will later appear.

The operator now actuates the listening key 36 to associate her telephone set 35 with the cord C through conductors 77, 78 and 79. At the same time a contact 105 of the key closes a gap in the circuit of relay 42, including conductor 79, winding of repeating coil 37, conductor 104, transmitter of the operator's set 35, conductor 103 and retardation coil 43. Relay 42 disconnects the conductor 100 containing the back supervisory lamp 19 from the winding of the buzzer relay 28, and unites it at contact 108 to battery by way of conductor 109 and key 45. Therefore, with the listening key thrown the buzzer will not sound when the lamp 19 lights. A contact 80 of the key 36 completes a current path through conductor 81, winding of relay 26, lower low resistance

winding of relay 31, conductor 82 and front contact 83 of relay 30. Relay 31 extinguishes the lamp 18 by opening contact 76. At contact 84 of relay 31 and contact 85 of relay 26 a high impedance bridge of the cord circuit is completed. Starting at strand 67 this includes conductor 65, winding 32 of retardation coil I, make contact 86 of relay 30, contact 84 and upper high resistance winding of relay 31, contact 85 of relay 26, conductor 87, resting contact of key 47, conductor 88, retardation coil windings 34 and 33 and conductor 89 to strand 68. Relay 26 at contact 90 short circuits the shunt 25 of supervisory relay 21 leaving the low resistance 24 thereon, at this time, however, without useful result.

Upon the receipt of the calling subscriber's order the private branch exchange operator inserts the plug 17 in the jack 15 of the desired extension line 14. At the resting springs of the jack conductor 91 supplying current to the extension signal 14' is broken to prevent the latter from lighting. The back supervisory lamp 19 is illuminated by means of a circuit through the sleeve contacts of the jack 15 and plug 17, conductor 92', back contact 93 of supervisory relay 21, conductor 100, contact 108 of relay 42, conductor 109 and key 45. The operator now releases her key 36 and rings over the line 14 by means of the key 49. When contact 80 of the listening key is broken, the originating circuit of relays 26 and 31 is severed, the former releasing. Relay 31 is held up, however, by current from the central office battery *b* over the tip side of the trunk 11, tip contacts of the jack 10 and plug 16, upper resting contact of ringing key 48, strand 67 of the cord, conductor 65, retardation coil winding 32, contact 86 of relay 30, contact 84 of relay 31 and the upper high resistance winding thereof, contact 92 of relay 26, which makes before contact 85 breaks, cord strand 68, short circuit of supervisory relay 20 including contact 71 of relay 23, lower resting contact of key 48, ring contacts of the plug 16 and jack 10 and ring side of the trunk. It will be seen that there is now a relatively low impedance bridge across the cord, comprising winding 32 of the retardation coil and the upper winding of relay 31 in series. This serves to maintain a current path for holding the calling supervisory relay *r* at the central station energized, so that a disconnect signal shall not be given to the central station operator after the private branch exchange operator disconnects her set and before the extension subscriber removes the receiver from its hook. When the listening key 36 is actuated tripping current, to energize the relay *r'* at the central station and thus stop the automatic ringing, passes through the operator's set and high impedance bridge of the cord in parallel during



the silent interval. During the ringing interval the alternating current traverses the winding of relay 40 and condenser 41, causing said relay to close its contact 94 and short circuiting the high resistance winding 38 of retardation coil I'. The bridge containing the low resistance winding 39 of the coil I' will pass sufficient current to energize the tripping relay.

When the called subscriber at A takes down the receiver, the contacts of the switch hook permit the passage of current from the central station battery over the trunk 11, cord C and line 14 to energize the supervisory relay 21 in the cord strand 68. This breaking its contact 93 extinguishes the supervisory lamp 19. At front contact 95 relay 21 reenergizes relay 26, this circuit including sleeve contacts of jack 15 and plug 17, conductor 92', contact 95, winding of relay 26, lower low resistance winding of relay 31, conductor 82 and contact 83 of relay 30. The closure of contact 85 of relay 26 restores the high impedance bridge including the three windings of retardation coil I in series, while at contact 92 the low impedance bridge is opened. The high impedance bridge, though not appreciably affecting transmission, prevents the central office supervisory relay *r* from responding to rapid circuit changes produced at the extension subscriber's switch hook. As a result of this, the extension subscriber cannot flash the calling supervisory lamp at the central station and supervision over said subscriber is retained by the private branch exchange operator. Relay 26 at contact 90 also short circuits the high resistance shunt 25 of relay 21. The low resistance non-inductive shunt 24 remaining on relay 21 effectively passes voice currents, yet diverts sufficient steady current through the winding of the relay to hold its already attracted armature.

