

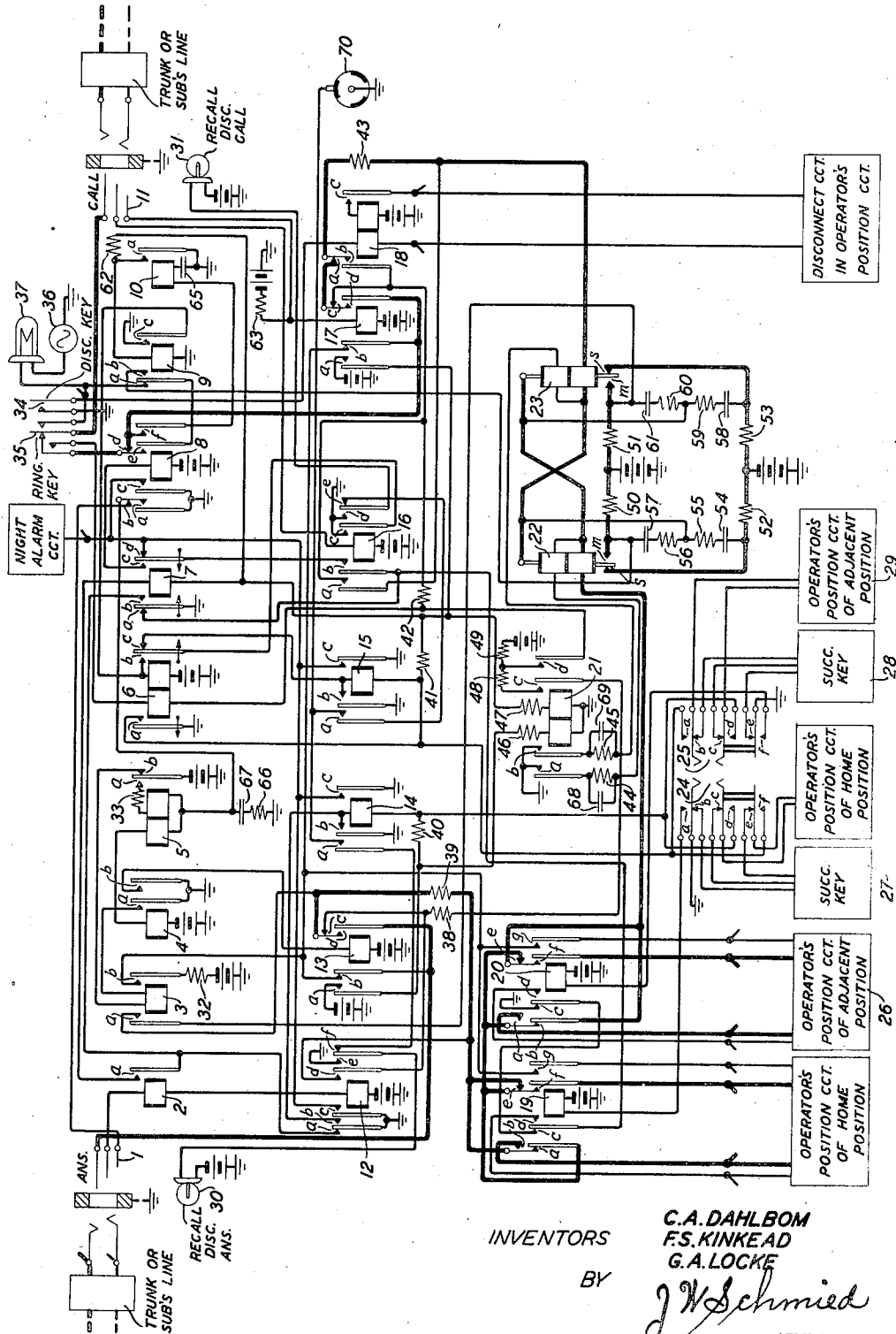
Oct. 10, 1944.

C. A. DAHLBOM ET AL

2,360,040

TELETYPEWRITER CORD CIRCUIT

Filed Nov. 7, 1941



INVENTORS
BY

C.A. DAHLBOM
F.S. KINKEAD
G.A. LOCKE

J.W. Schmied
ATTORNEY

UNITED STATES PATENT OFFICE

2,360,040

TELETYPEWRITER CORD CIRCUIT

Carl A. Dahlbom, Brooklyn, Fullerton S. Kinkead, New York, and George A. Locke, Glenwood Landing, N. Y., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application November 7, 1941, Serial No. 418,142

9 Claims. (Cl. 178—2)

This invention relates to teletypewriter switching systems and particularly to an improved manual teletypewriter cord circuit for extending connections between calling and called teletypewriter circuits. More particularly the invention is an improved cord for use in a straightforward teletypewriter switching system. One of the most important aspects of a cord circuit suitable for use in a straightforward system is that in addition to transmitting telegraph communication signals, it must be capable of transmitting supervisory signals received at one end of the cord through the cord to the other end thereof automatically without the intervention of an operator.

The disclosure of Patent 2,228,890 to F. J. Singer, January 14, 1941, includes cord circuits arranged for use in a straightforward teletypewriter switching system. The cord circuit herein may be regarded as an improvement over the cord circuits shown in the Singer patent.

An object of this invention is the improvement of teletypewriter switching systems.

A more particular object of this invention is the improvement of the cord circuit employed in manual straightforward teletypewriter switching systems.

A feature of the improved cord circuit is an arrangement wherein a supervisory signal, such as a disconnect signal, is operated by the supervisory signal means associated with the calling end of a cord and simultaneously the disconnect signal is transmitted directly through the cord to control supervisory signal apparatus in the circuits associated with the originating end of the circuit. This is done automatically without the intervention of the operator. The operator administering the cord circuit at a tandem position may be instructed to disconnect the cord in response to the supervisory signal without waiting for the reception of a disconnect signal from the originating operator. This is a time saver in switchboard operation.

Alternatively, the operator at a tandem switchboard, along the route of a straightforward call, may be instructed to disregard the disconnect signal associated with the calling end of the cord and await a disconnect signal from the originating operator. Such signal would be registered by the supervisory signal apparatus associated with the answering end of the cord. This alternative method of operation would make it possible for the originating operator to recall the called party if it were required.

A further feature of this invention is the inclusion in a cord circuit, arranged to provide straightforward supervision, of means for discriminating between various connected circuits to which supervisory signals are and are not required to be sent.

A further feature of this invention is the combining in a cord circuit, arranged for straightforward operation and in which the telegraph transmission and supervisory paths are completely independent and which cord simultaneously indicates and transmits supervisory signals, of other features, such as interfering cord lock-out, flashing recall, flashing recall release, and discrimination between connected circuits, etc.

These and other features will become apparent from the following descriptions, when read with reference to the associated drawing showing the improved straightforward cord circuit of this invention, as well as from the appended claims.

