May 23, 1944. C. A. DAHLBOM ET AL 2,349,539

TELETYPEWRITER SWITCHING SYSTEM

Filed Dec. 26, 1941 7 Sheets-Sheet 1

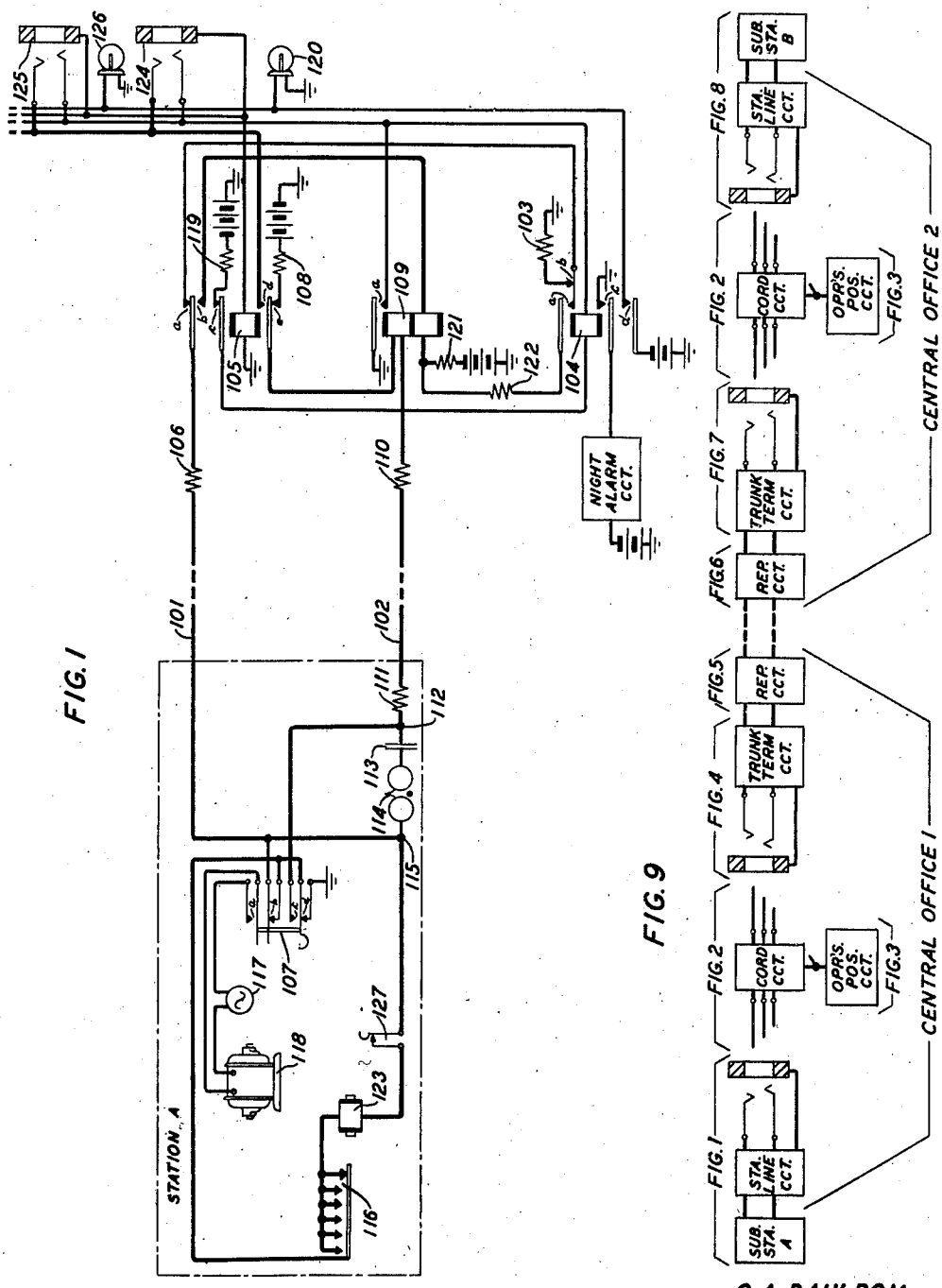

FIG. 1

FIG. 9

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TELETYPEWRITER SWITCHING SYSTEM

