

999,729.

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TELEPHONE SYSTEM.

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To all whom it may concern:

Be it known that I, FRANK B. ALLEN, a citizen of the United States, residing at Elyria, in the county of Lorain and State of Ohio, have invented certain new and useful Improvements in Telephone Systems; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to telephone systems and more particularly to what are known as divided central or trunking systems. In such systems two central offices remote from each other are connected by a trunk circuit which, through an interposed central station circuit, is used to connect telephone lines terminating at the different central stations. The various operations which complete this connection are made by two operators, and are controlled by a system of signals which depend upon this operation and which, if followed, insure the success of the connections without inconvenient complications or unnecessary actions on the part of the operators.

My invention relates to such a system, and I endeavor to simplify the same by improving the system of signaling now in use. More particularly, I introduce apparatus and circuits so arranged and connected as to give a distinctive signal to both the calling subscriber and the central station at which his line terminates, whenever the called line to which the trunk circuit is connected, is already in use.

In systems of this character the central station at which the calling and call-initiating line terminates, is known as the A exchange and the end of the trunk circuit there, the outgoing end. The other end of the trunk is known as the incoming end, and the central station therein, the B exchange.

Other objects and purposes of my invention will be clear from the particular description. I have explained these as being the principal objects I intend to accomplish, but I do not desire to be limited thereby.

My invention will be best understood by reference to the following description when taken in connection with the accompanying illustration showing one specific embodi-

ment thereof, while its scope will be more particularly pointed out in the appended claims.

The figure is a diagram of the circuits and apparatus composing my invention in normal condition.

In the upper left hand corner I show a subscriber's line terminating in multiple jacks at the A exchange. At A I show a cord circuit terminating in plugs and adapted to connect the subscriber's line with a second line; or, as shown in the figure, a trunk circuit terminating upon the same board in a jack J^1 . At R and R^1 I show the line and cut-off relays of the subscriber's line; and at L, the line lamp. R^2, R^3, R^4 and R^5 are the supervisory relays controlling the supervisory lamps L^1 and L^2 . At P and P^1 I show the answering and calling plugs respectively. The functions of these parts will be clear from the description of the operation to be given later on.

The trunk line W extends from the A exchange where its outgoing end terminates in the jack J^1 , to a second or B exchange where its incoming end terminates in the plug P^2 . The trunk circuit is conductively separated and inductively connected at the induction coils I and I^1 , the windings of which are in each side of the trunk. The winding of the coil I and that of I^1 in each side of the trunk are separated by the condensers K^3 and K^4 interposed in the outgoing and incoming ends respectively.

At R^6 I show a trunk relay connected in the outgoing end side of the trunk in bridge of the condenser K^3 , and normally in circuit with the resistance X. At R^7 I show a subscriber's relay which is adapted to be controlled by the called subscriber or by an automatic circuit breaker.

L^3 is a combined guard and ringing lamp, which, in its guard capacity serves to indicate that the plug P^1 has been inserted into the jack J^1 , and, in its ringing capacity, serves to indicate to the B operator the response of the called subscriber to the calling signal.

L^4 is a disconnect lamp serving to apprise the B operator of the withdrawal of the plug P^1 from jack J^1 .

R^8 is a relay controlling circuits at the incoming end and which, for the sake of convenience, I call the terminal relay. R^9 is a

second relay controlling circuits of the same character which I call, for the sake of convenience, a second terminal relay.

R^{10} is a relay which, for the sake of convenience, I call the controlling relay and which is utilized for the purpose of making and interrupting the circuits during the connections.

R^{11} is a relay controlling the connections of the automatic busy test apparatus, and which I call, for the sake of convenience, the test relay.

R^{12} is a relay which controls the connection of the signaling current and which I call the signaling relay.

Y is a continuously rotating commutator which automatically makes and breaks the circuit of the signaling relay whereby the signaling source is alternately connected and disconnected from the line during such periods of time.