General

The invention herein is limited to an improved teletypewriter cord circuit per se. The detailed description is therefore limited to a description of the detailed operation of the cord circuit. In its relation to cooperating circuits, the operation of the cord circuit herein is disclosed by describing the conditions imposed by the cooperating circuits on the various cord circuit conductors which connect to cooperating circuits, to control the cord in the performance of its various functions.

It is pointed out that, in general, when it is explained that the cord circuit is connected to a particular circuit, to exemplify a particular operation within the cord, the conditions encountered on the conductors to which the various conductors are connected are described, but the cooperating conductors and apparatus, in the circuit external to the cord circuit of this invention, are not shown, as they are not part of the invention herein and their showing is not thought necessary to an understanding of the invention herein.

The cord circuit herein is arranged

1. To interconnect a calling subscriber's line directly to a called subscriber's line when both lines are terminated in the same teletypewriter switchboard.

2. To extend a call originating in a calling subscriber's line, in the switchboard where the cord circuit herein is located, through a trunk circuit extending to a distant central teletypewriter switching station for completion or further extension.

3. To extend a call incoming over a trunk circuit from a distant central teletypewriter switching station by means of another trunk circuit to another distant central teletypewriter switching station for completion or further extension.

4. To complete a call incoming over a trunk circuit from a distant central teletypewriter switching station directly to a called subscriber's

line having a termination in the switchboard where the cord circuit herein is located.

In performing all of the above functions, the incoming call is answered with the answering plug I. The operator's position circuit is connected temporarily to the cord. The operator communicates with the calling subscriber or with the distant central station operator through the answering end of the cord by means of the operator's position circuit. The call is completed or extended by means of the calling plug II. The operator's position circuit is disconnected from the cord to serve with other cords. The cord circuit remains interconnected in the established circuit until communication between the calling and called parties is ended. A supervisory signal, called a disconnect signal, is operated in the cord when communication is finished. The operator then takes down the cord.

The cord circuit is arranged to provide a flashing recall signal at each end of the cord so that a central station operator may be signalled by the calling or called party or by a distant central station operator as long as the cord circuit forms a link in the connection.

When the cord circuit herein is serving as a link at an intermediate central station in a tandem connection, it is arranged to receive a disconnect signal from a circuit connected to calling plug II, and immediately pass the supervisory signal, through a channel in the cord, so that the supervisory signal is impressed through the answering plug I on a trunk circuit extending toward the originating central station. Thus, in response to the reception of the supervisory signal, on the calling end of the cord, the supervisory signal is impressed on a trunk circuit connected to the answering end of the cord, to control a supervisory signal in the cord circuit at a distant office where the call originated. It is to be understood that there may be a number, such as three or four or more, central switching stations connected in tandem in such a connection. The importance of passing the supervisory signal directly through the successive cords automatically should be readily appreciated. It saves operating effort and it saves both operating time and idle line time.

The cord circuit is arranged so that the supervisory channel and the telegraph communication channel are maintained separate within the cord circuit. This distinguishes it from other cords in which the telegraph repeater relays in the cord operate in the transmission of disconnect and recall signals and discrimination between communication signals and supervisory signals is obtained through slow release relays having windings in the main transmission path. These relays are held operated while ordinary communication signals are being transmitted through the main transmission path. Disconnect and recall signals in such cords are of sufficient duration to permit the slow release relays to release to bring in the supervisory signals. In such cords the supervisory signals are subject to false operation which is avoided when the channels are separate as in the cord herein.

As mentioned above, a distinguishing feature of the cord circuit is that it is arranged so that while a supervisory signal, received through the calling plug is being automatically transmitted through the cord to the answering plug, for transmission over a trunk to another cord connected thereto, a supervisory signal is simultaneously registered in the present cord itself.

Ordinarily, in the case of tandem connections, involving the connection of subscriber's lines through two or more manual central switching offices, only the operator at the office where the call originates will respond to the supervisory signals. Operators at intermediate and completing offices in the chain will be instructed to disregard such supervisory signals and await a disconnect signal from the originating operator, which will appear on the lamp associated with the answering end of the cord. Such operation permits the originating operator to rering the called subscriber, if desired, while the chain connection through the tandem offices is still established. By providing a supervisory lamp for the calling end of each cord in the chain connection and arranging that the calling end supervisory lamp in each cord is operated, in response to a supervisory signal transmitted by the called party, while simultaneously the supervisory signal is automatically transmitted through each of the tandem cords toward the originating office, it is possible to disconnect the cords at each office as soon as the disconnect signal is registered, without waiting for a second disconnect signal to be automatically transmitted in the reverse direction as each cord, starting with the originating cord at the calling office is disconnected.

Which of the above two methods of operation is used with the cord circuit herein is a matter of choice. The particular method used would depend upon the percentage of calls which were found to require the attention of the originating operator to perform some service requiring the complete connection through to the called subscriber at the end of a call and would vary for different areas and different types of service.

The cord circuit herein is arranged for direct ringing or through ringing. Direct ringing is performed by actuating a key in the cord which connects a ringing supply circuit which furnishes 20-cycle alternating current to the calling end of the cord. Direct ringing is used when the cord is used as the originating cord on a tandem connection. It is also used when the cord is used to interconnect two subscribers directly. This is possible when both the calling and called line terminate at the same switchboard.

By through ringing is meant ringing by remote control. Through ringing is used on tandem connections. The ringing through the intermediate and completing cords is performed by remote control by operating a key in the cord at the central office to which the calling subscriber is directly connected.

The through ringing arrangement in the present cord operates as follows: Twenty-cycle alternating current is connected to the tip conductor of the calling end of the originating cord manually by the operation of a key. The ringing current is transmitted over the tip conductor of the calling end of the cord and the tip conductor of the trunk circuit interconnecting the central offices and through the tip conductor of the answering end of the intermediate cord or completing cord depending on the number of central offices in the tandem connection. The 20-cycle ringing current operates the cord circuit repeater relay associated with the answering end of the cord. This connects 20-cycle reversals of positive and negative direct current through the winding of an alternating current relay associated with the calling end of the same cord. This in turn connects another 20-cycle alternating current ringing supply circuit to the calling end of

the intermediate or completing cord. This is impressed on the called subscriber's line in the case of a completing cord. Or, alternatively, the procedure may be repeated through as many tandem offices as required to a remote completing office.

It will be observed that in this system of operation 20-cycle alternating current is transmitted over the trunks interconnecting central offices and over the called subscriber's line to operate the ringer therein. This method has been found more reliable particularly over long circuits than 20-cycle reversals of positive and negative direct current used by cord circuits presently employed.

