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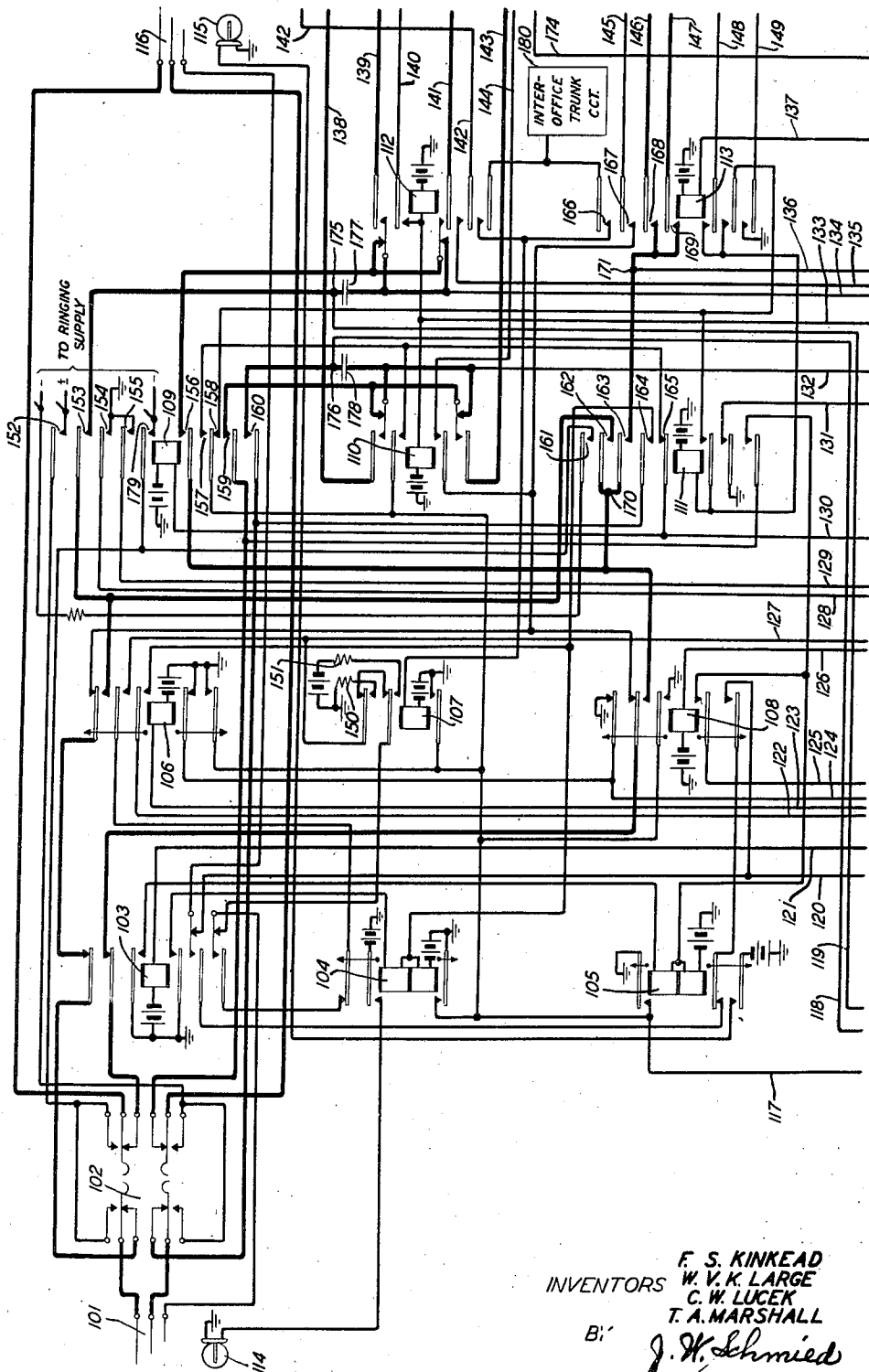
2,306,701

COMBINED TELEPHONE AND TELEGRAPH CORD AND ATTENDANTS' CIRCUITS

Filed June 20, 1941

4 Sheets-Sheet 1

FIG. 1



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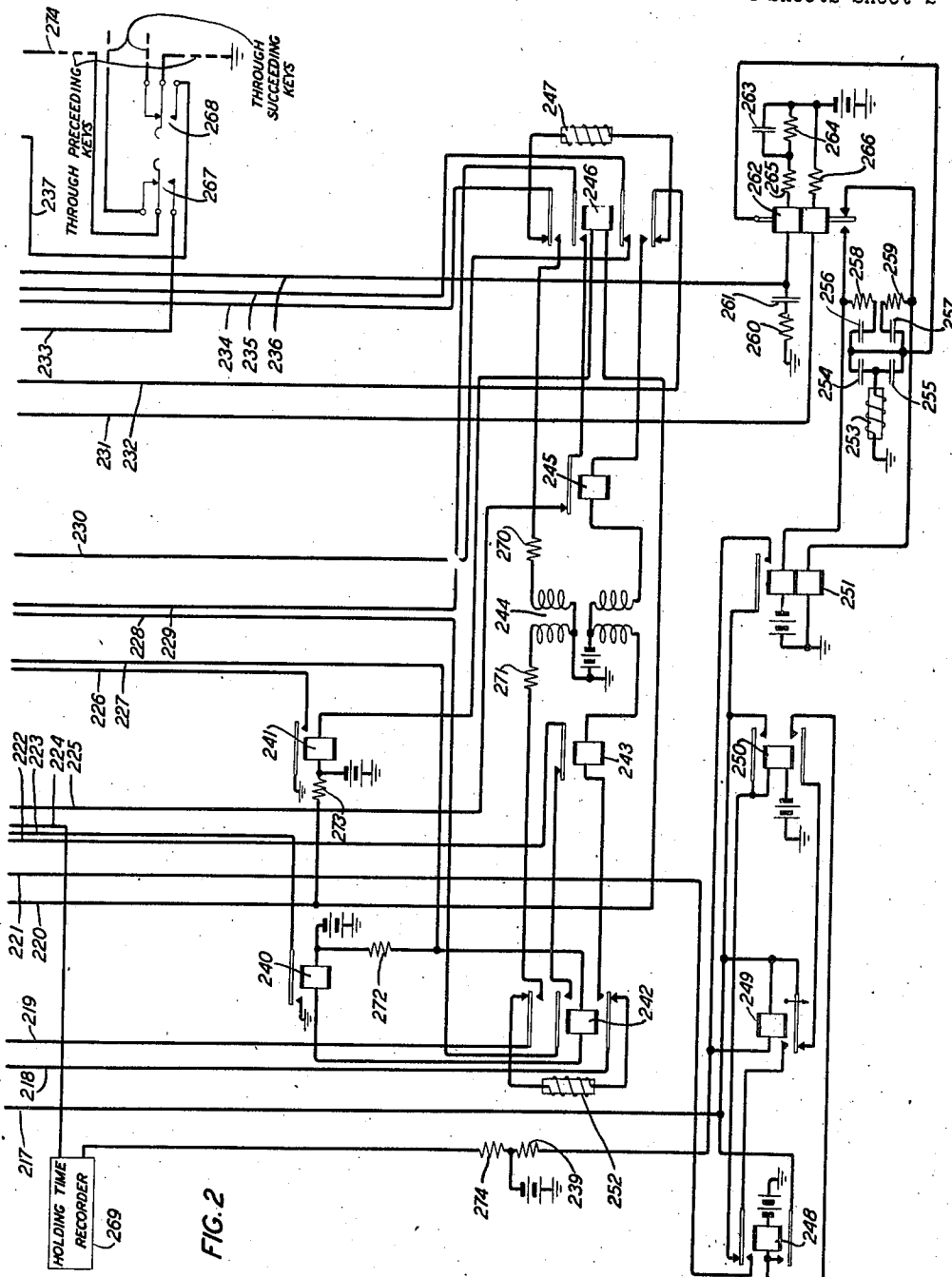
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4 Sheets-Sheet 2



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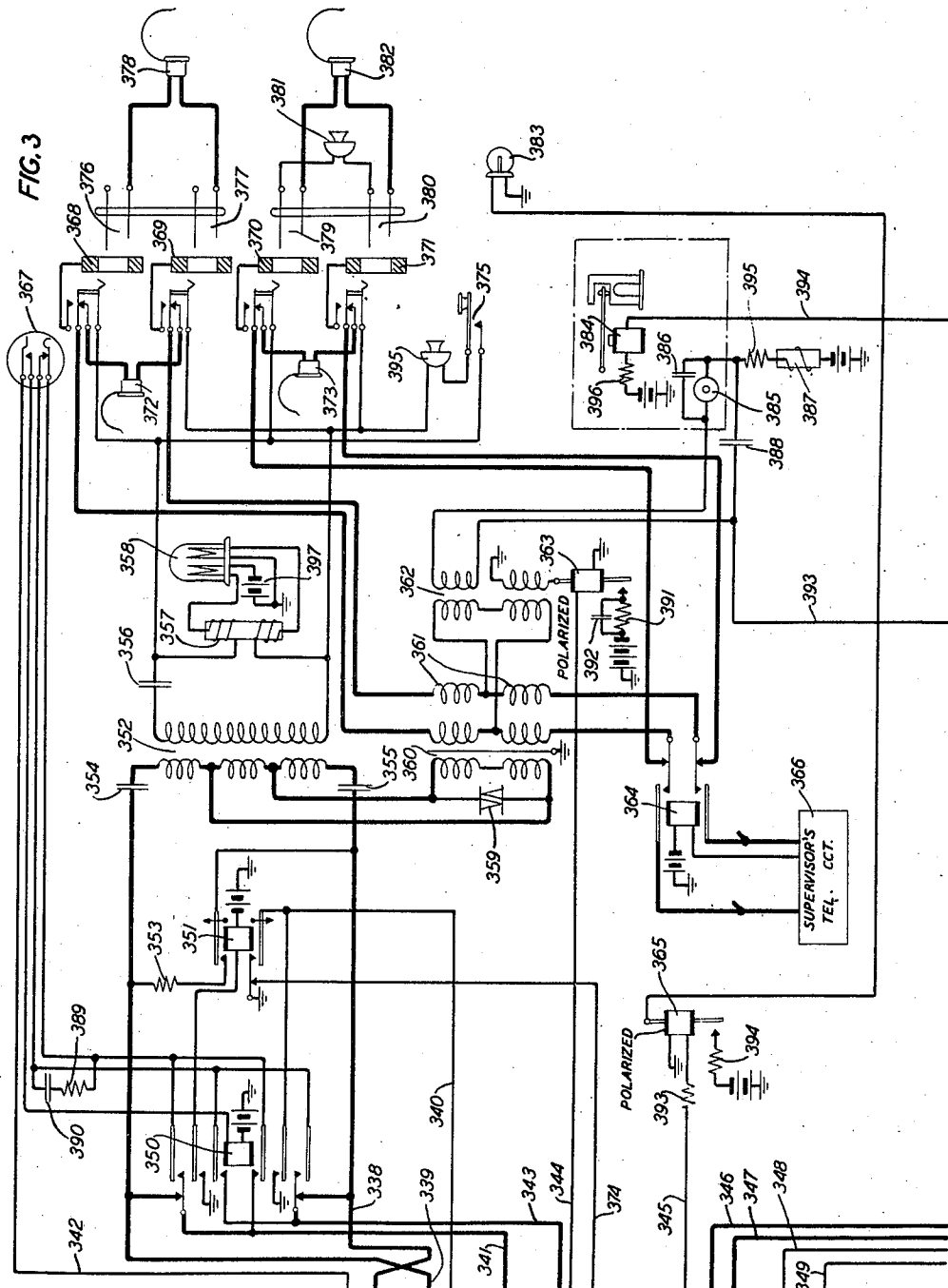
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4 Sheets-Sheet 4