At M , M^1 , M^2 and M^3 I show sources of current which are adapted to produce currents of different distinctive characteristics to which the signal receiving device at stations on a party line are adapted to respond. N , N^1 , N^2 and N^3 are the ringing switches which are controlled by keys to connect these machines to the line.

N' and N'' are the master keys which are depressed each time any of the ringing springs N , N^1 , N^2 or N^3 is operated.

At Z I show a continuously operating circuit breaker consisting of a pendulum z which oscillates continuously making and breaking a circuit including the secondary of the induction coil I^2 . The primary of this induction coil is connected in circuit with a rheotome V . The pulsating current produced by this rheotome is interrupted at intervals by the interrupter Z , so that the current is imposed upon the line for certain intervals only.

On the right hand side of the figure I show a telephone line upon which there are four substations, which terminated at the B exchange in the multiple jacks J^2 . Each of the stations is provided with a signal device responsive to the particular character of current produced by one of the machines M , M^1 , M^2 , or M^3 . R^{13} and R^{14} are the cut-off and line relays respectively in this line, and L^5 , the line lamp thereof. Stations upon this line are indicated at D , D^1 , D^2 and D^3 .

The apparatus, the circuits and the functions of the same will be best understood by a description of the operation of the system.

The operation is as follows: Supposing the subscriber at the station C in the upper left hand corner desires to talk with the subscriber at the station D upon the line at the right of the figure. The subscriber at C removes the receiver E from the hook H , completing the following circuit: from posi-

tive side of B^{10} —1—2—3— H —transmitter T —4—5— R —back to B^{10} . This energizes the relay R which pulls up the armature 7 closing the switch 7—8 and completing a circuit through the lamp L as follows: positive side of B^{10} —9— L —8—7—back to B^{10} . This lights the lamp L . The A operator inserts the plug P into the jack J , completing a circuit from G^3 — B^1 —10— R^2 —11—12— R^1 —1—to ground at G . This energizes the relay R^1 which attracts its armatures 5 and 6 cutting off the line from the line relay and lamp and extinguishing the lamp. The relay R^2 is also energized, pulling up its armature 13 and closing the switch 13—14. This would cause the lighting of the lamp L^1 were not a circuit simultaneously made through the relay R^3 which pulls up its armature 15 breaking the circuit of the lamp L^1 at 15—16. The circuit through the relay R^3 is as follows: G^2 —winding of R^3 —17—18—19—21—2—3— H — T —4—22—23—24—25—winding of R^3 —26—battery B^1 —to ground. The A operator then throws her listening key which connects her head set (not shown) in circuit with the subscriber C at the switch 27—28. Having ascertained from this subscriber that the subscriber D is wanted, she calls up and communicates with the B exchange operator over a separate order wire (not shown), and having been informed that the trunk W is the one to be used, she immediately inserts the calling plug P^1 of her cord into the jack J^1 of the trunk W . In connections of this character the insertion of the plug at the outgoing end generally takes place before that at the incoming end, as the A operator is ready with the plug of her cord circuit when instructed to use a particular trunk. The insertion of the plug P^1 into the jack J^1 completes a circuit through R^4 as follows: G^3 —battery B^1 —29— R^4 —30—31—32—33—to ground G^7 . R^4 pulls up its armature 34 closing switch 34—35 and completing a circuit through the lamp L^2 as follows: G^4 — L^2 —36—37—35—34—29— B^1 —to ground G^3 . Over this the lamp L^2 is lighted. A second circuit is completed as follows: ground at G^5 —winding of relay R^5 —40—41—42—43— X —44— R^6 —45—46—47—48—49—50—51—52—winding of R^5 —53—battery B^1 —to ground G^3 . Owing to the presence of the resistance X in this circuit, the current flow therein is not sufficient to operate the relay R^5 , so that the lamp L^2 continues to burn after the completion of this circuit. The relay R^6 is operated pulling up its armature 60, closing the switch 60—61 and lighting the lamp L^3 over the following circuit; ground G^8 — B^3 —60—61—62—63—64— L^3 —to ground G^{10} . The operation of L^3 informs the B operator that the connection at the outgoing end has been made. She first tests the called line by applying the tip 62' of the plug P^2 to the ring