Answering incoming call from subscriber line

A line signal indicating that a call is incoming from a subscriber's line is answered by inserting the answering plug 1 in the jack associated with the line, shown at the left of the drawing. When the answering plug 1 is first connected to a calling subscriber's line circuit, only two conductors connected to the cord plug 1 are engaged. These are the tip and sleeve conductors. The tip and sleeve conductors are the top and bottom conductors of the plug. The ring or middle conductor is not engaged in responding to a call as the corresponding conductor on the ring of a subscriber's jack is open for the calling condition. The sleeve conductor of the answering plug is connected to ground through the winding of a relay in the sleeve circuit of the calling line and the circuit extends from the sleeve, or bottom conductor, of plug 1 through contact 8b, left-hand winding of relay 5 and the winding of relay 4 to battery. Relays 4 and 5 in the cord circuit operate. The operation of relay 4 establishes a circuit from ground through contact 4b and the winding of relay 13 to battery operating relay 13. The operation of relay 13 operates relay 21 from battery through contact 13a, resistance 46 and the left-hand winding of relay 21 to ground. The operation of relay 21 closes ground to the artificial line circuits of repeater relays 22 and 23. The operation of relay 21 also provides holding battery for the line windings of relays 22 and 23, when required, to hold the armatures of these relays on their marking contact. This will now be described in more detail.

Relays 22 and 23 are shown with their armatures in engagement with their spacing contacts. Before plug 1 is inserted in a jack and before relay 21 is operated, no current flows through any of the windings of relays 22 and 23. When plug 1 is inserted into a jack the tip of plug 1 is connected to the tip of the associated subscriber's line circuit. When the subscriber's line circuit is closed for the marking condition, a loop is established through the line circuit and the return conductor is terminated in negative battery. From the tip of plug 1 the circuit extends through contact 13d, resistance 39, contacts 19a and 19e in parallel, contact 20b and 20e in parallel and the bottom winding of relay 22 to the armature of relay 23. When the armature of relay 23 is in engagement with its spacing contact 23s, as shown, the circuit extends through resistance 53 to negative battery. Since both ends of the loop are terminated in battery of the same magnitude and polarity for this condition, no current flows in the loop and the bottom winding of relay 22 is deenergized. With relay 21 operated a circuit may be traced from ground through contact 21a, resistance 44, top winding

of relay 22, armature of relay 23, contact 23s and resistance 53 to negative battery. The effect of current flowing in this path energizes the top winding of relay 22 and its effect actuates the armature of relay 22 to engage with its marking contact 22m. The operation of relay 21 also provides a path from negative battery through resistance 49, contact 21d, resistance 42, contact 17c, contact 18a, resistance 43 and the bottom winding of relay 23 to the armature of relay 22. When the armature is in engagement with its marking contact 22m, the circuit is extended through resistance 50 to positive battery. It will be observed that the opposite ends of this path are terminated in batteries of opposite polarity so that the batteries are in series-aiding relationship. Full line current, therefore, flows through the bottom winding of relay 23. A circuit may also be traced from ground through contact 21b, resistance 45 and the top winding of relay 23 to the armature of relay 22. When the armature of relay 22 is in engagement with its right-hand or marking contact 22m, the circuit extends through resistance 50 to positive battery. The effect of current flowing in the bottom or line winding of relay 23 tends to actuate the armature of relay 23 to engage with its left-hand or marking contact. This effect is opposed by the effect of current flowing through the top winding of relay 23 and tending to actuate the armature of relay 23 to engage with its right-hand or spacing contact 23s. The effect of the current in the bottom or line winding of relay 23 preponderates for this condition and the armature of relay 23 is actuated so as to engage with its left-hand or marking contact 23m. When the armature of relay 23 engages with marking contact 23m, the subscriber's loop is terminated in the circuit extending through resistance 51 to positive battery. For the marking condition, therefore, when the subscriber's loop circuit is closed, since the line end is permanently terminated in negative battery, and the cord end for marking is terminated in positive battery, the batteries are in series-aiding relationship for the marking condition. Full line current, therefore, flows through the bottom or line winding of relay 22 for the marking condition. The effect of this current will maintain the armature of relay 22 in engagement with its right-hand or marking contact 22m. The direction of current flow through the top winding of relay 22 is reversed when the armature of relay 23 engages with its marking contact. The effect of current in the top winding of relay 22 for this condition tends to actuate the armature of relay 22 towards its left-hand or spacing contact 22s, but it is ineffectual, since the effect of current in the bottom or line winding of relay 22 is dominant and the armature of relay 22 is maintained in engagement with its right-hand or marking contact 22m. When the armature of relay 22 is in engagement with its right-hand or marking contact 22m, the direction of the flow of current through the top winding of relay 23 is reversed. This tends to actuate the armature of relay 23 to engage with its spacing contact 23s, but the effect of current in the bottom or line winding of relay 23, tending to actuate the armature of relay 23 towards contact 23m, is dominant and the armature of relay 23 is maintained in engagement with its left-hand or marking contact 23m.

In tracing the sleeve circuit in the cord, it was shown to extend through the left-hand winding of relay 5 and the winding of relay 4 to negative

battery. This is a high resistance path. After relay 5 has been operated a parallel low resistance locking path for relay 5 is established extending through the right-hand winding of relay 5 and resistance 33 to negative battery. The object of this is to establish a low resistance sleeve circuit to provide protection against interference caused by the connection of more than one cord circuit simultaneously to the same line circuit.

Prevention of interference when more than one cord is connected simultaneously to one line

The manner in which interference is prevented when more than one circuit, such as, the cord herein, is connected to the same line circuit simultaneously, will now be described.

If an interfering cord is plugged into one of the multiple jacks of the seized line circuit, the relay corresponding to relay 4 in the interfering cord will operate, but the relay in the interfering cord corresponding to relay 5, which is a marginal relay, will not operate, owing to the shunting effect of the low resistance sleeve circuit of the first cord. Relay 4 of the interfering cord, when operated, operates relay 13 of the interfering cord in the same manner as described above. The operation of relay 4 in the interfering cord also operates relay 3 in the interfering cord, over a circuit corresponding to that which may be traced from ground through contact 4a, winding of relay 3 and contact 5b to battery. As explained above, the relay corresponding to relay 5 in the interfering cord is not operated, and therefore the path through contact 5b is available for operating the relay corresponding to relay 3 in the interfering cord.

The operation of relay 13 in the interfering cord in turn operates relay 21 in the interfering cord. The corresponding path has heretofore been traced. This energizes the biasing windings of the polar repeater relays corresponding to relays 22 and 23 in the interfering cord. It also supplies negative battery to the line winding of the relay corresponding to relay 23 in the interfering cord. In the interfering cord the operation of relay 3 establishes a circuit which may be traced from positive battery through resistance 51, contact 3a, resistance 39, contacts 19a and 19e in parallel, contacts 20b and 20e in parallel and the bottom or line winding of relay 22 to the armature of relay 23. For this condition the armature of the polar relay in the interfering cord corresponding to relay 23 will be actuated so as to engage with its marking contact. The armature of the relay corresponding to relay 22 in the interfering cord will be actuated so as to engage with its spacing contact. This prevents transmission through the interfering cord.