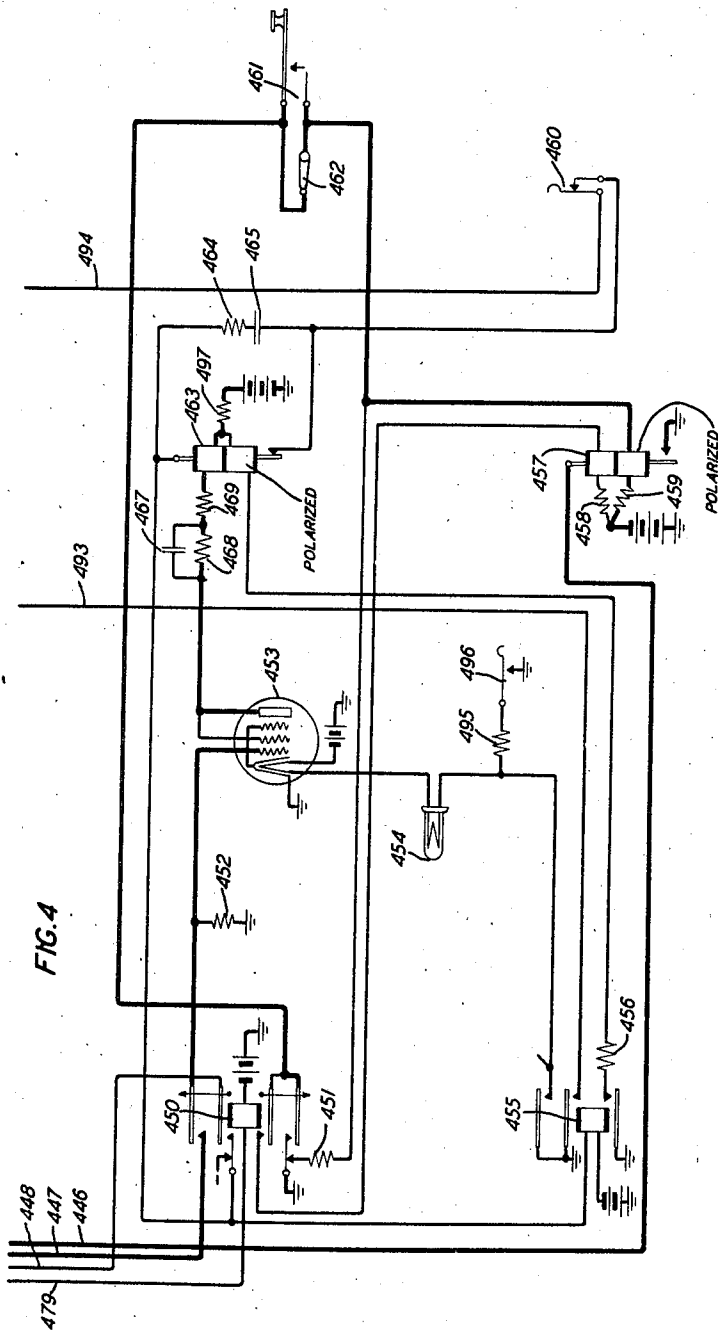


FIG. 4

FIG. 5

FIG. 1	FIG. 3
FIG. 2	FIG. 4

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UNITED STATES PATENT OFFICE

2,306,701

COMBINED TELEPHONE AND TELEGRAPH
CORD AND ATTENDANTS' CIRCUITS

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13 Claims. (Cl. 179—4)

This invention relates to communication systems, particularly to a telegraph system which includes complementary telephone facilities. More particularly, this invention relates to a combined telegraph and telephone cord circuit together with cooperating attendant's telegraph and telephone set circuits.

In the operation of certain telegraph switchboards, it has been found necessary to provide, in addition to means for interconnecting the various telegraph facilities, means for interconnecting various telephone facilities which are terminated in the same board. These telephone facilities are required to complement the telegraph facilities, generally for maintenance purposes. In the operation of certain telegraph concentration boards where private telegraph line networks are built up, the total number of complementary telephone circuits required is sometimes considerable. If sufficient telegraph cord circuits are furnished to care for the total number of telegraph interconnections that may be required at a particular time at a particular position and, in addition, sufficient telephone cord circuits are furnished to care for the total number of telephone interconnections that may be required at another time at the same position, the aggregate of telegraph and telephone cord circuits required will be greater than if cords arranged to perform both functions are furnished.

Certain cord circuits are presently available for interconnecting both telegraph and telephone circuits and for permitting an attendant's telegraph set or an attendant's telephone set to be interconnected through the combined cord. A form of telegraph transmission, known as inverse neutral telegraph repeater transmission, has recently been incorporated widely into the telegraph plant. It is used more generally in interconnecting private telegraph networks at telegraph boards known as concentration boards. Such systems are described in a pending application Serial No. 362,548, filed October 24, 1940, by Bonorden et al. The presently known combined telephone and telegraph cord circuits are not suitable for use with telegraph circuits equipped with inverse neutral telegraph repeaters. The circuits of the present invention are arranged to cooperate with inverse neutral telegraph repeater circuits.

An object of this invention is the improvement of circuits designed to cooperate both with telephone and telegraph circuits.

A feature of this invention is a combined telephone and telegraph cord circuit arranged to

cooperate with telegraph circuits equipped with inverse neutral telegraph repeaters.

A further feature of this invention is a combined telegraph and telephone cord circuit which may be used for either telegraph or telephone connections and which, when conditioned for either telegraph or telephone operation by connection to either a telegraph or telephone trunk, will remain so conditioned until taken down.

A further feature of this invention is an arrangement which provides for originating or answering calls on interoffice telegraph or telephone trunks.

A further feature of this invention is an arrangement which provides for the immediate release of the circuits herein from an interoffice telegraph trunk to which it may be connected upon receipt of a disconnect signal even though the plug of the cord circuit herein remains connected to the trunk.

A further feature is an arrangement in the combined cord which cooperates with facilities in an interoffice trunk to which the cord may be connected so as to transfer the line calling signal of the interoffice trunk to another position in the switchboard.

A further feature is an arrangement in the combined cord which provides for supplying talking battery from the combined cord to the telephone circuit in the cord for one condition where-in talking battery is required and which establishes a talking circuit without supplying talking battery from the cord to the telephone circuit in the cord when talking battery is supplied to the telephone circuit from the facility to which the cord is connected.

These and other features will be understood from reference to the drawings forming part of this application in which:

Fig. 1 is the upper portion of a combined telephone and telegraph cord circuit;

Fig. 2 is the lower portion of a combined telephone and telegraph cord circuit;

Fig. 3 is an attendant's telephone set which may be selectively connected to any of a plurality of cords per Fig. 1 and Fig. 2;

Fig. 4 is the attendant's telegraph set which may be selectively connected to any of a plurality of cords per Fig. 1 and Fig. 2; and,

Fig. 5 is a block diagram showing the manner in which Figs. 1, 2, 3 and 4 should be arranged, each in relation to the other, so as to conform to the following description.

Attention is called to the fact that in order to readily locate apparatus in the following descrip-

tion, apparatus shown in Fig. 1 is numbered in the hundreds series, apparatus shown in Figs. 2, 3, and 4 are numbered in the two hundreds, three hundreds and four hundreds series, respectively. In tracing the various circuits, it will be observed, in the case of conductors which extend from one figure into an adjoining figure, the conductor is numbered in the hundreds series corresponding to the figure in which it is shown. When it extends into an adjoining figure, it retains the last two digits while the first digit is changed to correspond to that of the number of the figure through which it is extended.