If the central station operator has occasion to rering when the connection is made through to the extension station and the receiver thereat is upon the hook, the ringer at A responds. Relay 31, at this time locked by central station battery *b* through its upper winding in the low impedance bridge, releases upon the application of ringing current or the removal of battery current by the withdrawal and reinsertion of plug *p* of cord *c*, and the front supervisory lamp 18 is lighted through its back contact 76, conductor 75, contact 74 of relay 23 and conductor 72. The private branch exchange operator is thereby informed that the central station operator is calling. If the extension subscriber answers, relay 31 is energized through the front contact of the back supervisory relay, as already described, and the supervisory lamps are extinguished. If the private branch exchange operator listens in

the lamp 18 is also extinguished, relay 31 being reenergized through the circuit already traced, including the contact 80 of key 36. If the extension subscriber cannot be obtained and the private branch exchange operator so desire, she may hold the trunk by leaving the front plug 16 in the trunk jack. The front supervisory lamp 18 will not be illuminated because its circuit is open at contact 76 of relay 31 energized by its upper winding in the low impedance bridge. If, however, the central station operator rering the lamp 18 will be lighted by the release of the relay.

At the completion of a conversation, the private branch exchange operator is informed of the fact by the lighting of the back supervisory lamp 19, when the subscriber at A, returning the receiver to its hook, severs the circuit of relay 21, so that the latter closes the circuit of lamp 19 at its contact 93. A signal is also given by the buzzer 72, since with the listening key 36 in its normal position, relay 42 is deenergized and the lamp conductor 100 is joined to the winding of the buzzer relay 28 at contact 101. The consequent withdrawal of the plugs 16 and 17 by the operator releases all the relays of the cord C and restores this portion of the private branch exchange system to normal.

In a call outgoing from an extension line to a central station, upon the closure of the switch hook contacts by a subscriber, as at A, current is supplied to the lamp 14' through the upper contact of jack 15, tip side of the line 14, the substation apparatus at A, ring side of the line, lower contact of jack 15, conductor 91, resting contact of key 44, conductor 102, winding of relay 28, conductor 106 and key 45. The private branch exchange operator responds to the illumination of the lamp and the sound of the buzzer 27 by inserting the plug 17 of one of the cords C in the jack. The contacts of the latter in the lamp circuit are separated, the lamp extinguished and relay 28 released. Back supervisory relay 21 attracts its armature, there being a path for current through the winding of this relay from battery 29 by way of back contact 63 of relay 30, conductor 65, winding 32 of the retardation coil I, strand 67 of the cord, upper resting contact of ringing key 49, tip contacts of the jack 15 and plug 17, over the line 14 through the contacts of switch hook at substation A, ring contacts of the plug and jack, lower ringing key contact, conductor 96, winding of relay 21 in parallel with the combined resistance of shunt 25—24, conductors 68 and 89, winding 33 of the retardation coil, conductor 66 and contact 64 of relay 30. Relay 21 opens the circuit of the back supervisory lamp 19. The operator actuates her listening key 36 and, upon receiving the



extension subscriber's order, places the front plug 16 in the trunk jack 10 and the line lamp 7 at the central station lights. From this point the operation of the system may be understood from the description of the incoming call already given.

In a call from one extension for another, as from substation A to substation A', the private branch exchange operator answers with the back plug 17 in the jack 15 as just stated, and the back supervisory lamp 19 is prevented from lighting in the same manner. The front supervisory lamp 18 now receives current over the sleeve contacts of jack 15 and plug 17, conductor 92', back contact 97 of supervisory relay 20, conductor 98, contact 73 of relay 23 and conductor 72. When the front plug 16 is inserted in the jack 15<sup>a</sup> of the wanted line the battery connection on its sleeve, being the reverse of that at the trunk jack, is not such as to energize relay 30, and since its contacts 69 and 83 are open, relays 23, 26 and 31 remain inert. Talking current is supplied by battery 29 through the contacts 63 and 64 of relay 30 and the windings 32 and 33 of retardation coil I. Supervision of the calling and called lines is by means of the back and front supervisory lamps 19 and 18, respectively, controlled by the relays 21 and 20, which are respectively shunted by the non-inductive resistances 24—25 and 22. In calls local to the private branch exchange the resistance of these shunts is not objectionable, as the demands of transmission are less severe than in trunk connections.