In the operator's position circuit associated with the interfering cord a signal is provided to indicate the interfering condition in the following manner. In the interfering cord the operation of key 24 or key 25 will operate relay 19 or relay 20 over obvious circuits. This connects the operator's position circuit at the home or adjacent position to the interfering cord. A circuit is then established from negative battery through resistance 32, contact 3b, and contact 19g or contact 20g depending upon which key has been operated. The armatures associated with these contacts are each connected to a relay in its associated operator's position circuit which controls a signal, such as the lighting of a lamp, to indicate the interfering condition. Upon observ-

ing this the interfering operator will disconnect the interfering cord.

During the interval while the interfering cord was connected, the positive battery supplied from the interfering cord through resistance 51 and contact 3a to the tip transmission conductor to operate the armature of polar relay 22 in the interfering cord to spacing and prevent transmission through the interfering cord, was impressed also through contact 13d of the interfering cord, relay 13 being operated, on the tip of the plug of the interfering cord. The tip of the interfering cord is connected to the tip of one of the subscriber's line jacks. The subscriber's line jacks of a particular line are all connected in multiple. The tip of the original cord is therefore connected in parallel with the tip of the interfering cord. As a result of this the armature of polar relay 22 of the original cord is also actuated to its spacing contact and maintained thereon as long as the interfering cord remains connected. Thus transmission through either cord is prevented while the interfering condition persists. When the interfering cord is removed and the actuated typing key therein is restored to normal the relays in the interfering cord are all restored to normal. The armature of polar relay 22 of the original cord is returned to its marking contact and transmission through the original cord may be resumed.

Connection to operator's position circuit

A number of the cord circuits herein, such as fifteen, may be located at a particular operator's position in a switchboard. The position is provided also with a single operator's position circuit. Adjoining positions in the switchboard are similarly equipped with, say fifteen cords and one position circuit. When a particular cord circuit is selected for use, it is necessary to connect a position circuit to that particular cord temporarily, so as to provide means whereby the operator at a particular position may communicate with the subscriber and receive the number of the called party or whatever direction is to be passed to the operator. After the operator has received this information and performed the necessary switching function or whatever function may be required, the position circuit is disconnected from the particular cord so as to be available for connection to other cords as required. The circuit herein is arranged in such a manner that it may be connected to a position circuit at the particular position where the cord circuit is located, or it may be alternatively connected to an operator's position circuit at an adjoining position. This feature is provided so that operators at adjoining positions may function as a team during periods of heavy load.

The invention herein does not include the operator's position circuit with which the cord circuit herein cooperates. Each cord circuit at a particular position is provided with two keys. One key connects the operator's position circuit located in the same position at which the cords are located to the particular cord. The other key connects the operator's position circuit in an adjoining position to the cord circuit. If it is desired to connect the operator's position circuit located at the same position as that at which the cord circuit is located to the cord, key 24 is operated. This establishes a circuit from ground through contact 24a and the winding of relay 19 to battery operating relay 19. The operation of relay 19 opens the transmission path inter-

connecting the tip of plug 1 and the bottom winding of polar relay 22 at two points, namely at contacts 19a and contacts 19c and connects the transmission circuit of the operator's position circuit in series between continuity contacts 19b and 19f. The operation of key 25 establishes a circuit from ground through contact 25f and the winding of relay 20 to battery operating relay 20. This inserts the transmission circuit of the operator's position circuit at an adjoining position between the tip of plug 1 and the bottom winding of polar relay 22. Contacts 20b and 20c in series in the transmission path through the answering end of the cord are opened and the transmission circuit through the adjacent operator's position circuit is inserted in series between continuity contacts 20a and 20f. The operation of relays 19 and 20 perform other switching functions which will be described hereinafter.

After the operator has communicated with the calling subscriber and obtained the necessary switching information she will perform the switching function required and then restore either key 24 or key 25 to normal releasing relay 19 or relay 20. This disconnects the associated position circuit from the particular cord and re-establishes the original transmitting path between the tip of plug 1 and the bottom winding of relay 22.

Busy test

A busy test is made by touching the tip of either answering plug 1 or calling plug 11 to a sleeve of a line jack before inserting the plug into the jack in order to guard against double connections. If the circuit associated with the line jack is busy, due to the connection of another cord to one of the multiple appearances of the jack at other positions in the board, negative battery will be connected to the sleeve of the jack from the sleeve of the associated answering or calling plug of the other connected cord.

If an answering plug of a cord similar to the cord herein is inserted in one of the multiple appearances of a jack, battery will be supplied to the sleeve of that jack over a circuit which may be traced from negative battery over parallel paths. The first branch extends through the winding of relay 4 and the left-hand winding of relay 5. The second branch extends through contact 5a, resistance 33 and the right-hand winding of relay 5. The branches join and the path continues through contacts 8b and the sleeve of plug 1 to the sleeve of the jack. If the calling plug, such as 11, of a cord circuit similar to the cord herein has already been inserted in one of the multiple appearances of the jack, negative battery is supplied through the winding of relay 17 and resistance 63 in parallel and the sleeve of plug 11 to the sleeve of the jack. Attention is called to the fact that when the testing is performed by touching the tip of the plug to the sleeve of the jack the whole plug is not inserted into the jack and the relays controlled by the sleeve circuit of the cord which is testing will not be operated. Before making a busy test an operator will operate either key 24 or key 25 in the particular cord to its alternate position.

It will be assumed first that the testing is performed by touching the tip of plug 1 to the sleeve of a jack on which negative battery has been impressed from another cord. Negative battery on the sleeve of the jack is impressed

through the tip of plug 1, contact 13b and, if key 24 has been actuated, through contact 19g and over a conductor which extends into the home operator's position circuit, through the winding of a relay connected thereto, to light a busy test lamp in the position circuit as an indication of the busy condition. If key 25 has been operated so that relay 20, rather than relay 19, has been operated, to connect the operator's position of the adjacent position to the particular cord, the circuit extends through contact 20g to corresponding apparatus in the adjacent operator's position circuit.

If the calling plug is to be used in establishing a connection the busy test will be made by first touching the tip of plug 11 to the sleeve of the jack. If the jack circuit is already busy, negative battery will be impressed through the tip of plug 11, break contact of ringing key 35, contact 8d, contact 17b and through either contact 19g or 20g to light the busy lamp in the same manner as described above.