63' of the called line. If this line is busy, the ring will be at a potential above that of ground, and impulses of current will pass through 62'—64'—65'—66—67—68—69—
 5 70—71— to the contact 72 to which the test device is connected. Assuming that the line is idle, the B operator inserts the plug P² into jack J² and depresses the ringing key at N which is adapted to connect up the ma-
 10 chine M which we will assume produces a current of the character to which the bell S¹ at the station D, responds. At the operation of the spring N, the master spring N' and N'' are operated. A circuit is then com-
 15 pleted from ground G²⁰—73—R¹³—63'—79—75—R⁸—77—N'—B⁵—G¹⁵. This energizes the cut-off relay R¹³ which attracts its arma-
 20 tures 80 and 81, cutting off the called line from the line relay and signal. Relay R⁸ is energized, pulling up the armature 71 clos-
 ing the switch 71—74 and cutting off the test apparatus at 71—72. The armature 75 is attracted, closing the switch 75—76 and lock-
 25 ing the relay R⁸ upon battery B⁵, making the subsequent operation of the relay dependent upon the plug P². This relay also draws up the armature 77, closing the switch 77—78 in the circuit of the lamp L⁴. By this opera-
 30 tion the relay R¹⁰ is energized from G²⁰—73—R¹³—63'—79—75—80—81—82—83—R¹⁰—N''—84—85—86—87—B⁸— to ground G¹⁶. This pulls up the armature 88 opening the switch 88—89; armature 90 locking the relay R¹⁰ on the battery B⁷ by closing the
 35 switch 90—91 and pulling up the armature 92, closing the switch 92—93 in the circuit of the signaling relay R¹². If the contacting segment of the commutator Y is on, and, if not, as soon as it comes on, a circuit is com-
 40 pleted through the ringing relay R¹² as follows: G¹⁸—Y—94—93—92—95—R¹²—62—61—60—B³— to ground G⁸. This circuit, as described, is alternately made and broken by the commutator. The relay R¹² pulls up its
 45 armatures 64' and 96, interrupting the trunk circuit at 65' and 97, and closing the signaling circuit as follows: from ground G¹⁹ through M—N—98—99—96—100—101—102—S¹—K⁵—103—104—62'—64'—105—to
 50 ground G¹⁷. This operates the signal S¹, and the subscriber at D responds by removing the receiver E¹ from the hook H¹. As soon thereafter as the relay R¹² is deenergized by the advent of the insulation upon the commutator Y, a circuit is completed
 55 through the relay R⁷ as follows: G⁹—B⁴—winding of R⁷—110—111—112—113—97—96—100—101—102—E¹—114—H¹—T¹—103—104—62'—64'—65'—66—67—68—
 60 69—70—winding of R⁷—71—74—to ground G¹². The relay R⁷ is energized, pulling up the armature 115, closing a shunt 116 about the resistance X, removing this resistance from the circuit of the relay R⁵ which is
 65 energized, pulling up its armature 37 and