General

The combined cord circuit is shown on Fig. 1 and Fig. 2. As indicated in the block diagram per Fig. 5, Fig. 1 should be located above Fig. 2. The conductors shown extending to the bottom margin of Fig. 1 connect to conductors extending to the upper margin of Fig. 2 in corresponding positions. Fig. 1 and Fig. 2 together constitute one combined telephone and telegraph cord circuit. An assortment of cord circuits of various kinds and a number of combined cords, such as in Fig. 1 and Fig. 2, will be located at a particular position in a communication switchboard in which telegraph and telephone lines and trunks are terminated in jacks. Any one of the combined telephone and telegraph cord circuit per Fig. 1 and Fig. 2 may be used at one time to interconnect two telegraph circuits, each of which has a jack termination at the same position where the combined cord is located. The combined cord per Fig. 1 and Fig. 2 may be used at another time to interconnect two telephone circuits, each of which has a jack termination at the position where the combined cord is located. The primary function of the combined cord is to flexibly interconnect either two telephone circuits or two telegraph circuits, so that parties connected to the remote ends of said circuits may communicate with each other. In order to permit the flexible connection of any calling party connected to the remote end of a telephone circuit, or a telegraph circuit, having terminations at the particular position where the combined cord is located, means are provided to enable an attendant who administers the circuits at a particular position to connect an attendant's telephone circuit or an attendant's telegraph circuit to the cord, so that the attendant may communicate with a calling party by either of these facilities, depending upon whether the calling circuit is a telephone or telegraph circuit. The attendant communicates with the calling party, receives information necessary to enable her to complete or extend the call and thereupon completes or extends the call. Having performed this function, the attendant will disconnect the attendant's telephone circuit or the attendant's telegraph circuit from the cord and communication may then proceed between the calling and called telephone or telegraph circuits, with the cord circuit serving as a flexible connecting telephone or telegraph link between the calling and called lines.

The cord circuit, in order to provide efficient service, must be arranged to provide supervisory signals to attract the attention of the operator administering the circuits at a particular position. The circuits of the invention herein are, therefore, arranged to provide supervisory signals under the control of the telephone or tele-

graph circuits to which the combined cord circuit per Fig. 1 and Fig. 2 may be connected.

The telegraph circuits with which the combined cord per Fig. 1 and Fig. 2 is arranged to cooperate are equipped with inverse neutral telegraph repeaters. These facilities are well known in the art and are described in the application per Serial No. 362,548 mentioned above. In order to permit cooperation of the combined cord with such circuits the attendant's telegraph set circuit per Fig. 4 is arranged to transmit and receive inverse neutral telegraph signals.

An inverse neutral telegraph repeater is a repeater arranged to supply inverse neutral signals.

Neutral telegraph signals, as generally understood in the art, are closed-circuit and open-circuit direct current signals or current and no-current signals. In neutral signaling the closed or current condition is the marking condition and the open or no-current condition is the spacing condition. Inverse neutral signals, in accordance with this specification, are also closed-circuit and open-circuit direct current signals or current and no-current signals and therefore neutral signals, but they are inverted in that the marking signal in a no-current signal and the spacing signal is a current signal, hence, the term inverse neutral signals. When the circuit is in the normal condition, that is, conditioned for communication, which is the marking condition, no current flows. When a spacing signal is transmitted current flows.

Inverse neutral repeaters may be arranged only to transmit inverse signals or to both transmit and receive inverse neutral signals. The latter type are frequently arranged to form branches of an inverse neutral hub circuit. The form which transmits only is an inverse neutral repeater arranged to be controlled on the incoming side of the repeater by signals of any sort and to transmit inverse neutral signals on the outgoing side. The form which both transmits and receives is an inverse neutral repeater which, in addition to the foregoing, can be controlled in the converse direction by signals from another inverse neutral signal source and relay signals in response thereto reversely in any form. An inverse neutral repeater hub circuit is a group of inverse neutral repeaters interconnected through a common neutral point, known as the hub. Any branch in the hub can transmit simultaneously to all other branches. No current flows in any branch for marking. Current flows in all branches for spacing. Each individual branch of the hub comprises a relay which receives signals of any sort from an incoming connected circuit and transmits inverse neutral signals through the hub to all other connected branches. Each branch of the hub also comprises a receiving relay which receives inverse neutral signals from all other branches connected to the hub and in response thereto transmits signals of any sort to an outgoing circuit to which the receiving relay is connected.

The attendant's telegraph set circuit per Fig. 4 herein is arranged to transmit to and receive from circuits each of which is equipped with an inverse neutral repeater. Connections to circuits equipped with inverse neutral repeaters are established through the cord circuit per Figs. 1 and 2 by means of plugs 101 or 116.

As will be made apparent below, the tip of each plug may be connected to the grid of tube 453 and the armature of relay 457 when the circuits herein are arranged for telegraph commu-

nication. In receiving, negative battery is connected from the inverse neutral repeaters in the circuit to which the tip conductors of plugs 101 and 116 may be connected, to the grid of tube 453. No current flows through the tube or through the top or line winding of relay 463 for the marking condition. For the spacing condition, positive battery is connected from the inverse neutral repeater to the grid of tube 453 and current flows in the tube and through the top winding of relay 463, operating its armature to the left against the influence of current in its bottom or biasing winding. Thus relay 463 will receive signals transmitted from inverse neutral repeaters to which plugs 101 or 116 may be connected.

Relay 457 in Fig. 4 which is under control of key 461, is arranged to transmit signals to circuits equipped with inverse neutral repeaters to which plugs 101 and 116 in Fig. 1 may be connected. The armature of transmitting relay 457 is connected to the tips of plugs 101 and 116. For the marking condition, the transmitting conductors of the circuits which may be connected to the tips of plugs 101 or 116 each extend through the winding of a receiving relay and the armature of a transmitting relay to a contact to which negative battery is connected. The armature of transmitting relay 457 in Fig. 4 is actuated to its left by its biasing circuit and is therefore open-circuited. No current flows. For the spacing condition, the armature of relay 457 will be actuated by the operation of key 461 to engage its right-hand contact which is grounded. Current will flow in each inverse neutral repeater circuit which may be connected to plugs 101 or 116 from the negative battery connected to the marking contact and armature in each inverse neutral repeater through the winding of the receiving relay in each repeater to the ground on the right-hand contact of relay 457. The receiving relay in each connected circuit will be operated. Thus signals may be transmitted from relay 457 in Fig. 4 to circuits equipped with inverse neutral repeaters to which plugs 101 and 116 in Fig. 1 may be connected.

The combined cord circuit per Fig. 1 and Fig. 2 is arranged for automatic disconnect. That is to say, the circuit is arranged so that on a telegraph connection, after the reception of a disconnect signal, the telegraph circuits with which the combined cord cooperates are released, so that they become available for use at other positions in the switchboard to which the telegraph circuit is multiplied, without the necessity of waiting until the cord circuit is disconnected from the telegraph circuit.

As has been mentioned above, a plurality of cord circuits are located in each switchboard position, while only one attendant's telephone set circuit and one attendant's telegraph set circuit is located at each position. The attendant's telephone set circuit or the attendant's telegraph set circuit is selectively connected, manually, to a particular cord, when the cord is selected for use. The combined cord circuit of the invention herein is arranged by means of a chain circuit so that it is impossible to connect the single attendant's telephone set circuit or the single attendant's telegraph set circuit, located at a particular position, to more than one cord circuit at any one time.

It is to be understood that the combined cord circuit per Fig. 1 and Fig. 2 connects to various telegraph and telephone facilities. These facilities

are not shown herein as they are not necessary to an understanding of the present invention. The conditions present on the various conductors in the facilities to which plugs 101 and 116 are connectable will be described only in so far as they are necessary to an understanding of the operation of the circuits herein.

TELEGRAPH OPERATION

Connection to interoffice telegraph trunk

The manner in which the combined cord circuit per Fig. 1 and Fig. 2 cooperates with a calling and called telegraph line to permit telegraph communication between them will first be described.

In response to a signal indicating that a telegraph line is calling, plug 101 will be inserted into the jack of the calling line, not shown, and the armature of key 268 will be actuated so as to engage with its front contact, to connect the single attendant's telegraph set circuit to the cord which has been selected.

As has been mentioned above, there are a number of cord circuits, such as Fig. 1 and Fig. 2, as well as other cord circuits at each operator's position, while there is but one attendant's telephone set circuit per Fig. 3 and one attendant's telegraph set circuit per Fig. 4 at each position. The combined cord circuits per Fig. 1 and Fig. 2, as well as cords of other kinds which may be located at the same position, are arranged so that the attendant's telephone set circuit per Fig. 3 or the attendant's telegraph set circuit per Fig. 4 may be connected to but one cord at any one time. In order to prevent the connection of either of these circuits to more than one cord at a particular time, the keys, such as keys 268 and 267 in each cord, are arranged so that ground is supplied in sequence, when the keys are in their normal positions, through a chain circuit extending through the armatures and back contacts of the keys, such as 268 or 267 in the various cords. When these keys are in their normal positions, ground is connected, therefore, through the armature and back contact of the first key, thence through the armature and back contacts of each succeeding key. If the armature of any key is operated to engage with its corresponding front contact, ground will be supplied over a circuit which extends through the armature and front contact of the operated key to the winding of a relay, such as relay 113, to battery. The operation of the relay such as relay 113 will connect the single attendant's telegraph set circuit to the particular cord. If any preceding key in the chain is actuated so that its armature engages its corresponding front contact, it will not be possible to operate the relay such as relay 113 in a cord in a succeeding position in the chain, as ground will have been disconnected from the armature of the key such as key 268 in the position succeeding that in which the key 268 has been operated.

Key 267, which controls the operation of relays 110 and 112, which in turn control the connection of the individual telephone circuit to a particular cord, is arranged in the same manner, so that it is not possible to connect the individual telephone set circuit to more than one cord at any one time.

It will be assumed that no key corresponding to key 263 in any cord arranged in a preceding position in the chain circuit is operated, so that ground extends to the armature of key 263 in the particular combined cord represented by Fig. 1 and Fig. 2.

When the armature of key 263 is actuated so

as to engage its lower contact, a circuit may be traced from ground, through the armature and front contact of key 268, conductor 237, into Fig. 1, where it extends through conductor 137 and the winding of relay 113 to battery, operating relay 113. The operation of relay 113 connects the attendant's telegraph set per Fig. 4 to the combined cord circuit per Fig. 1 and Fig. 2.