I claim as my invention:

1. A plurality of telephone lines, a link circuit for connecting said lines, a relay having its windings in the link circuit, a shunt normally across the winding of said relay, and means for placing a short circuit upon the shunt.

2. A plurality of telephone lines, a link circuit for connecting two of said lines, a supervisory relay for each of the connected lines, said relays having their windings in the link circuit, a shunt normally across the winding of each supervisory relay, and means for placing a short circuit upon each shunt.

3. The combination with a plurality of telephone lines, of a link circuit therefor, a relay having its winding in the link circuit, and means for short circuiting said winding upon the connection of the link circuit with a line.

4. The combination with a plurality of telephone lines, of a link circuit therefor, a relay having its winding in the link circuit, a relay energized upon the connection of the link circuit with a line, and a short circuit closed by the last-named relay about the first-named relay.

5. The combination with a plurality of telephone lines, of a link circuit therefor, a source of current normally joined to the link circuit, a supervisory relay having its winding in the link circuit, and a relay energized upon the connection of the link circuit to a line and acting to disconnect the current source from the link circuit and to alter the effect of the impedance of the supervisory relay in the link circuit.

6. The combination with a plurality of telephone lines, of a link circuit therefor, a supervisory relay having its winding in the link circuit, a primary relay energized upon connection of the link circuit to a line, and a secondary relay controlled by the primary relay and serving to alter the effect of the impedance of the supervisory relay in the link circuit.

7. The combination with a plurality of telephone lines, of a link circuit therefor, a supervisory relay having its winding in the link circuit, a shunt about the winding of the supervisory relay, and means for short circuiting a portion of the shunt upon the connection of the link circuit to a line.

8. The combination with a plurality of telephone lines, of a link circuit therefor, a supervisory relay having its winding in the link circuit, a shunt about the winding of the supervisory relay, a relay energized by the connection of the link circuit to a line, and a short circuit for a portion of the shunt controlled by the last-named relay.

9. In a private branch exchange system, a trunk line and an extension line, a link circuit for connecting the lines, a supervisory relay having its winding in the link circuit, and means for shunting the winding of the supervisory relay when the link circuit joins a trunk line and an extension line, said means being ineffective when two extension lines are thus joined.

10. In a private branch exchange system, a trunk line and an extension line, a link circuit for connecting the lines, a supervisory relay having its winding in the link circuit, a relay energized only when the link circuit is united with the trunk line, and means controlled by said relay for shunting the winding of the supervisory relay.

11. Calling and called telephone stations, a circuit connecting the same, a bridge across the circuit, and means for increasing the impedance of the bridge upon the removal from its hook of the receiver at the called station.

12. Calling and called telephone stations, a circuit connecting the same, operator's equipment temporarily associated with the circuit, a low impedance bridge across the circuit during the interval between the time of connection of the operator's equipment thereto and response of the called station,



and means for increasing the impedance of the bridge upon such response.

13. Calling and called telephone stations, a circuit connecting the same, a bridge across the circuit, a relay for varying the impedance of the bridge, and an energizing circuit for said relay controlled by the switch hook of the called station.

14. In a telephone system, calling and called lines, a link circuit connecting the lines, a bridge across the link circuit, a relay for varying the impedance of the bridge, and a supervisory relay associated with the link circuit and controlling the first-mentioned relay.

15. In a telephone system, calling and called lines, a link circuit connecting the lines, a bridge across the link circuit, a relay for varying the impedance of the bridge, a supervisory relay associated with the link circuit and controlling the first-mentioned relay, and a shunt of the supervisory relay controlled by said first-mentioned relay.

16. In a telephone system, calling and called lines, a link circuit connecting the lines, a contact device in the link circuit, a bridge across the link circuit, a relay for varying the impedance of the bridge, and circuits for energizing the relay controlled by one of the lines and by the contact device.

17. In a telephone system, calling and called lines, a link circuit connecting the lines, a listening key in the link circuit, a bridge across the link circuit, a relay for varying the impedance of the bridge, and circuits for energizing the relay controlled by the called line and by the listening key.

18. Calling and called telephone stations, a circuit for connecting the same, a plurality of relays associated with the circuit, a bridge of the circuit extending through contacts of the relays, and means for changing the condition of one of the relays and thereby varying the impedance of the bridge.