Calling open loop subscriber line

Before connecting the calling cord to a subscriber's line the operator will operate either key 24 or 25 to connect a position circuit to the cord as described above. When the calling plug 11 is connected to a subscriber's line, ground will be connected from the associated circuit to the sleeve of plug 11 and the circuit extends through the winding of relay 17 to battery in parallel with resistance 63. Relay 17 operates. The operation of relay 17 establishes a circuit from battery through contact 17a, resistance 62 and the winding of relay 9 to ground, operating relay 9. The operation of relay 17 also closes the transmission circuit of the calling end of the cord at contact 17d. The circuit may be traced from the tip of plug 11 through the break contact of ringing key 35, contact 8d, contact 17d, contact 18a, resistance 43, bottom winding of polar relay 23, armature of polar relay 22, contact 22m and resistance 50 to positive battery. A circuit is also established from ground on the ring of the line circuit through the ring of plug 11 and the winding of relay 16 to battery operating relay 16. Relay 15 does not operate at this time, as direct ground is connected from the position circuit through contact 24f or contact 25a to the bottom terminal of relay 15. Therefore, battery supplied through contacts 17a and resistance 41 finds a low resistance path shunting the path through the winding of relay 15, contact 6c and contact 16c to ground. The operation of relay 16 provides a circuit extending from ground through contacts 16d and the filament of lamp 31 to battery, lighting lamp 31, which remains lighted until the call is answered. The operation of relay 16 also establishes a circuit from ground through contact 7a, contact 16b and contact 7d to the conductor extending into the night alarm circuit. The operation of relay 16 also connects negative battery to the transmission circuit to hold polar repeater relay 23 on its marking contact pending the subscriber's answer. The circuit may be traced from negative battery through resistance 49, contact 21d, resistance 42, contact 16a, bottom winding of polar repeater relay 23, armature or relay 22, contact 22m and resistance 50 to positive battery.

The subscriber is signaled by actuating ringing key 35 to close its right-hand contact. This establishes a circuit from a common ringing supply for all of the cords, which extends from

ground through the alternating current ringing generator 36, filament of lamp 37, right-hand contact and armature of ringing key 35 and the tip of calling plug 11. The tip circuit of the subscriber's line circuit to which calling plug 11 is connected is grounded at the subscriber's station through a condenser in series with a ringer, which ringer is actuated by the alternating ringing current to attract the subscriber's attention. When ringing key 35 was operated to ring the subscriber's station, a circuit was also established to operate relay 6. This circuit extends from battery through resistance 49, contact 21d, left-hand winding of relay 6, left-hand make contact of key 35, contact 8d, contact 17d, contact 18a, resistance 43, bottom winding of polar relay 23, armature of polar relay 22, contact 22m and resistance 50 to positive battery. In parallel with a portion of this circuit, between the bottom terminal of the left-hand winding of relay 6 and the bottom terminal of resistance 43, is a second branch extending through resistance 42 and contact 16a. When relay 6 operates it locks from battery through its right-hand winding, contact 6b and contact 16c to ground. The operation of relay 6 also opens the path through the winding of relay 15. When the subscriber responds, the transmission loop circuit extending through the subscriber's station is closed. This actuates the relays in the subscriber's line circuit at the central station to disconnect ground from the ring circuit to which the ring of plug 11 is connected. This, in turn, releases relay 16.

The release of relay 16, when the subscriber answers, opens contact 16a through which negative battery was supplied to the right-hand terminal of the bottom winding of polar relay 23, to hold the armature of this relay on its marking contact during the interval pending the answering of the call by the subscriber. When the subscriber answers, the tip and ring conductors of the line circuit at the subscriber's station are connected. The ring circuit of the subscriber loop is terminated in negative battery. This negative battery takes the place of the negative battery supplied through resistance 49 to hold the armature of polar relay 23 on marking and the armature is thereafter held in engagement with its marking contact by the negative battery supplied around the subscriber's loop circuit to the tip of the calling cord.

The release of relay 16, when the subscriber answers, releases relay 6, by opening contact 16c which supplies ground to the holding winding of relay 6. The release of relay 16 also breaks the circuit heretofore traced through the filament of lamp 31, extinguishing the lamp, as a signal that the subscriber has answered. The release of relay 16 also opens the circuit to the night alarm heretofore traced. The transmission path through the calling side of the repeater is now established.

When it is necessary to ring on the answering cord, the position circuit is connected to the cord by operating key 24 or 25. A key is operated in the position circuit to control a relay in the position circuit which connects continuous ringing current from the position circuit to the tip or transmitting conductor of the answering side of the cord.

Answering incoming call from an automatic signaling intertoll trunk

Now the manner in which the cord circuit herein functions when it is used to answer a call

incoming over an automatic signaling trunk will be described. When the answering plug 1 of the cord herein is connected to an automatic signaling intertoll trunk, all three conductors, tip, ring and sleeve, of the plug engage corresponding conductors connected to the jack of the trunk. The tip and sleeve connections in the trunk are the same as described above. The ring connection in the trunk extends to ground through a high resistance. Relays 4 and 5 operate in the same manner as described above. Relay 2 operates over a circuit from the high resistance ground on the ring of the jack through the windings of relays 2 and 12 to battery. Relay 12 does not operate due to the high resistance in the ring circuit. The operation of relay 2 closes a circuit which extends from ground through contact 12a, contact 2a and the winding of relay 7 to contact 17a which is open. The reason for this will become apparent below.

The operation is otherwise the same as described above for the connection to an open loop subscriber's line.

Calling open loop subscriber when the answering cord is connected to automatic signaling intertoll trunk

The cord circuit herein may be used to complete a call incoming over an automatic signaling intertoll trunk to an open loop subscriber's line. Under such circumstances a signal associated with the incoming end of an automatic signaling intertoll trunk will indicate that a call is incoming over such a trunk. The operator will respond by connecting plug 1 of the answering cord to the jack of the incoming automatic trunk. For this condition as described above, all three conductors, tip, ring and sleeve of the answering plug 1 will be engaged. The ring and sleeve will each be connected to ground in the automatic trunk. The ring of the automatic trunk is grounded for this condition through a high resistance. Relay 2 will operate from this ground over a circuit through the windings of relays 2 and 12 to battery. Relay 12 will not operate due to the high resistance in the ring of the connected circuit. Relay 5 and relay 4 will both be operated by ground connected to the sleeve of the plug over a circuit heretofore traced. Relay 5 will lock as described heretofore. When the call from the automatic trunk, to which the answering plug 1 is connected, is extended by means of plug 11 to the subscriber's line all three conductors, tip, ring and sleeve will be engaged. Relay 17 will be operated from ground connected to the sleeve of the subscriber's line. The operation of relay 17 closes the transmission circuit at contact 17d. The operation of relay 17 also operates relay 9. These circuits have been traced heretofore. Since relay 2 was operated when plug 1 was connected to the automatic trunk, the operation of relay 17 also operates relay 7 over a circuit which may be traced from battery through contacts 17a, winding of relay 7, contact 2a and contact 12a to ground.