If plug 101 has been connected to the jack of an interoffice telegraph trunk, the sleeve of plug 101 meets ground on the sleeve of the trunk. A circuit may then be traced from ground which extends through the sleeve of plug 101, the continuity contacts associated with the bottom outermost armature of relay 103, top inner armature and back contact of relay 107, top outer back contact and armature of relay 107, conductor 127 and conductor 227 to a two-branch parallel circuit. The first branch of said parallel circuit extends through resistance 272 to battery. The second branch of said parallel circuit extends in series through the windings of relays 242 and 240 to battery.

The combined cord circuit, per Figs. 1 and 2, cooperates with a number of different connecting circuits. The combined cord is arranged to function in different manners depending upon the circuit to which it may be connected. The manner in which discrimination is achieved is by connecting resistances of different magnitudes in the sleeve circuits of the various circuits with which the combined cord cooperates. When the combined cord is connected to an interoffice telegraph trunk, the magnitude of the resistance in the sleeve circuit of the trunk is high. Under these circumstances, the magnitude of the current flowing through the windings of relays 242 and 240, while sufficient to operate relay 240, is insufficient to operate relay 242. The operation of relay 240 establishes a circuit from ground through the front contact and armature of relay 240, conductor 223, conductor 123 and the winding of relay 106 to battery, operating relay 106. The operation of relay 106 disconnects the tip of plug 101 from the path to the busy test circuit, which will be described below, and extends the tip circuit, which is the telegraph transmission circuit, towards the attendant's telegraph set circuit. This path will be traced in detail hereunder. The operation of relay 106 establishes a circuit from ground through the bottom outer front contact and armature of relay 106, through conductor 117, conductor 217, winding of relay 249 and resistance 239 to battery, operating relay 249. The operation of relay 249 establishes a circuit which may be traced from battery through the winding of relay 250, top back contact and armature of relay 248, front contact and armature of relay 249, conductor 217, conductor 117 and through the bottom outer armature and front contact of relay 106 to ground, operating relay 250. When relay 250 operates, it locks through its top armature and front contact to ground, connected through the bottom outer front contact and armature of relay 106.

When relay 113 operated, a circuit was established from battery through the winding of relay 111, bottom middle front contact and armature of relay 113, contacts 158 of relay 109 and the bottom outer armature and front contact of relay 106 to ground, operating relay 111. When relay 111 operates, it locks through its bottom innermost armature and front contact, contacts 158 of relay 109 and the bottom outer armature and front contact of relay 106 to ground. The

operation of relay 113 established a circuit from ground through the bottom outermost front contact and armature of relay 113, conductor 149, conductor 349, conductor 449 and the winding of relay 450 to battery, operating relay 450.

When it is expected that the telegraph circuit, per Fig. 4, will be used, preparation for its use is made by actuating the armature of key 496 to engage with its front contact. This establishes a circuit which extends from ground through the front contact and armature of key 496, resistance 495, filament of lamp 454, and the filament of vacuum tube 453 to battery. This permits a current of low magnitude to flow through the filament of vacuum tube 453 and adjusts the temperature to such a level that the vacuum tube may be brought to almost instant readiness through the operation of relay 455, which connects ground directly to the filament of lamp 454, short-circuiting resistance 495. The operation of relay 450 establishes a circuit which extends from ground through the bottom outer front contact and armature of relay 106, contacts 158 of relay 109, bottom middle armature and front contact of relay 113, bottom innermost front contact and armature of relay 113, conductor 149, conductor 349, conductor 448, top inner armature and front contact of relay 450 and the winding of relay 455 to battery, operating relay 455. This establishes the direct heating circuit for the filament of vacuum tube 453, as described above, at the top outer armature and front contact of relay 455. The operation of relay 455 also establishes a biasing circuit, which extends from ground through the bottom armature and front contact of relay 455, resistance 456, bottom winding of relay 463 and resistance 497 to battery. This causes a current of low value to flow through the bottom winding of relay 463. The effect of this current is to tend to actuate the armature of relay 463 to engage with its right-hand or marking contact. It is effective when the top winding is not energized by the spacing current in the manner to be described below. The operation of relay 455 also establishes a circuit from ground through the top inner armature and front contact of relay 455, conductor 493, conductor 393, top right-hand winding of repeating coil 362, winding of receiving magnet 385, resistance 395, and inductance coil 387 to battery, energizing the receiver 385.

Before relay 450 is operated a circuit may be traced from ground through resistance 451, bottom winding of relay 457 and resistance 459 to battery. The effect of this current tends to actuate the armature of relay 457 toward the left. This effect is unopposed during the idle period so that the armature of relay 457 is maintained in its left-hand position to prevent the connection of ground to the armature. The reason for this will become apparent below.

A circuit may be traced from the tip of plug 101, which is connected to the jack of the interoffice trunk, through the left-hand top armature and back contact of key 102, top outermost armature and back contact of relay 103, top outermost armature and front contact of relay 108, contacts 162 of relay 111 and contacts 163 of relay 111 to a two-branch parallel circuit. The first branch of the parallel circuit extends through contact 168 of relay 113, conductor 146, conductor 345, conductor 446 to the armature of polarized relay 457. The armature of relay 457 is normally disengaged from its right-hand contact. The second branch of the parallel circuit extends through contacts 169 of relay 113, conductor 147, con-

ductor 347, conductor 447, top outer front contact and armature of relay 450 to a two-branch parallel circuit. The first branch of the parallel circuit extends through resistance 452 to ground. The second branch extends to the control grid of vacuum tube 453. The output circuit for vacuum tube 453 may be traced from positive battery through resistance 497, top winding of polarized relay 463, resistance 469, resistance 468, the anode of vacuum tube 453 and the cathode of vacuum tube 453 to ground.

The armature of relay 463 is normally held in engagement with its right-hand or marking contact, under the influence of current flowing through the circuit, heretofore traced, which extends through the bottom winding of relay 463. When plug 101 is connected to the jack of an interoffice telegraph trunk, the tip conductor, which is connected to the tip conductor of the trunk, for the marking condition, finds negative battery on the tip conductor of the trunk. Under this condition, no current will flow in the output circuit of vacuum tube 453. For the spacing condition ground is connected to the tip conductor of the associated trunk. Under this condition current of sufficient magnitude will flow through the top winding of relay 463 that its effect preponderates over the effect of current through the bottom winding of relay 463 and the armature of relay 463 will be actuated toward the left. When the armature of relay 463 is in engagement with its right-hand or marking contact, a circuit may be traced from ground through the bottom outer front contact and armature of relay 106, contacts 158 of relay 109, bottom middle armature and front contact of relay 113, bottom innermost front contact and armature of relay 113, conductor 148, conductor 348, conductor 448, top inner armature and front contact of relay 450, armature and right-hand or marking contact of relay 463, front contact and armature of key 460, conductor 494, conductor 394, winding of receiving magnet 384 and resistance 396 to battery, operating the sounder associated with magnet 384. When, in response to a spacing signal from the associated trunk, the armature of relay 463 disengages from its right-hand contact, the energizing circuit for the sounder magnet is opened and the sounder armature is released. Thus marking and spacing signals transmitted by the associated trunk circuit are received by the sounder. The received signals are picked up by transmitter 385 and impressed through transformer 362 and the balanced coil arrangement 361. When plugs 376 and 377, associated with the attendant's telephone receiver 378, are connected to jacks 368 and 369, respectively, the signals may be received by the attendant. In this manner the attendant will receive the information necessary to enable her to complete the connection. The operation of the telephone receiving circuit and balancing coil arrangement will be described in more detail below.

The attendant has telegraph sending means for communicating to the calling party. This is accomplished by means of the transmitting apparatus in the telegraph circuit per Fig. 4. Attention was called to the fact that when the circuit per Fig. 4 was idle, the armature of relay 457 was maintained in its left-hand position so as to prevent the connection of ground through its right-hand contact, which would result in a spacing signal being transmitted. Switch 462, associated with transmitting key 461, is normally closed. After relay 450 is operated, a circuit

may be traced from battery through resistance 459, bottom winding of relay 457, front contact and armature of switch 462 and through the bottom outer armature and front contact of relay 450 to ground. A circuit may also be traced from battery through resistance 458, top winding of relay 457, bottom inner front contact and armature of relay 450, and bottom outer armature and front contact of relay 450 to ground. When the circuit is thus arranged, the effect of the current through the top winding of relay 457 tends to actuate the armature of relay 457 to engage with its right-hand or spacing contact. This effect is opposed by the effect of the current flowing through the bottom winding of relay 457 and the effect of the current in the bottom winding preponderates, so that the armature of relay 457 is maintained in its left-hand or marking position. When the attendant wishes to transmit, switch 462 is opened, so that transmitting key 461 may take control of the transmitting circuit. As the key is opened and closed the armature of relay 457 alternately engages with and disengages from its right-hand or spacing contact.

In tracing the circuit which extends from the tip or transmitting conductor of the interoffice trunk circuit, to which the tip of plug 101 is assumed to be connected, the circuit was shown to break into parallel branches at contacts 168 and 169 of relay 113. The branch which extended through contacts 168 was shown to extend through conductor 146, conductor 346, conductor 446, to the armature of relay 457. When ground is connected to this armature, therefore, the tip or transmitting conductor of the trunk circuit is grounded. Under these circumstances battery flows from the associated trunk (not shown) through the winding of a receiving relay, which is connected in series in the transmitting conductor of the trunk, to ground connected to the armature of relay 457. When the armature of relay 457 is actuated to the left, this circuit is broken and the winding of the receiving relay in the associated trunk is deenergized. Thus signals may be transmitted from the attendant's telegraph set circuit per Fig. 4 to any telegraph circuit connected to Fig. 1.