19. Calling and called telephone stations, a circuit for connecting the same, a plurality of relays associated with the circuit, and a bridge of the circuit extending through contacts of the relays and the winding of one of said relays.

20. In a telephone system, calling and called lines, a link circuit connecting the lines, a plurality of relays associated with the link circuit, a bridge of the link circuit extending through the relays, an energizing circuit for the relays local to the link circuit, and a locking circuit for one of the relays including one of the lines.

21. In a telephone system, calling and called lines, a link circuit connecting the lines, a plurality of relays associated with the link circuit, and a bridge of the link circuit extending through the contacts of a

plurality of the relays and a winding of one of the relays and serving as locking means for the relay whose winding is included therein.

22. In a private branch exchange system, a trunk line switch and extension line switches, a link circuit joining said switches, a bridge of the link circuit, means for varying the impedance of the bridge when connection is made to a trunk switch, and means for thereafter producing a further variation in the impedance.

23. In a private branch exchange system, a trunk line and an extension line, a link circuit connecting said lines and giving a path for current over the trunk line to the extension line, and a signal associated with the link circuit actuated upon the removal of current from the trunk line.

24. The combination with a central station, a trunk line, and a private branch exchange connected to said central station by the trunk line and having extension lines and a link circuit for joining the trunk and extension lines and supplying current from the trunk to the extension lines, of a relay associated with the link circuit and having its condition altered by the removal of current from the trunk line, and a signal governed by said relay.

25. The combination with a central station, a trunk line, and a private branch exchange connected to said central station by the trunk line and having extension lines and a link circuit for joining the trunk and extension lines, of a relay associated with the link circuit and energized by battery current from the central station over the trunk line and released upon the substitution of ringing current upon the trunk line, and a signal governed at a back contact of said relay.

26. In a telephone system, a central station, a private branch exchange having extension lines, a signal at the private branch exchange, a relay for governing the signal controlled by variations in current from the central station, and means associated with an extension line for also controlling the relay.

27. The combination with a central station, a trunk line, and a private branch exchange connected to said central station by the trunk line and having extension lines and a link circuit for joining the trunk line and extension lines, of a relay associated with the link circuit and energized by battery current from the central station over the trunk line and released by variations in current over the trunk line, a signal governed at a back contact of said relay, and a circuit for energizing the relay including an extension line.

28. The combination with a central sta-



tion, a trunk line, and a private branch exchange connected to said central station by the trunk line and having extension lines and a link circuit for joining the trunk and  
5 extension lines, of a relay associated with the link circuit and energized by battery current from the central station over the trunk line and released by variations in current over the trunk line, a signal governed at a  
10 back contact of said relay, and circuits for energizing the relay including an extension line and an element of the link circuit.

29. In a telephone exchange system, a plurality of link circuits each having a signal, an operator's telephone set, switching  
15 means associated with each link circuit for connecting the operator's set thereto, an auxiliary signal effective upon the operation of any one of the link circuit signals, and  
20 means for rendering the auxiliary signal ineffective upon the actuation of any one of the switching means.

30. In a telephone exchange system, the combination with a link circuit having a signal, an operator's telephone set and switching  
25 means for connecting said set with the

link circuit, of an auxiliary signal effective upon the operation of the first-mentioned signal, a relay controlling the auxiliary signal, and a circuit for the relay extending  
30 through contacts of the switching means and the operator's transmitter.

31. In a telephone exchange system, calling and called stations, a circuit for connecting said stations and including operator's  
35 switching means, line and supervisory visual signals associated with the circuit, an audible signal adapted for operation upon the display of any one of the signals, a relay through which the supervisory visual signal  
40 is associated with the audible signal, and an energizing circuit for the relay extending through the switching means.

In testimony whereof, I have signed my name to this specification in the presence of  
45 two subscribing witnesses, this 28th day of June, 1915.

HENRY M. BASCOM.

Witnesses:

WILLIAM H. HORNER,  
RICHARD A. HAISLIP.

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



It is hereby certified that in Letters Patent No. 1,175,112, granted March 14, 1916, upon the application of Henry M. Bascom, of Brooklyn, New York, for an improvement in "Telephone Systems," an error appears in the drawing requiring correction as follows, to wit: A connection should appear on the drawing between the armature of relay 21 and the conductor 92', the same having been erroneously omitted; and that the said Letters Patent should be read with this correction that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of June, A. D., 1916.

[SEAL.]

J. T. NEWTON,  
*Acting Commissioner of Patents.*