Relay 16 is operated from ground on the ring conductor of the line circuit through the ring of plug 11 and the winding of relay 16 to battery. As either key 24 or key 25 was operated before the plug was inserted in the subscriber's line jack, ground is supplied from the position circuit through either contact 24f or 25a to the bottom terminal of relay 15. The closing of contact 17a, therefore, which establishes a circuit from battery through contact 17a and resistance 41

to the bottom terminal of relay 15, does not operate relay 15, as the direct ground supplied from the position circuit shunts the path to ground through the winding of relay 15, contact 6c and contact 16c. The operation of relay 16 lights lamp 31 over a circuit from battery through the filament of the lamp and contact 16d to ground. Lamp 31 will remain lighted until the subscriber answers, when it will be extinguished in a manner to be described below. The operation of relay 16 also supplies negative battery to hold the armature of relay 23 in engagement with its marking contact during the interval before the calling subscriber answers. The negative battery is supplied over a circuit extending through resistance 49, contact 21d, resistance 42 and contact 16a to the right-hand terminal of the bottom or line winding of polar relay 23. The operation of relay 16 establishes a circuit which may be traced from battery through the winding of relay 8, contact 7c, contact 16b, contact 19c and contact 20c to ground operating relay 8. The operation of relay 8 opens the sleeve circuit of the answering cord at contact 8b to transmit a supervisory signal back over the circuit connected to plug 1 to the originating cord. The operation of relay 8 also disconnects the path to ground through the sleeve of the automatic trunk circuit and substituted instead ground through contact 8a, to hold relays 4 and 5 operated. The operation of relay 8 also supplies ground to the night alarm circuit through contact 8c. The subscriber is signaled in the same manner as described above for calling an open loop subscriber's line.

When the subscriber answers, ground is disconnected from the ring circuit of the subscriber's line which opens the path through the winding of relay 16, releasing relay 16. The release of relay 16 extinguishes calling lamp 31 to indicate that the called subscriber has responded. The release of relay 16 also opens the path from negative battery through contact 16a which was holding the armature of polar relay 23 on its marking contact during the interval before the subscriber responded. The release of relay 16 also releases relay 6 which was locked through contact 16c. The release of relay 16 also releases relay 8, the operating path for which extended through contact 16b. The release of relay 8 restores the sleeve circuit of the answering cord to normal and again transmits a supervisory signal to the originating office to indicate that the subscriber has answered. The release of relay 8 also removes the ground from the night alarm circuit. The cord is now ready for communication.

Ringling the subscriber from the outward operator

When answering cord 1 is connected to an automatic signaling intertoll trunk and calling cord 11 is connected to a subscriber's line and a disconnect signal exists from the subscriber, the outward operator at the distant end of the intertoll trunk can signal the subscriber by transmitting 20-cycle alternating current ringing from her cord circuit. This ringing current will be transmitted over the automatic signaling intertoll trunk to the local cord circuit.

At any time when it would be necessary to ring the subscriber's line to which the calling cord 11 is connected, the line would be in the disconnect condition. By this is meant that the tip circuit of the line would be connected to ground through

a condenser and a ringer at the subscriber's station. The transmission path through the subscriber's station would be open. The ring and sleeve conductors, to which the ring and sleeve of the calling plug 11 would be connected, would each be terminated in ground. Relay 8 would be operated in the manner described above. This would transmit a supervisory signal back to the originating cord as a signal that the connection was established and that the originating operator should ring. Twenty-cycle reversals of direct current incoming from the automatic signaling intertoll trunk will actuate the armature of relay 22 between its marking and spacing contacts at 20-cycles per second. This will send pulses of positive and negative current at 20-cycles per second over a circuit which extends from the marking and spacing contacts of polar relay 22 through the armature of relay 22, bottom winding of relay 23, contact 17d, contact 9f, winding of relay 10 and condenser 55 to ground operating relay 10. The operation of relay 10 will connect a direct ground to the top terminal of relay 9, thereby shunting the path through the winding of relay 9, which was operated in a manner described above, releasing relay 9. A circuit will then be established from ground through a source of alternating ringing current 36, filament of lamp 37, contact 9a, contact 8e, break contact and armature of ringing key 35 and the tip of calling plug 11 out over the tip of the subscriber's line to actuate the ringer in which the tip of the subscriber's line is terminated. Relay 16, which is operated from ground on the connected ring circuit, supplies negative battery to the right-hand terminal of polar relay 23, in the manner described above, to hold the armature of relay 23 in engagement with its marking contact until the subscriber answers. During the periods between the ringing intervals, relay 10 will release. This disconnects the direct ground from the top terminal of the winding of relay 9 and relay 9 will reoperate. While relay 9 is reoperated positive battery will be supplied over a path through resistance 50, contact 9b and contact 8e to the tip of the calling cord. When the subscriber answers ground will be disconnected from the ring and sleeve conductors of the subscriber's line releasing these relays. This, in turn, releases relays 8 and 9 as described above and the circuit is conditioned for communication.

Calling on ringdown intertoll trunk

When the calling cord 11 is connected to a ringdown intertoll trunk the tip and sleeve conductors are engaged. The ring of calling cord 11 is connected to an open circuit and the sleeve of calling cord 11 is connected to ground through a low resistance relay winding in the ringdown trunk. Relay 17 operates but relay 16 remains unoperated. In calling on such a trunk ringing source 36 is not employed. The call signal is transmitted by opening the tip or transmitting conductor for an interval of two seconds. This is performed by first operating either key 24 or key 25 to connect an operator's position circuit in series with the transmission path through the answering end of the cord. A key in the operator's position circuit is operated to open the transmission loop through the position circuit under control of a relay therein. When the transmission path through the bottom winding of polar relay 22 is thus open the armature of relay 22 is actuated so as to engage with its spacing contact,

under the influence of current through its top or biasing winding. This condition is maintained for two seconds resulting in the reception of a call signal at the distant end of the ringdown trunk.

Transmission through cord circuit

Teletypewriter communication through the cord circuit is effected by operation of the single line polar repeater relays 22 and 23, which are arranged with local circuits which serve to bias the relay when the associated line circuit is closed and to hold the relay when the associated line circuit is open. Thus in transmitting from the answering end of the cord toward the calling end of the cord, when the armature of relay 22 is on its right-hand or marking contact a biasing potential from positive battery through resistance 50, armature of relay 22, top winding of relay 23, resistance 45 and contact 21b is supplied to the top winding of relay 23. This opposes the effect of the line current through the bottom winding of relay 23. The effect of the line current is greater than the effect of the biasing current and the armature of relay 23 is held in engagement with its left-hand or marking contact. When the armature of relay 22 is actuated so as to engage with its left-hand or spacing contact the current in the bottom or line winding of relay 23 is reduced to zero. But the polarity of the current supplied from negative battery through resistance 52, contact 22s, armature of relay 22, top winding of relay 23, resistance 45, and contact 21b is reversed and its effect holds the armature of relay 23 in engagement with its left-hand or marking contact.