Attendant connects to called line

It will be assumed that the call requires connection of the calling end of the cord to an interoffice telegraph trunk. Plug 116 is thereupon connected to a jack of such a trunk (not shown). The sleeve of the plug 116 is connected to ground through a high resistance. The circuit is extended from the sleeve of plug 116 through the continuity contacts associated with the bottom middle armature of relay 103, conductor 120 and conductor 220 to a two-branch parallel circuit. One branch extends through the windings of relays 246 and 241 in series to battery, operating relay 241 only. The other branch extends through resistance 273 to battery. Relay 241 operated closes a circuit from ground through the contacts of relay 241, conductor 226, conductor 126 and the winding of relay 108 to battery, operating relay 108. The telegraph transmission circuit of the trunk is joined to a circuit which extends from the tip of plug 116, top right-hand armature and back contact of key 102, top middle armature and back contact of relay 103, top middle armature and front contact of relay 108, junction point 170, contacts 163 of relay 111 and junction point 171 to the parallel branches which extend through contacts 168 and 169 of relay

113. The parallel branches have heretofore been traced.

The interoffice telegraph trunk circuit with which the combined cord cooperates is equipped at the distant office with a lamp which serves as a line-calling signal, in order to attract the attention of the operator at the distant office. The combined cord is arranged in such a manner in its relation to the interoffice trunk circuit, not shown, that, in order to light the distant lamp, a break signal is transmitted from the attendant's telegraph set circuit connected to the combined cord. In order to transmit a break signal, the attendant who is administering the combined cord and its associated position circuits will open telegraph key 461 for an interval of two seconds. As a result of this, the armature of relay 457 will be actuated so as to engage with its right-hand or spacing contact, in a manner which has been described in detail above. Ground is thereupon connected to the transmitting conductors of the combined cord which, in turn, control relays in the associated trunk to light the distant lamp.

It will be observed that the transmission circuit for the answering end of the cord, which extends through the tip of plug 101, is joined to the transmission circuit for the calling end of the cord, which extends through the tip of plug 116 at junction point 170. The spacing signal which is transmitted toward the distant called office to light the line lamp signal thereat will also be transmitted toward the calling office. This should cause no difficulty and the calling party will understand that it is an indication that the call is proceeding. The supervisory lamps associated with the combined cord do not function on this operation.

Calling and called party communicate over telegraph circuit

When the called party responds, the attendant who administers the combined cord will restore key 268 to its original position. This releases relay 113 which disconnects the attendant's telegraph set circuit from the combined cord. Relay 111 will remain operated since it is locked under control of both relays 106 and 109, which are both operated and supply ground in parallel to the circuit which extends through contacts 158 of relay 109 and the bottom innermost front contact and armature of relay 111 to battery through the winding of relay 111.

It is important, for reasons which will become apparent hereunder, that relay 109 should not be operated due to the accidental operation of key 267. In order to prevent this, the operating path for relay 109 is extended through contacts 165 of relay 111. Since, as has been described, relay 111 is locked in the operated condition at this time, the accidental operation of relay 110 through the operation of key 267 cannot result in the operation of relay 109.

When the answering and calling ends of the combined cord are interconnected, a circuit may be traced from the tip of plug 101 through the left-hand top armature and back contact of key 102, top outermost armature and back contact of relay 103, top outermost armature and front contact of relay 106, contacts 162 of relay 111, through junction point 170, top middle front contact and armature of relay 108, top middle back contact and armature of relay 103, right-hand top back contact and armature of key 102 to the tip of calling cord 116. While the cords are combined, another branch is joined to the transmit-

ting path, to provide disconnect supervision, which extends from junction point 170 through contacts 163 of relay 111, junction point 171, conductor 136, conductor 236, top winding of relay 262, resistance 265 and resistance 264 to negative battery. During the marking condition negative batteries of equal magnitude will be connected to the tip of plug 101 and the tip of plug 116 so that no current flows through the transmission path just traced. Since negative battery is also connected through resistances 264 and 265 to the right-hand terminal of the top or line winding of relay 262, the top winding of relay 262 will be deenergized. A biasing circuit for relay 262 may be traced from negative battery through resistance 266, bottom winding of relay 262, conductor 231, conductor 131 and the bottom middle front contact and armature of relay 111 to ground. The effect of current in the biasing winding of relay 262 is to tend to actuate the armature of relay 262 so as to engage with its right-hand or marking contact and this effect will maintain the armature of relay 262 in engagement with its right-hand contact while the transmission path connecting the tips of plugs 101 and 116 is in the marking condition. Ground is connected to either plug 101 or plug 116 when a spacing signal is being transmitted from the circuit with which each plug is associated. Under these circumstances current will flow from negative battery through the top winding of relay 262 toward said ground, energizing the top winding of relay 262. Under these circumstances the effect of the energizing current in the top winding preponderates over the effect of the biasing current in the bottom winding and the armature of relay 262 will be actuated so as to engage with its left-hand or spacing contact. Relay 262 will, therefore, follow all telegraph communication signals through the combined cord.

Reception of disconnect signal from interoffice telegraph trunk

The interoffice telegraph trunk is arranged so that 20-cycle ringing current may be supplied over the transmission conductor as a disconnect signal. As relay 262 responds to ordinary communication signals, relay 251 is unaffected. When the armature of relay 262 is vibrated at 20-cycles per second, however, in response to the 20-cycle ringing current which serves as a disconnect signal, relay 251 is operated. The manner in which this is achieved is as follows. Inductance coil 253 and condensers 254 and 255 serve as a tuned circuit for 20-cycle signals. When the armature of relay 262 is in engagement with its left-hand or spacing contact, a circuit may be traced from negative battery through the top winding of relay 251, the left-hand or spacing contact and armature of relay 262 to condensers 254 and 255 in parallel and through inductance coil 253 to ground. Condensers 254 and 255 are charged. As the charging current flows, the top winding of relay 251 is energized. When the armature of relay 262 is in engagement with its right-hand or marking contact, a circuit may be traced from ground through inductance coil 253, condensers 254 and 255 in parallel, the armature and right-hand or marking contact of relay 262 and through the bottom winding of relay 251 to ground. The charged condensers discharge through this path, energizing the bottom winding of relay 251. The windings are arranged so that the magnetic flux established in the core of relay 251 for the charging and discharging of the con-

densers is in the same direction. The constants of the various elements comprising this circuit are so chosen with relation to the ringing frequency at which relay 262 is operated that relay 251 is operated. As stated above, relay 251 does not operate as relay 262 responds to ordinary communication signals.

The operation of relay 251 releases relay 249 by short-circuiting the winding of relay 249. This in turn operates relay 248 over a circuit from battery through the winding of relay 248, bottom front contact and armature of relay 250, which is operated, bottom back contact and armature of relay 249, conductor 217, conductor 117, to ground supplied in parallel through the bottom outer armature and front contact of relay 106 and the top innermost armature and front contact of relay 108. When relay 249 operates, it locks through its bottom front contact and armature to the same ground supplied in parallel from relays 106 and 108. Relay 251 releases at the end of the 20-cycle disconnect signal.

When relay 251 releases, relay 249 reoperates, as the short circuit around its winding is removed. The reoperation of relay 249 operates relay 103 over a circuit from battery through the winding of relay 103, conductor 121, conductor 221, top front contact and armature of relay 248, bottom front contact and armature of relay 249, conductor 217, conductor 117 to ground connected in parallel through the bottom outer front contact and armature of relay 106, and the top innermost armature and front contact of relay 108. The operation of relay 103 opens two branches in the transmission path through which the tip of plug 101 and the tip of plug 116 have been connected together, when the top outermost armature and the top middle armature of relay 103 separate from their respective back contacts. Each of these branches when opened is also disconnected from the portion of the transmission path by means of which they were connected to relay 262, which followed transmission through the cord. Each is disconnected also from the path which extends through the contacts of relay 113, by means of which the transmission path through the cord could be connected to the attendant's telegraph set circuit.

The operation of relay 103 transfers the sleeve circuit of each cord to a new path. The bottom outermost continuity contacts of relay 103 are opened and the sleeve of plug 101 is connected through the bottom outermost front contact and armature of relay 103, top outer back contact and armature of relay 104, top middle armature and front contact of relay 106, conductor 127 and conductor 227 to parallel branches, extending through resistance 272 to battery and through the windings of relays 242 and 240 in series to battery. The sleeve of plug 116 is transferred to a corresponding circuit through the bottom middle front contact and armature of relay 103, bottom inner back contact and armature of relay 105, bottom outer armature and front contact of relay 108, to conductors 120, 220 and windings of relays 246 and 241 to battery in parallel with resistance 273.

The operation of relay 103 also closes a circuit from ground through its top innermost armature and front contact and through the top and bottom windings of relay 105 in series to battery. It also closes a circuit from ground through the bottom innermost armature and front contact of relay 103 and through the top

and bottom windings of relay 104 in series to battery. Relays 103 and 104 do not operate at this time, however, as, in each instance, the top and bottom windings of these relays are connected differentially.

Attention is called to the fact that the junction of the top and bottom windings of relays 104 and 105 each connect to the ring or middle conductor of one of the plugs. The circuit for relay 104 extends from the junction of its top and bottom windings through contacts 164 of relay 111, and through the left-hand bottom back contact and armature of key 102 to the ring of plug 101. The circuit for relay 105 extends from the junction between its top and bottom windings through the bottom outermost front contact and armature of relay 111 and through the right-hand bottom back contact and armature of key 102 to the ring of plug 116. If battery or ground is connected to the ring circuit of either plug, the corresponding relay, 104 or 105, will operate. In such event, in each case, one winding will be short-circuited while the other will be energized to operate the relay.

It has been assumed that the combined cord is connected to an interoffice telegraph circuit. A disconnect signal received from such a circuit will operate the disconnect relay associated with the plug connected to the circuit from which the disconnect signal is received. If it is assumed that the disconnect signal is received over the calling cord, battery will be connected to the ring of plug 116. This will energize the top winding of relay 105 and deenergize the bottom winding. Relay 105 will operate. The operation of relay 105 will open the sleeve circuit of plug 116 at the bottom inner front contact and armature of relay 105. Supervisory lamp 115 associated with the calling end of the cord 115 is lighted as a disconnect signal. The circuit may be traced from ground through the filament of lamp 115 and through the bottom outer front contact and armature of relay 105 to battery.