extinguishing the lamp L² which indicates to the A operator that the called subscriber has responded. The relay R⁷ also pulls up the armature 117, closing the switch 117—118 and completing a circuit through the
 70 relay R⁹ as follows: ground at G²¹—B⁵—75¹—76—R⁹—118—117—80—75—79—63'—73—to ground G²⁰. The relay R⁹ pulls up the armature 120, breaking the switch 120—121. The armature 63 is attracted, break-
 75 ing the circuit of the lamp L³ and extinguishing the same. The armature 82 is attracted, locking relay R⁹ through 81 and 80. R⁹ also draws up 82 breaking the circuit of R¹⁰ and disconnecting the ringing current
 80 from the line. The subscribers are now connected for conversation which takes place as follows: through transmitter T at station C—4—22—23—24—condenser K²—51—50—49—47—45— through the induction coils
 85 43—J¹ and P¹—K¹—18—19—21—2—E—3—H— back to T. These currents are induced into the other side of the trunk through the coils I and I¹. This side of the talking circuit is traced as follows: T¹—
 90 103—104—62'—64'—65'—66—67—68—69—through the windings of the coils I and I¹—110—111—112—113—97—96—100—101—102—E¹—114—H¹— back to T¹. When the conversation is completed the subscribers
 95 hang up their receivers, the circuit of the relay R³ is broken, the lamp L¹ lighted and the A operator pulls down plug P restoring the left hand portion of her cord to normal. The relay R⁷ is deenergized permitting the
 100 armature 115 to fall back breaking the shunt of the resistance X which causes the lamp L² to be lighted, whereupon the A operator pulls out the plug P¹, restoring the cord circuit to normal. The relay R⁶ is thus
 105 deenergized, allowing the armature 60 to fall back upon the contact 130, completing the following circuit: G⁸—B³—60—130—131—77—78—L⁴—G¹¹— lighting the lamp
 110 L⁴ which gives the disconnect signal and the B operator who immediately pulls out the plug P², interrupting the circuit of the relays R⁸ and R⁹ which restores the system to normal condition.

In the operation of systems of this char-
 115 acter the B operator will often fail to test the line before inserting the plug of the trunk into the jack of the called line; or, as is possible with my system, it may be in-
 120 tended that she shall connect without testing. Assuming that the line at the right hand side of the figure is busy, that is, that a plug of some cord circuit is inserted in one of the multiple jacks of the line and the
 125 B operator inserts the plug P² into the jack J². The ring 63' will be at a potential higher than ground, owing to the presence of the plug of the cord circuit in the multiple jack. Current will flow from 79—75—
 130 winding of R¹¹—135—89—88—121—120—

to ground G^{13} . The relay R^{11} will be energized pulling up its armatures 87, 68 and 111. The switch 86—87 is opened, preventing the making of a circuit through R^{10} when the master spring N'' is actuated. The armature 87 engages the front contact 136, completing a locking circuit through the relay R^{11} as follows: ground G^{16} — B^5 —87—136— R^{11} —75—79—63— R^{13} —73—to ground G^{20} . The trunk circuit is broken at 67—68, 111—112, and the vibrator Z connected in the trunk circuit at 111—137 and 68—138. The vibrator Z constantly opens and closes the switch 140—141, and a second switch 142—141. This second switch is closed before the first and opened thereafter. A condenser K^6 in a shunt 143 of the switch 140—141 is controlled by the latter contacts. The object of this is to take up the discharge of the circuit and prevent sparking at the contacts. The rheotome V is working constantly, putting a tone upon the secondary of the induction coil I^2 . This tone is constantly being interrupted by the vibrator Z so that short series of impulses only are placed upon the trunk circuit through the following connection: beginning at the contact 140—144—138—68—69—the primary of the coil I — K^4 —primary of the coil I^1 —110—111—137—145—secondary of induction coil I^2 —141. These impulses are induced into a circuit including the receiver E which consists of the following connections: beginning at K^3 —the secondary of the induction coil I^1 —45—46—47—49—50—51— K^2 —24—23—22—4— T — H —3—2—21—19—18— K^1 —41—42—43—secondary of the induction coil I . This apprises the subscriber at the station C of the fact that the called-for line is busy, whereupon he would return his receiver to the hook giving the disconnect signal to the A exchange. The B operator being unaware of the automatic busy signal, will depress the proper ringing key which operates the switch N' —77, completing a circuit through the relay R^8 , plug P^2 and jack J^2 , as already traced. The relay will lock itself on the battery B^5 and will close the switch 74—71. Each time the switch 140—141 is closed, the relay R^7 will be energized over the following circuit: ground G^9 —battery B^4 —winding of R^7 —110—111—137—145—141—140—144—138—68—69—70—winding of R^7 —71—74—ground G^{12} . Each time the circuit is made the shunt 116 of the resistance X will be closed and the relay R^5 operated, with the result that the lamp L^2 will be flashed before the A operator which is a signal to her that the called-for line is busy. She then pulls out the plug P^1 which will cause the actuation of the disconnect signal and the taking down of the connections at the B exchange. When the relay R^7 is first actuated, a circuit will be com-

pleted from the battery B^5 —relay R^9 —switch 118—117— P^2 — J^2 —to ground as previously described. This relay, when once actuated locks itself on the battery B^5 , retiring the ringing signal L^3 .