In the transmitting from the calling end of the cord toward the answering end of the cord, when the armature of relay 23 is in engagement with its left-hand or marking contact, positive battery is supplied through resistance 51, contact 23m, armature of relay 23, top winding of relay 22, resistance 44 and contact 21a to ground. The effect of this current opposes the line current in the bottom winding of relay 22, but the effect of the line current preponderates and the armature of relay 22 is held in engagement with its right-hand or marking contact. When the armature of relay 23 is actuated to engage with its right-hand or spacing contact negative battery is supplied through resistance 53, contact 23s, armature of relay 23, top winding of relay 22, resistance 44 and contact 21a to ground. The line current through the bottom winding of relay 22 has been reduced to zero, but the effect of the current through the top winding of relay 22, since its direction has been reversed, holds the armature of relay 22 in engagement with its right-hand or marking contact.

Recall signal

The cord circuit herein is arranged to receive a recall signal over either the answering end of the cord or the calling end of the cord. The condition requisite for the reception of a recall signal in each case is that direct ground be connected momentarily to the ring of the associated answering plug 1 or calling plug 11 from the connected circuit, followed by the restoration of an open or high resistance ground condition. Attention is called to the fact that in the case of any connecting circuit in which the ring circuit may be open for an incoming call, the connecting circuit must be arranged to connect ground to the ring of the cord to operate the supervisory signals in the cord.

In the case of a recall signal received over the

answering end of the cord the direct ground on the ring conductor will operate relays 2 and 12. If received over the calling end of the cord the direct ground on the ring conductor will operate relay 16. If the momentary ground occurs on the ring of calling cord 11 and answering cord 1 is connected to an automatic signaling intertoll trunk, the operation of relay 16 will be followed by the operation of relay 8 in a manner described above. The operation of relay 8 in turn will open the sleeve circuit of the answering cord at contact 8b to transmit a supervisory signal back to the originating cord. The operation of relay 16 will in turn operate relay 15 over a circuit from negative battery through contact 17a, resistance 41, winding of relay 15, contact 6c and contact 16c to ground. When relay 15 operates it locks to ground through contact 15b. Upon the removal of the direct ground from the ring of the plug 11, relay 16 releases and establishes a path for flashing lamp 31 as a recall signal. This path may be traced from battery through the filament of lamp 31, contact 16e and contact 15a to ground through interrupter 70.

If the recall signal is received from the circuit to which plug 1 is attached the momentary ground operates relays 2 and 12 which in turn operates relay 14. The circuit may be traced from negative battery through contact 13a, resistance 40, winding of relay 14 and contact 12b to ground. Relay 14 locks through contact 14b. The removal of the temporary direct ground from the ring of plug 1 releases relays 2 and 12. This establishes a circuit for the flashing of lamp 30 as a recall signal. The circuit may be traced from battery through the filament of lamp 30, contact 12f and contact 14a to ground through interrupter 70.

When lamp 30 or lamp 31 is flashed to recall the operator the flashing of the lamp may be terminated by operating the home typing key 24 or the position typing key 25. This, as has been shown, results in the connection of direct ground from the position circuit to the bottom terminal of relay 15, shunting the path through the winding of relay 15, as described above, and releasing the relay. It also results in the connection of direct ground to the bottom terminal of relay 14 to perform the same function in the same manner. When relay 14 or relay 15 is released, the path to ground through interrupter 70 is opened for the associated lamp and the flashing is terminated.

The cord circuit herein is arranged for transmitting a recall signal over a connected ringdown intertoll trunk connection. In performing this operation typing key 24 or 25 is operated to connect the associated position circuit to the cord circuit. Then the transmission circuit through the associated position circuit is opened for a measured interval by controlled means in the associated position circuit. This results in the transmission of a spacing signal from the repeater in the cord circuit for an interval of seven seconds as a recall signal over the ringdown intertoll trunk.

Receiving a disconnect signal

A disconnect signal is received as a steady direct ground over the ring of the plug connected to the circuit transmitting the disconnect signal. The steady direct ground will operate either relays 2 and 12 or relay 16 depending upon whether the disconnect signal is transmitted by the circuit to which the plug 1 is connected or by the circuit to which plug 11 is connected. The

operation of relay 12 lights lamp 30 as a disconnect signal. The operation of relay 16 lights lamp 31 as a disconnect signal. The circuits have heretofore been traced. Since neither key 24 nor key 25 is operated at this time ground is not provided for shunting the path through the winding of relay 14 or relay 15 as described above and these relays operate at this time. However, since relay 12 and relay 16 remain operated due to the steady ground connected to the corresponding ring circuit for this condition, the circuit for each lamp remains terminated in steady ground supplied through the contact of relay 12 or 16 to maintain the lamp continuously lighted and the operation of the flashing relay 14 or 15 performs no function at this time.

In the description above it has been pointed out that a steady lamp is used as a disconnect signal and a flashing lamp as a recall signal. There is of course no reason why a flashing lamp may not be used as a disconnect signal and a steady lamp as a recall signal if the cooperating circuits are arranged to supply the proper conditions to the ring and sleeve circuits of the cord circuit herein to bring in a flashing lamp as a disconnect signal and the steady lamp as a recall signal.

As a matter of fact in cooperating with one particular type of circuit, namely, a carrier-operated toll line station circuit, the conditions imposed on the ring circuit of the cord circuit herein are such that lamp 30 or lamp 31 is flashed to indicate a disconnect signal. In order to effect this a momentary direct current is connected to the ring of the associated plug of the cord herein to operate either relay 12 or relay 16 and then the direct ground is removed to release relay 12 or relay 16 to bring in a flashing lamp as described above. The only difference of course is in what the signals indicate. The flashing lamp in this instance indicates a disconnect rather than a recall signal.

Through supervision

The cord circuit herein as indicated above is arranged to pass a supervisory signal received from a circuit to which one plug is connected directly through the cord to another circuit to which the other plug is connected. For instance, when answering plug 1 is connected to an automatic signaling intertoll trunk and the calling plug 11 is connected to another circuit, a disconnect signal received from the circuit to which calling plug 11 is connected will be transmitted through the cord circuit directly to the automatic signaling intertoll trunk. This is effected by the opening of the sleeve circuit of answering plug 1 at contact 8b when relay 8 is operated. The manner in which relay 8 is operated is described above for such a connection.