The opening of the transmission conductor connected to the tip of plug 116 as heretofore described and the opening of the sleeve conductor of plug 116 releases the trunk to which the calling plug 116 is connected immediately, without the necessity for waiting until the plug 116 is actually removed from the associated jack. This is true notwithstanding that battery remains connected to the ring of the telegraph circuit to which plug 116 is connected. If the plug of another combined cord at another position is connected to a multiple appearance of the jack of the interoffice telegraph trunk with which plug 116 is assumed to be connected, the presence of battery on the sleeve of the trunk cannot light the lamp, such as lamp 115, in the second combined cord. Relay 103 will be unoperated in the second cord and the relay corresponding to relay 105 in the second cord cannot be operated until after the relay corresponding to relay 103 in the second cord has been operated, as described above, following the transmission of 20-cycle ringing current as a disconnect signal.

Connection to telegraph trunk to supervisor's desk

Instead of being used at an intermediate office to interconnect parties at remote offices over two telegraph trunks, the combined cord of the invention herein may be used to connect to a telegraph trunk which extends to some point within the office where the cord is located such as to

a telegraph trunk which extends to a supervisor's desk. In such case the resistance of the sleeve circuit of the trunk to which the cord connects (not shown) will be low. This will permit relay 242 to operate in addition to relay 240 if plug 101 is used to connect to the supervisor's trunk. If plug 116 is used, relays 241 and 246 will operate in parallel over a circuit which extends from the sleeve of plug 116, through the continuity contacts associated with the bottom middle armature of relay 103, which relay is released, conductor 129 and conductor 220 to parallel branches. One of the parallel branches extends through resistance 273 to battery and the other extends in series through the windings of relays 246 and 241 to battery. The operation of relay 242 or 246, however, on such a connection, will not affect the operation of the combined cord on a telegraph connection.

Disconnection from a trunk, such as a trunk to the supervisor's desk, is effected in a manner different from that described above for a trunk to a distant telegraph office. Instead of connecting 20-cycle ringing current to the tip circuit, the trunk to the supervisor's desk connects ground to the ring of the combined cord as a disconnect signal. This, as has been described, will operate relay 104 if plug 101 is connected to the supervisor's trunk, or relay 105 if plug 116 is connected thereto. This will light the associated lamp 114 or 115 as a signal to the operator to take down the cord. If relay 103 has been operated previously, by the reception of 20-cycle ringing current over a telegraph trunk to a distant office, in the manner described above, the sleeve circuit, connected to the supervisor's trunk, which sleeve circuit will have been transferred to the path through the contacts of relay 104 or relay 105 when relay 103 was operated, will be opened by the operation of relay 104 or relay 105. If the disconnect signal is received from the supervisor before it is received from the interoffice trunk, relay 103 will be unoperated. Under these conditions the sleeve circuit of the end of the combined cord connected to the supervisor's trunk will remain intact.

TELEPHONE OPERATION

Attendant responds to telephone line calling signal

When the attendant at the position where the combined cord is located observes a calling signal associated with a telephone line, she will insert plug 101 of the combined cord into the jack associated with the calling line. It is to be understood that the telephone line facilities to which the combined cord connects are not shown. The telephone lines may be arranged in either of two manners depending upon whether or not talking battery is supplied from the line or must be furnished from the combined cord. In order to discriminate the sleeve circuit of the lines to which the sleeve of plug 101 connects will have a resistance of low magnitude or high magnitude. It will be assumed that the line circuit to which plug 101 is first connected is a line circuit which includes talking battery, so that talking battery need not be supplied from the combined cord. In this case, the magnitude of the resistance in the sleeve circuit of the line to which plug 101 connects is high.

The sleeve circuit for plug 101 has been traced in the description above for telegraph operation. It was shown to extend to battery through the windings of relays 242 and 240. Relay 240 oper-

ates but relay 242 does not operate for the high resistance sleeve condition. The operation of relay 240 in turn operates relay 106 over the same circuit as traced above.

As mentioned above, the attendant's telephone circuit is individual to a position and at each position there are a plurality of combined cords such as Fig. 1 and Fig. 2 as well as other cords. The cord circuits are arranged as explained above so that the keys which control the connection of the single attendant's telephone set circuit cannot connect the attendant's telephone set circuit to more than one cord at a time. For reasons which will become apparent below, the chain circuit is arranged in a slightly different manner than the chain circuit which controls the connection of the single telegraph set circuit to the various cords. Relay 351 is normally unoperated and ground is supplied through the continuity contacts associated with the bottom armature of relay 351, through conductor 374, conductor 174, conductor 274, through the chain circuit comprising the armature and back contact of keys corresponding to key 267 in other cords, to the armature of key 267 in the present combined cord. When key 267 is depressed, the circuit extends through the front contact associated with key 267, conductor 233 and conductor 133 to battery through the windings of relays 110 and 112 in parallel, operating relays 110 and 112 in the present combined cord. When relay 110 is operated, a circuit may be traced from battery, through the winding of relay 109, contacts 165 of relay 111, top inner front contact and armature of relay 110, to ground through the bottom outer armature and front contact of relay 106, operating relay 109.

A circuit may now be traced from the tip of plug 101 which connects to the tip conductor of the telephone trunk to which plug 101 is connected, through the left-hand top armature and front contact of key 102, top outermost armature and back contact of relay 103, relay 103 being released, top outermost armature and front contact of relay 106, contacts 153 of relay 109, condenser 177, top outer make contact and armature of relay 112, conductor 139, conductor 339, condenser 354, left-hand windings of repeating coil 352, condenser 355, conductor 338, conductor 138, top outer armature and front contact of relay 110, condenser 178, contacts 160 of relay 109, left-hand lower back contact and armature of key 102 to the ring of plug 101 which connects to the ring of the telephone line to which plug 101 is connected. A circuit may also be traced from junction point 175 in the tip conductor circuit of the answering side of the telephone cord, conductor 119, conductor 219, top outer armature and back contact of relay 242, which is unoperated, inductance coil 252, bottom back contact and armature of relay 242 conductor 218 and conductor 118 to junction point 176 in the ring conductor of the answering side of the telephone cord. When talking battery is supplied from the telephone line to which plug 101 is connected, it is not necessary to supply talking battery from the combined cord. Inductance coil 252 is bridged across the tip and ring conductors of the answering side of the combined cord in such manner as to provide a direct current path through the loop, established by the connection of the answering side of the combined cord to the telephone line, for supervisory purposes. By means of this bridge, supervisory relays in a cord circuit connected to the

distant end of the telephone line circuit may be controlled to provide disconnect signals, etc.

Variations in potential due to the modulation of the current in the connected circuit by the distant speaker's voice are impressed across the primary of transformer 352 and the primary of transformer 360 which is bridged across a portion of the primary of transformer 352. This results in corresponding variations in potential across the secondary windings of transformers 352 and 360.

The secondary of transformer 360 is connected in a circuit which is designed to prevent the repetition back through the primary winding of transformer 360, of the telegraph signals and busy test signals. The telegraph signals are picked up by the microphone transmitter 385 from the sounder 384 and are impressed on the top right-hand winding of transformer 362. The busy test signals are received by relay 363 and are impressed on the lower right-hand winding of transformer 362.

When no plugs are inserted in jacks 368, 369, 370 and 371, the contacts of these jacks are in the positions indicated and dummy or balancing receivers 372 and 373 are connected to the opposite ends of the circuit comprising the secondary of transformer 360 and the balancing coils 361. A circuit may be traced from the top terminal of the secondary of transformer 360 through the top armature and back contact of jack 368, dummy balancing receiver 372, back contact and top armature of jack 369, top terminal of balancing coils 361, through the top and bottom balancing coils 361, continuity contacts associated with the bottom armature of relay 364, top armature and back contact of jack 371, dummy balancing receiver 373, back contact and top armature of jack 370, continuity contacts associated with the top armature of relay 364, bottom terminal of the secondary of transformer 360 and through the bottom and top coils of the secondary of transformer 360 back to the top terminal of the secondary of transformer 360. Bridged across the junctions of the top and bottom coils of the secondary of transformer 360 and the balancing windings 361 is the secondary of transformer 362. The top and bottom coils of the secondary of transformer 360 are matched each with the other. The top and bottom coils comprising the balancing arrangement 361 are matched each with the other and with the top and bottom coils of the secondary of transformer 360. The coils of the secondary of transformer 360 are arranged so that the voltages induced in them from the primary of transformer 360 are additive and current flows around the circuit through the coils of the secondary of transformer 360, through the dummy balancing receiver 372, the top and bottom balancing coils 361 and through the dummy balancing receiver 373 over the circuit traced above. If plugs 376 and 377 are inserted in jacks 368 and 369, respectively, receiver 378, which has an impedance equal to that of dummy balancing receiver 372, will be substituted therefor. If plugs 379 and 380 are inserted in jacks 370 and 371, respectively, receiver 382, which has an impedance equal to that of dummy balancing receiver 373, will be substituted therefor. It is to be understood that the impedance of the top half of the circuit, including the top coil of the secondary of transformer 360, the dummy balancing receiver 372, or its equivalent impedance, receiver 378, and the top balancing

coil 361 is matched by the impedance of the bottom coil of the secondary of transformer 360, the dummy balancing receiver 373, or its equivalent, receiver 382, and the bottom balancing coil 361. Either receiver 378 or 382 may be connected or disconnected without upsetting the balance. When either receiver 378 or 382 is connected, a circuit is extended through the front contact associated with the top armature of jack 368 or 370, the sleeve of jack 368 or 370, sleeve of plug 376 or 379, receiver 378 or 382, sleeve of plug 377 or 380, sleeve of jack 369 or 371, and the front contact associated with the top armature and top armature of jack 369 or 371. Signals impressed on the secondary winding of transformer 360 may be heard in receiver 378 or 382 or both if both are connected simultaneously to their respective jacks.