While I have shown circuits and apparatus of this particular arrangement, which is the one suggesting itself to me as being the most convenient, I do not desire to be bound thereto as it will be obvious to those skilled in the art that numerous and extensive departures from the form and details of the apparatus here shown, may be made without departing from the spirit of my invention, the same being herein shown solely for the purpose of clearly illustrating one specific embodiment thereof.

I claim—

1. In a telephone system, a plurality of telephone lines, circuit connections for connecting said lines together for conversational purposes, automatic means in said circuit connections for giving a busy back signal to the calling subscriber, electric switches for connecting said means to said circuit connections, said circuit connections being normally continuous through said switches and means for operating said switches to interrupt said circuit connections and connect said automatic means in circuit back of said interruption when said circuit connections are connected to a busy line.

2. In a telephone system, a plurality of telephone lines, a central station, a sub-central station, each of said lines terminating at one of said stations, a central station connection circuit, a trunk leading from one central station to the other, said central station connection circuit and said trunk adapted to coöperate to connect a calling and a called line, an automatic busy signaling means associated with said trunk, switches for connecting said means in circuit with said trunk, said trunk circuit normally continuous through said switches and means operating when said trunk is connected with a busy line, to interrupt said trunk circuit and connect said automatic means to signal the calling subscriber.

3. In a telephone system, the combination of a pair of central stations, a plurality of telephone lines each terminating at one of said central stations, a trunk line having an outgoing end at one central station, an incoming end at the other and extending between said stations, a signal at said incoming end serving as both guard and ringing signal, a ringing key and means for automatically retiring said signal when the trunk is connected with a busy line and said key is operated.

4. In a telephone system, the combination of a pair of central stations, a plurality of telephone lines each terminating at one of said central stations, a trunk line having an

outgoing end at one central station, an incoming end at the other and extending between said stations, a signal at said incoming end serving as both guard and ringing signal, a ringing key and an automatically actuated relay for automatically retiring said signal when the trunk is connected with a busy line and said key is operated.

5. In a telephone system, the combination of a pair of central stations, a plurality of telephone lines each terminating at one of said central stations, a trunk line having its outgoing end at one of said stations, its incoming end at the other and extending between said stations, a lamp serving both as a guard and a ringing signal in the incoming end, a relay at said end controlling the operation of said signal and an automatically operating circuit maker controlling said relay, said controlling apparatus adapted to retire said signal when said trunk is connected with a busy line.

6. In a telephone system, a plurality of telephone lines, a central station, a link conductor thereat, a sub-central station, each of said lines terminating at one of said central stations, a trunk circuit connecting said central stations, a supervisory relay at said central station associated with said link conductor adapted to be connected in circuit with said trunk, a resistance in said trunk governing the operation of said relay, means in said trunk circuit adapted to change the association of said resistance with said trunk when the trunk is connected with a busy line, whereby said supervisory signal is governed to indicate said busy condition at the central station.

7. In a telephone system, a plurality of telephone lines, a central station, a sub-central station, each of said lines terminating at one of said central stations, a trunk circuit connecting said central stations, a supervisory signal at said central station, a resistance device associated with said trunk governing the operation of said supervisory signal, a relay associated with said trunk controlling the association of said resistance device with said trunk, a circuit for said relay, an automatic device for making and breaking the circuit through said relay when said trunk is connected to a busy line, said relay changing the association of said resistance device with each operation whereby said supervisory signal is operated to give the busy signal to the central station.

8. In a telephone system, a plurality of telephone lines terminating at central stations, a trunk circuit connecting said stations terminating in a plug, jacks for said telephone lines, an automatic busy signaling means associated with said trunk but normally disconnected therefrom, a relay adapted to connect said means in circuit

with said trunk to signal a calling subscriber when the plug of the trunk is inserted into the jack of a busy line and a supervisory signal at said central station controlled by said automatic means to indicate said busy condition to the main operator.