Transmitting a disconnect signal for ringdown trunks

A disconnect signal for ringdown intertoll trunks is transmitted by momentarily operating key 34. This establishes a circuit from ground through the contact of key 34 and the right-hand winding of relay 18 to a conductor common for all cords which extends through the made contacts of a relay in the connected position circuit to battery operating relay 18. When relay 18 is operated it locks over a circuit from battery through its right-hand winding and contact 18c, through a conductor, also common to all cords, which extends into the position circuit through

the winding of a relay therein to ground, through the made contacts of a second relay in the position circuit. The relays in the position circuit control a selector. The selector is operated for a period of ten seconds. During this interval relay 18 remains operated opening the tip or transmission circuit of the calling end of the cord. The operation of relay 18 also establishes a circuit from negative battery through resistance 49, contact 21d, resistance 42, contact 18b and resistance 43 to the right-hand terminal of the bottom winding of polar relay 23 to hold the armature of relay 23 in engagement with its marking contact during the ten second interval. The ten second open interval of the tip circuit serves as a disconnect signal which is transmitted over the circuit to which calling plug 11 is connected.

Conference connection

The cord circuit herein is arranged for establishing a conference connection by means of which it is possible for a group of subscribers, such as three or more, to communicate simultaneously. The conference circuit itself is well-known in the art. In order to establish a conference connection a calling party is answered by means of answering plug 1. After it has been established that the calling party wishes to communicate with a group of subscribers simultaneously, calling plug 11 is connected to one of the means of access to the well-known conference circuit. Other subscribers are interconnected to other means of access to the same conference circuit. Since the conference circuit is well-known in the art, it is not thought necessary to describe this operation in detail.

Description of functions of various other apparatus

Resistance 63 which is connected in shunt with the winding of relay 17 is a non-inductive resistance shunt around the winding of relay 17 in the sleeve circuit to prevent shocks when connections are being established by means of plug 11.

Resistance 66 and condenser 67 are connected to the sleeve of plug 1 to reduce the possibility of shock while connections are being established through plug 1. Condenser 54 and resistance 55 shunt contacts 22s to protect these contacts against the effect of sparking. Condenser 57 and resistance 56 shunt contacts 22m, condenser 58 and resistance 59 protect contacts 23s and condenser 61 and resistance 60 protects contacts 23m for the same reason.

The function of condensers 68 and 69 which shunt resistances 44 and 45 in the artificial line circuits of polar relays 22 and 23 is to provide anti-kickoff protection.

What is claimed is:

1. In a manual teletypewriter switching system, a manual teletypewriter cord circuit, a calling plug and an answering plug both in said circuit, means in said circuit for registering in said circuit a supervisory signal impressed on said calling cord and means also in said circuit for simultaneously transmitting said supervisory signal through said answering cord by way of a path completely independent of the telegraph signal transmission path in said cord.

2. In a manual teletypewriter switching system, a manual teletypewriter cord circuit, a calling plug and an answering plug both in said circuit, means in said circuit for registering a supervisory signal received through one of said

plugs and means also in said circuit for simultaneously transmitting said supervisory signal from one to the other of said plugs by way of a path completely independent of the telegraph signal transmission path in said cord.

3. In a manual teletypewriter switching system, a manual teletypewriter cord circuit, means in said cord circuit for flexibly interconnecting a calling and a called circuit, means in said cord circuit for registering a disconnect signal, means in said cord circuit for registering a recall signal different from said disconnect signal, and means in said cord circuit for transmitting said disconnect and recall signals through said cord circuit by way of a path completely independent of the telegraph signal transmission path in said cord to one of said connected circuits as said supervisory signals are registered in said cord circuit.

4. In combination in a manual teletypewriter cord circuit, an answering and a calling plug, a telegraph channel including a telegraph repeater interconnecting said plugs, a ringing supply circuit, means responsive to an electrical condition impressed on one of said plugs for connecting said ringing supply circuit to the other of said plugs, a supervisory channel independent of said telegraph channel, interconnecting said plugs, means responsive to an electrical condition imposed on one of said plugs, for transmitting a signal through said supervisory channel to the other of said plugs and means responsive to an electrical condition imposed on one of said plugs for preventing the transmission of a signal received by the other of said plugs, through said supervisory channel.

5. In a teletypewriter cord circuit, a telegraph channel, a supervisory channel completely independent of said telegraph channel, means in said cord, responsive to a first condition imposed on said cord upon connection to a first circuit, for preconditioning said supervisory channel to transmit supervisory signals completely through said supervisory channel between calling and answering plugs in said cord, when supervisory signals are impressed on said cord and means in said cord, responsive to a second condition imposed on said cord, upon connection to a second circuit, for preconditioning said supervisory channel to prevent the transmission of supervisory signals completely through said supervisory channel between calling and called plugs in said cord when supervisory signals are impressed on said cord.

6. In a teletypewriter switching system, a cord circuit, an answering and a calling end on said cord circuit, a supervisory signal associated with one of said ends, a telegraph signal transmitting channel interconnecting said ends, a supervisory

channel, completely independent of said telegraph channel, interconnecting said ends, means in said cord for operating said signal in response to a condition impressed on one of said ends and means in said cord circuit for simultaneously impressing a corresponding condition on the opposite end of said cord through said supervisory channel.

7. In a manual teletypewriter switching system, a cord circuit, a first and a second flexible manual switching means in said cord for extending a call between a calling and a called subscriber, a telegraph signal transmitting channel in said cord interconnecting said switching means, a telegraph repeater in said channel, a supervisory signal channel in said cord, completely independent of said telegraph channel, interconnecting said switching means for transmitting supervisory signals from one to the other of said switching means, and selectively operated means responsive only to the connection of one of said switching means to a particular kind of circuit to which a supervisory signal is to be transmitted for conditioning said supervisory channel to transmit said signal.

8. In a manual teletypewriter switching system, in combination in a manual teletypewriter cord circuit, a switching means conditioned to answer incoming calls, relay means directly connected to said switching means for preventing the simultaneous operative connection of two interconnected cords, selectively operated relay means also directly connected to said switching means responsive to the connection of said switching means to a particular kind of circuit only for conditioning said cord to transmit a supervisory signal when received from the calling end of said cord, by way of a completely independent supervisory channel, through said answering switching means.

9. In a teletypewriter cord circuit, in combination, an answering end equipped with a plug, a plurality of conductors attached to said plug, means in said cord for preventing telegraph transmission through said cord when said plurality of conductors of two identical independent cords are interconnected directly through multiple jacks, flashing recall means associated with said answering end, means in said cord for connecting an alternating current ringing supply circuit to the calling end of said cord in response to an electrical condition impressed on one of said conductors and means for impressing a supervisory signal condition on one of said conductors in response to a supervisory signaling condition imposed on the calling end of said cord.

CARL A. DAHLBOM.
FULLERTON S. KINKEAD.
GEORGE A. LOCKE.