In the case of voltages induced in the secondary of transformer 362 by signals in the top and bottom primary coils of transformer 362, the effect will be currents which divide equally in the circuits through the top and bottom halves of the balanced circuit heretofore traced. These effects will be balanced out in the top and bottom coils of the secondary of transformer 360. Since one-half of the current will flow in one direction through the top coil of the secondary of transformer 360 and one-half in the opposite direction through the bottom coil, the effect in each coil will oppose the effect in the other with the result that no voltage will be induced in the primary of transformer 360.

When plug 379 is inserted in jack 370 and plug 380 in jack 371, a circuit is established by means of which the attendant at the position where the combined cord per Fig. 1 and Fig. 2 is assumed to be located may talk to a party connected to the distant end of the circuit to which the cord may be connected. Talking battery for the attendant's transmitter is supplied over a circuit which may be traced from ground through battery 397, left-hand filament of lamp 358, top winding of inductance coil 357, tip of jack 370, tip of plug 379, transmitter 381, tip of plug 380, tip of jack 371, bottom winding of inductance 357 and the right-hand filament of lamp 358, back to ground. If key 375 is closed, battery from source 397 may be connected across transmitter 395. Voltage variations caused by speech in the transmitter are impressed through condenser 356 on the right-hand winding of transformer 352. These are induced in the left-hand winding and flow through conductors 338 and 339 and the circuit heretofore traced to the tip and ring conductors of plug 101. The calling party and the attendant may now communicate.

Attendant calls the called party

The attendant obtains the information necessary to enable her to complete the connection. The connection may be completed directly to a telephone line which extends to the called station or it may be extended toward the called party by means of a telephone trunk to a distant control office. The attendant, thereupon, inserts calling plug 116 in the proper jack. It will be assumed that the plug 116 is connected to a jack associated with a telephone trunk which extends to a distant central office.

In such a connection the sleeve of the calling plug will be connected to a high resistance circuit in the sleeve of the trunk. As a result of this, relay 241, which corresponds in the calling end of the cord to relay 240 in the answering

end of the cord, will be operated and relay 246, which corresponds in the calling end of the cord to relay 242 in the answering end of the cord, will remain unoperated due to the high resistance in the sleeve circuit of the trunk circuit to which calling plug 116 has been connected. The circuit for this is the same as traced above for telegraph operation. Since relay 246 remains unoperated, inductance coil 247 will be bridged across the calling end of the cord to provide a bridge for supervisory signals in the cord (not shown) which will be connected to the distant end of the interoffice trunk to which calling plug 116 is connected. Battery will be furnished from the called trunk circuit.

The trunk to which calling plug 116 is connected may be what is known in the art as an automatic trunk, a ring-down trunk or a dial trunk. If it is an automatic trunk, the calling signal which summons the attention of the attendant at the distant end will be controlled by apparatus within the trunk in response to the connection of the plug 116 to the jack of the automatic trunk, without the necessity for any additional operation on the part of the attendant who is administering the combined cord, per Fig. 1 and Fig. 2.

If it is a ring-down trunk, after the attendant has connected plug 116 to the jack of the ring-down trunk, the attendant will operate the right-hand armatures of key 102 to engage with their respective front contacts. As a result of this alternating current is supplied to the calling end of the trunk over a circuit which extends from the alternating current ringing supply through contacts 152 of relay 109, through the bottom right-hand front contact and armature of key 102 out over the ring conductor of the cord, ring of plug 116, to the ring circuit of the connected trunk. After passing through apparatus controlling the calling signal in the trunk, the circuit returns over the tip conductor of the trunk, tip of plug 116, tip conductor of the cord, top right-hand armature and front contact of key 102 and contacts 179 of relay 109 to the opposite side of the alternating current ringing supply.

If the trunk to which plug 116 is connected is a trunk to a machine switching central office, the attendant will operate her dial 367. When the dial is moved off normal the top pair of dial contacts are closed and remain closed during the dialing operation. When these contacts are closed a circuit may be traced from battery through the winding of relay 350, front contact and top armature of dial 367, conductor 342, conductor 142, bottom middle armature and front contact of relay 112, which relay is operated, conductor 135, conductor 235, bottom inner armature and back contact of relay 246, which relay is released when connection is made to a machine switching trunk, conductor 230, conductor 130, contacts 165 of relay 111, which relay is released, through the top inner front contact and armature of relay 110 and contacts 157 of relay 109 in parallel, through the bottom outer armature and front contact of relay 106 to ground, operating relay 350. The operation of relay 350 disconnects the tip of the calling cord from the tip of the answering cord and from the path which extends through condenser 354 to the top terminals of the left-hand winding of transformer 352 when the top continuity contacts of relay 350 are opened. It also disconnects the ring of the calling cord from the ring

of the answering cord and from the path which extends through condenser 355 to the bottom terminal of the left-hand winding of transformer 352. This separates the calling side of the cord from the answering side of the cord. The bottom contacts of dial 367 are connected across the calling side of the cord. The armature of the bottom pair of contacts of the dial is connected through the top outermost armature and front contact and through the bottom innermost armature and front contact of relay 350, in parallel, to the tip conductor of the calling cord. The break contact of this pair is connected through the top innermost armature and front contact and the bottom outermost armature and front contact of relay 350 in parallel to the ring conductor 343 of the calling cord.

In transmitting codes to control the selecting mechanism in the machine switching trunk to which the calling end of the combined cord is connected, the bottom pair of contacts of dial 367 will be opened and closed. This opens and closes the loop comprising the tip and ring conductors of the calling end of the cord and the tip and ring conductors of the machine switching trunk to which it is connected to direct selecting mechanism in the trunk.

The operation of relay 350 established a circuit from ground through the front contact and top middle armature of relay 350 and the winding of relay 351 to battery, operating relay 351. The operation of relay 351 disconnects ground from the chain circuit which was traced through the bottom continuity contacts of relay 351, conductor 374, conductor 174, conductor 274 and contacts corresponding to the armature and back contact of key 267 in preceding keys such as key 267 in preceding cords, which keys are assumed to be released, to the armature of key 267 of the present combined cord, per Fig. 1 and Fig. 2, which armature is assumed now to be depressed to engage its associated front contact, thence through the front contact, conductor 233, conductor 133 and the windings of relays 110 and 112 in parallel. Relays 110 and 112 were operated over this circuit. When relays 350 and 351 are operated and relays 110 and 112 are operated in a particular cord to which the attendant's individual telephone set circuit is connected, relays 110 and 112 in that cord are locked, over a circuit which extends from battery in parallel through the windings of relays 110 and 112, top inner front contact and armature of relay 112, conductor 140 and conductor 340 to ground through the bottom middle armature and front contact of relay 350 and the bottom armature and front contact of relay 351 in parallel. The operation of the armature of key 267 in a particular cord disconnects ground from cord keys, such as key 267, in a later position in the sequence circuit than the operated key. The operation of relay 351 disconnects ground from the whole chain circuit during the dialing operation so that if any other cord circuit key is operated, whether such key is in a position in the chain either preceding or succeeding the key which is connecting the individual attendant's telephone circuit to the present combined cord, the attendant's telephone circuit will remain connected to the present cord and cannot be connected to another. The locking of relays 110 and 112 in the operated position from the time dial 367 is moved off normal until after dialing is completed and relay 351 restores to normal prevents the loss of any dialing pulses by the false operation of key 267 of

the present combined cord. The operation of relay 351 also connects a bridge across the tip and ring conductors of the telephone set circuit. This bridge may be traced from the tip conductor through resistance 353, top make contact and armature of relay 351 to the ring conductor of the main telephone circuit. Relay 351 is slow to release. After dial 367 returns to normal relay 350 releases. This reconnects the tip and ring conductors of the answering and calling ends of the cord and reconnects them to the left-hand winding of transformer 352. The bridge through resistance 353 remains connected across the main tip and ring conductors of the telephone circuit at a point beyond where the answering and calling ends of the cords are rejoined for an interval after the rejoining until relay 351 releases. The object of this is to prevent the generation of an additional pulse as the inductance coil 247 is reconnected to the line.

Calling and called parties communicate over telephone cord

When the connection is established between the calling and called parties, the attendant who is administering the combined cord will restore key 267 to normal. This will disconnect the attendant's telephone set circuit from the combined cord as relays 110 and 112 are released. The tip and ring conductors associated with the calling end of the cord and the answering end of the cord will be interconnected through the contacts of relays 110 and 112 when they are released. The calling and called parties may then communicate each with the other through the cord circuit.

Telephone disconnect signal

On connections to telephone circuits having high resistance sleeves, it was shown that relays 242 and 246 remain unoperated. The sleeve resistance of such circuits may be reduced, through the operation of a relay (not shown) in the circuit to which either plug 101 or 116 is connected to provide a disconnect signal. The manner in which this is performed is as follows:

It will be assumed first that the calling party disconnects. In response to this the resistance of the sleeve circuit to which plug 101 is connected is lowered, through the operation of a relay, not shown, which controls the amount of resistance in the sleeve of the connected circuit. As a result of this, relay 242 operates as the current through its winding increases. This establishes a circuit which may be traced from battery through the bottom winding of relay 104, top innermost front contact and armature of relay 106, conductor 122, conductor 222, armature and contact of relay 243, top inner front contact and armature of relay 242, conductor 228, conductor 128 and contacts 154 of relay 109 to ground, operating relay 104. The operation of relay 104 lights lamp 114 over an obvious circuit as a signal that the calling party has disconnected.

In response to a disconnect signal from the circuit to which plug 116 is connected, relay 246 operates due to the lowered sleeve resistance. This operates relay 105 over a circuit which extends from battery through the bottom winding of relay 105, bottom inner front contact and armature of relay 108, conductor 125, conductor 225, contacts of relay 245, top inner front contact and armature of relay 246, conductor 229, conductor 129 and contacts 155 of relay 109 to ground. This lights lamp 115 over an obvious

circuit to indicate that the called party has disconnected. The attendant thereupon disconnects the plugs from their associated jacks and the circuit is restored to normal.