9. In a telephone system, a plurality of telephone lines terminating at central stations, a trunk circuit extending between said central stations adapted to connect said telephone lines for conversation, a signaling switch associated with said trunk circuit, a switch for connecting said trunk to a called line, an automatic signaling means adapted to signal the calling subscriber when said trunk is connected with a busy line, a supervisory signal associated with one of said central stations adapted to indicate the busy condition of the called line to the operator at that central station, said supervisory relay controlled to give said signal by the automatic means and the signaling switch jointly.

10. In a telephone system, a main central station, a sub-central station, a plurality of lines each terminating at one of said stations, a trunk circuit connecting said central stations, a supervisory signal associated with said main central station and adapted to be controlled over said trunk, a relay in said trunk controlling the operation of said signal, a circuit for said relay, a signaling switch controlling the circuit of said relay, an automatic current interrupter normally disconnected from said relay circuit, and a second relay adapted to connect said interrupter in circuit with said signal controlling relay when the trunk circuit is connected with a busy line.

11. In a telephone system, the combination of two central stations, a plurality of subscribers lines each terminating at one of said stations, a trunk line having an outgoing end at one of said central stations, an incoming end at the other and extending therebetween, a signal at the incoming end serving as both a guard and a ringing signal and means acting automatically when the trunk is connected to a busy line to prevent said signal performing the latter function.

12. In a telephone system, the combination of a main central station, telephone lines terminating thereat, a sub-central station, telephone lines terminating thereat, a trunk circuit having an outgoing end at said main central station, an incoming end at the sub-central station and extending therebetween, a signal at the incoming end serving both as a guard and a ringing signal, said signal operated when said trunk is connected in a circuit at the main station and means to prevent said signal serving the function of indicating the ringing connection when the trunk is connected to a busy line.

13. In a telephone system, the combination of a pair of central stations, a plurality of telephone lines each terminating at one of said central stations, a trunk circuit
5 extending between said central stations, switches at the central station for connecting said trunk in conversational relation with said telephone lines, an automatic device for signaling a calling line when said
10 trunk is connected in conversational relation with a busy called line, and locking means for maintaining said connection until such relation is disturbed.

14. In a telephone system, the combination of a central station, a sub-central station, telephone lines terminating at each, circuit connections extending between said central stations adapted to connect a line terminating at each said central stations in conversational relation, an automatic signaling
20 device associated with said circuit connections, means in said circuit connections for connecting said automatic device in said circuit connections when a calling line is connected in conversational relation with a busy
25 line and locking means for maintaining such connection.

15. In a telephone system, the combination of a central station, a sub-central station, subscribers' lines terminating at each of said stations, a trunk line extending between said central station adapted to connect telephone lines in conversational relation, a
30 switch at one end of said trunk for connecting said trunk to a called line, means for automatically signaling the calling line when

said switch is operated to connect it in conversational relation with a busy line, and means for maintaining said automatic signaling until said switch is restored.

16. In a telephone system, the combination of a central station, a sub-central station, telephone lines terminating thereat, a trunk circuit extending between said stations and adapted to connect telephone lines thereat in conversational relation, a switch at said
40 sub-central station adapted to connect said trunk with a called line, an automatic busy signal device associated with said trunk circuit, a relay adapted to connect said automatic device in said trunk when said switch
45 is fully operated, and a locking circuit for said relay.

17. In a telephone system, the combination of a central station, a sub-central station, telephone lines terminating thereat, a
50 trunk circuit extending therebetween, a switch at one end of said trunk adapted to connect it with a called line, means associated with said trunk for signaling the called subscriber when the trunk is connected
55 with a busy line, a relay for connecting said signaling means in said trunk when the switch is operated to connect the trunk with a busy line, and a locking circuit for said relay controlled by said switch. 65

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

FRANK B. ALLEN.

Witnesses:

F. O. RICHEY,
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