Connection to telephone circuits having low resistance sleeves

As mentioned above, the combined cord herein may be connected to telephone circuits to which it is necessary to supply talking battery from the combined cord. Such circuits have low resistance sleeve circuits. Relay 242 will operate if plug 101 is connected to a circuit having low resistance in the sleeve circuit. Under this condition the bridge through inductance 252 will be disconnected. Battery will be connected through the left-hand top and bottom windings of coils 244 to the top outer front contact and armature of relay 242 and the bottom front contact and armature of relay 242, through resistance 271 and the winding of relay 243 respectively. Relay 246 will be operated if plug 116 is connected to a jack having a low resistance sleeve. Battery through the right-hand top and bottom windings of coils 244 will be connected to the top outer front contact and armature and the bottom outer front contact and armature of relay 246 through resistance 270 and relay 245 respectively. Inductance coil 247 will be disconnected from the calling end of the cord when relay 246 operates.

Disconnect signal for telephone connection to circuit having low resistance sleeves

The reception of a disconnect signal from a telephone circuit having a low resistance sleeve circuit to which plug 101 or 116 may be connected is different from the reception of disconnect signals for other conditions described above. It was shown above that, for such connections, talking battery was supplied from the cord circuit, when relay 242 or relay 246 was operated. The path through which battery is supplied to the answering end of the cord extends through the winding of supervisory relay 243. The path through which battery is supplied to the calling end of the cord extends through the winding of supervisory relay 246. When the answering loop is closed, which condition prevails while the answering end of the circuit is arranged for communication, relay 243 is operated. When the calling loop is arranged for communication, relay 245 is operated. At the end of communication, either or both loops may be opened. This releases relay 243 or 245 or both. The armature and contact of relay 243 and the armature and contact of relay 245 are in series in the paths traced above, by means of which supervisory relays 104 and 105 respectively were operated to light their associated lamps as a supervisory signal. With relays 242 and 246 operated, on connection to low resistance sleeves, the release of relays 243 or 245, due to the opening of the loop, operates the respective supervisory relay and lights the corresponding lamp. It should be pointed out, that under the condition described above, wherein connection is made to a normally high resistance sleeve circuit and the supervisory lamp is lighted through a change in the resistance of the sleeve circuit, followed by the operation of relay 242 or 246, when relays 243 and 245 are connected in series with their respective loops, they cannot operate as the loops are already opened before the sleeve resistances are reduced.

BUSY TEST

Busy test on telegraph connection

As mentioned above, the circuits herein are arranged to provide an indication when the circuits to which the combined cord is to be connected are busy.

Before an operator inserts either plug 101 or 116 into the jack associated with a called line the attendant will test the line to see whether or not it is busy. In order to do this the operator will connect the tip of either plug to the sleeve of the jack of the called line. If the line is not busy, the sleeve of the line will be connected through resistance to ground. If the line is busy, a cord circuit will be connected to some one of the multiple appearances of the jack of the called line to which the plug is to be connected. Battery will therefore be connected from the sleeve of the cord circuit to the sleeve of the called line and the sleeves of all of the multiple jacks will have battery connected thereto. A circuit may be traced from battery connected through the sleeve of a multiple appearance of the jack of a busy line (not shown) through the tip of plug 101, left-hand top armature and front contact of key 102, top outermost armature and back contact of relay 103, top outermost armature and back contact of relay 106, which is released, contacts 167 of relay 113, conductor 145, conductor 345, resistance 393, through the winding of relay 365 to ground operating relay 365. This establishes a circuit from battery through resistance 394, left-hand contact and armature of relay 365 and the filament of lamp 303 to ground, lighting lamp 303 as an indication that the called telegraph line is busy.

A busy test may also be obtained through the tip of plug 116. The circuit extends through the right-hand armature and back contact of key 102 and the top middle armature and back contact of relays 103 and 106, where it joins the path heretofore traced through contacts 167 of relay 113.

Busy test on telephone connection

On a telephone connection to a busy line, battery is present on the sleeve for the same reasons as described above. A circuit may be traced from said battery through the tip of plug 101, left-hand top armature and front contact of key 102, top outermost armature and back contact of relay 103, top outermost armature and back contact of relay 106, bottom inner armature and front contact of relay 110, conductor 144, conductor 344, and through the winding of relay 363 to ground, operating relay 363. This establishes a circuit from battery through resistance 391, left-hand contact and armature of relay 363 and the bottom right-hand winding of transformer 362. This causes a surge of current through the lower right-hand winding of transformer 362 which is induced in the left-hand windings of transformer 362, resulting in the energization of the windings of receiving magnet 378 or 382, if either is connected to its associated circuit, as described above.

A busy test may also be obtained through the tip of plug 116 on a telephone connection. The circuit is the same as traced above for a telegraph busy test using plug 116, except that, after passing through the top middle armature and back contact of relay 108, the circuit extends through the bottom inner armature and front contact of relay 110, beyond which point the circuit has been traced.

Call transfer

When it is found that a call received from an interoffice trunk arranged either for telephone or telegraph service should be transferred to another position, the attendant at the original position will operate one of a group of positional keys (not shown) to select the desired position. Operation of any of these keys will apply ground from the interoffice trunk circuit, indicated by rectangle 180, through the bottom outermost armature and front contact of relay 112 or contacts 166 of relay 113, depending upon whether the combined cord per Fig. 1 and Fig. 2 is connected for telegraph or telephone service and which of these relays is therefore operated, through the winding of relay 107 to battery operating relay 107. This establishes a circuit from battery through resistance 151, top inner front contact and armature of relay 107 and the continuity contacts associated with the bottom outermost armature of relay 103 to the sleeve of plug 101. The magnitude of resistance 151 is low. The increased voltage thus applied to the sleeve of the answering cord 101 and the jack of the circuit to which it is connected will control apparatus in the connected circuit (not shown) to light a lamp, associated with the connected circuit at the desired position, after plug 101 has been disconnected from the connected circuit, at the original position.

What is claimed is:

1. In a communications system, a cord circuit, an attendant's telegraph set circuit, an attendant's telephone set circuit, means for selectively connecting said attendant's circuits directly to said cord circuit at separate times and means in said telegraph set circuit for communicating by means of inverse neutral signals.

2. In a communications system, a cord circuit, means for transmitting speech signals through said circuit at a first time, means for transmitting telegraph signals through said circuit at a second time and a circuit extending through corresponding elements in a plurality of said cord circuits for preventing the connection of another circuit to more than one of said cords simultaneously.

3. In a communications system, a cord circuit, means therein for transmitting telephone signals through said circuit at a first time, means also therein for transmitting telegraph signals through said circuit at a second time, a supervisory signal in said cord circuit, supervisory signal control means also in said cord and means also in said cord for operating said control means in a plurality of manners to provide a disconnect signal for a plurality of conditions.

4. In a communications system, a cord circuit, means in said circuit for conditioning said circuit to transmit telephone signals, means in said circuit for conditioning said circuit to conduct telegraph signals, means in said circuit for connecting a source of direct current through an impedance to the telephone path in said circuit at a first time and means in said circuit for connecting an impedance only across said telephone path at a second time.

5. In a communications system, a cord circuit, means in said circuit for conditioning said circuit to transmit telegraph signals, means in said circuit for conditioning said circuit to transmit telephone signals, means for supplying direct current voltage from said circuit to the telephone path, while said circuit is conditioned to transmit telephone signals, at a first time and means for

connecting a shunt path for direct current across a pair of telephone transmission conductors in said circuit, while said circuit is conditioned to transmit telephone signals at a second time.

6. In a communications system, in combination, a cord circuit, an attendant's telephone set circuit, an attendant's telegraph set circuit, means for selectively interconnecting said circuits directly and a plurality of means in said circuits for indicating that circuits to which said cord circuit may be connected are in the busy condition.

7. In a communications system, a cord circuit, an attendant's telephone set circuit, an attendant's telegraph set circuit, means for selectively interconnecting said cord and said set circuits directly, means for conditioning said cord circuit to transmit telephone signals when said cord is connected to said telephone set circuit, means for conditioning said cord to transmit telegraph signals when said cord is connected to said telegraph set circuit, and means for transforming telegraph signals received by said telegraph set circuit so that they may be received in said telephone set circuit.

8. In a communications system, an attendant's telephone set circuit, means in said circuit for translating telegraph signals so that they may be received in a telephone receiving circuit and means in said telephone circuit comprising a system of balanced coils for preventing the repetition of said telegraph signals into a circuit to which said telephone circuit is connected.

9. An attendant's position circuit arranged for connection to a telephone circuit and a telegraph circuit, means in said circuit for transmitting and receiving telephone signals, means for translating telegraph signals so that they may be received in the telephone receiving portion of said circuit and means for preventing the transmission of said telegraph signals into a telephone transmission circuit to which said receiving circuit is inductively coupled.

10. In a communications system, an attendant's position circuit conditioned to cooperate with a

combined cord circuit arranged for either telephone or telegraph transmission and a system of transformers and balancing coils arranged to permit the reception of either telephone or telegraph signals including means for the suppression of transmission of telegraph signals to a connected circuit.

11. In a communications system, an attendant's position circuit conditioned to cooperate with a telephone cord circuit or a telegraph cord circuit, means in said attendant's circuit for transmitting and receiving telephone signals, means also in said attendant's circuit for receiving telegraph signals, a system of transformers and balancing coils therefor conditioned to permit the reception of telegraph signals and means to prevent the transmission of said telegraph signals through a circuit to which said coils are inductively coupled.

12. In a combined telephone and telegraph cord circuit, in combination, a first relay conditioned to follow telegraph transmission signals, a second relay, a circuit interconnecting said relays, means in said interconnecting circuit for preventing the operation of said second relay in response to the operation of said first relay by telegraph signals, a tuned circuit in said interconnecting circuit adapted to permit the operation of said second relay in response to the operation of said first relay at a particular frequency and a supervisory signal controlled by said second relay.

13. In a communications system, a cord circuit including facilities for cooperating with telephone and telegraph circuits and means therein for releasing another circuit to which said cord circuit is connected while said cord circuit remains connected to said other circuit so that said other circuit may be appropriated for use at a multiple appearance thereof notwithstanding said connection.

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