Filed Dec. 26, 1941 7 Sheets-Sheet 2

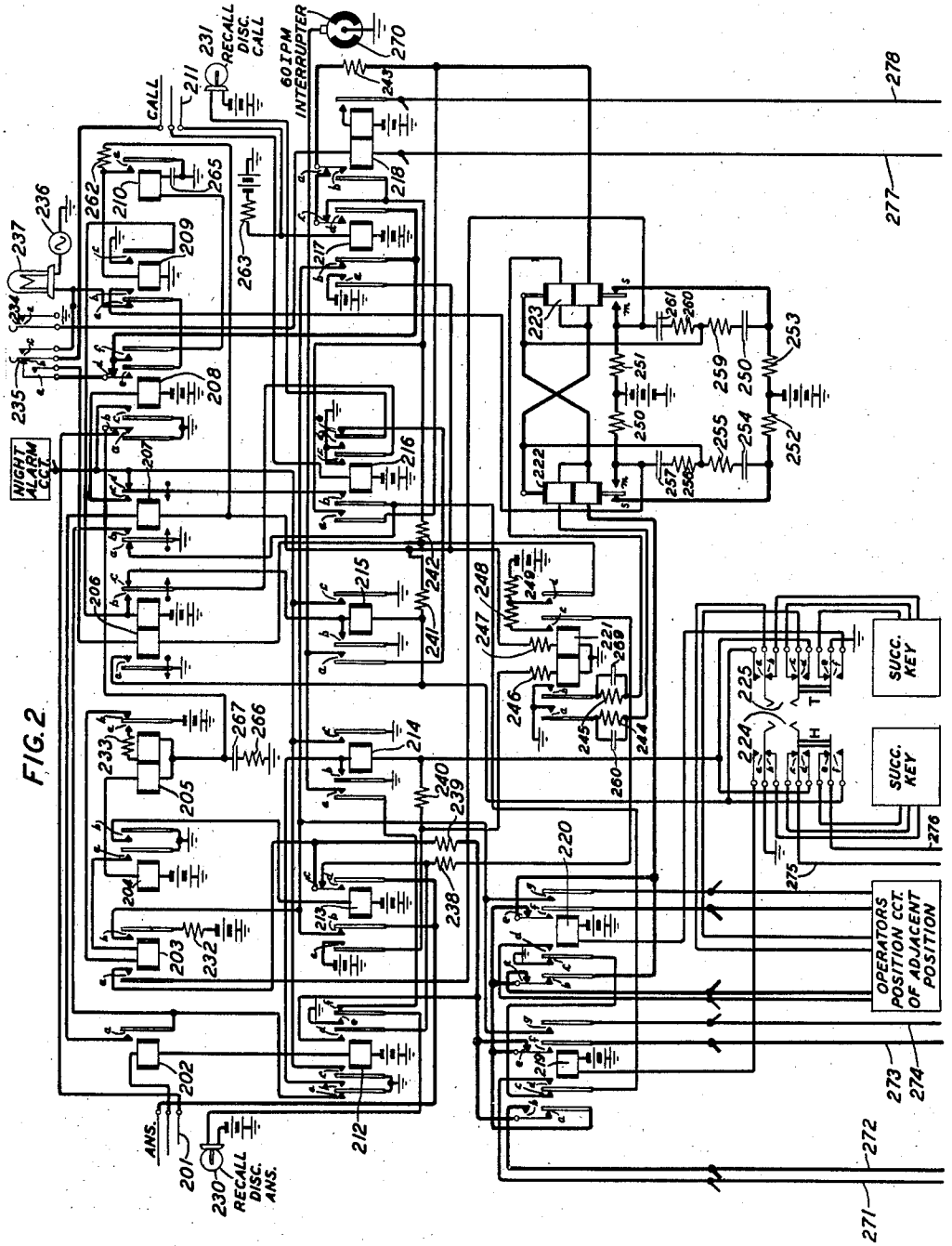

FIG. 2

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TELETYPEWRITER SWITCHING SYSTEM

Filed Dec. 26, 1941 7 Sheets-Sheet 3

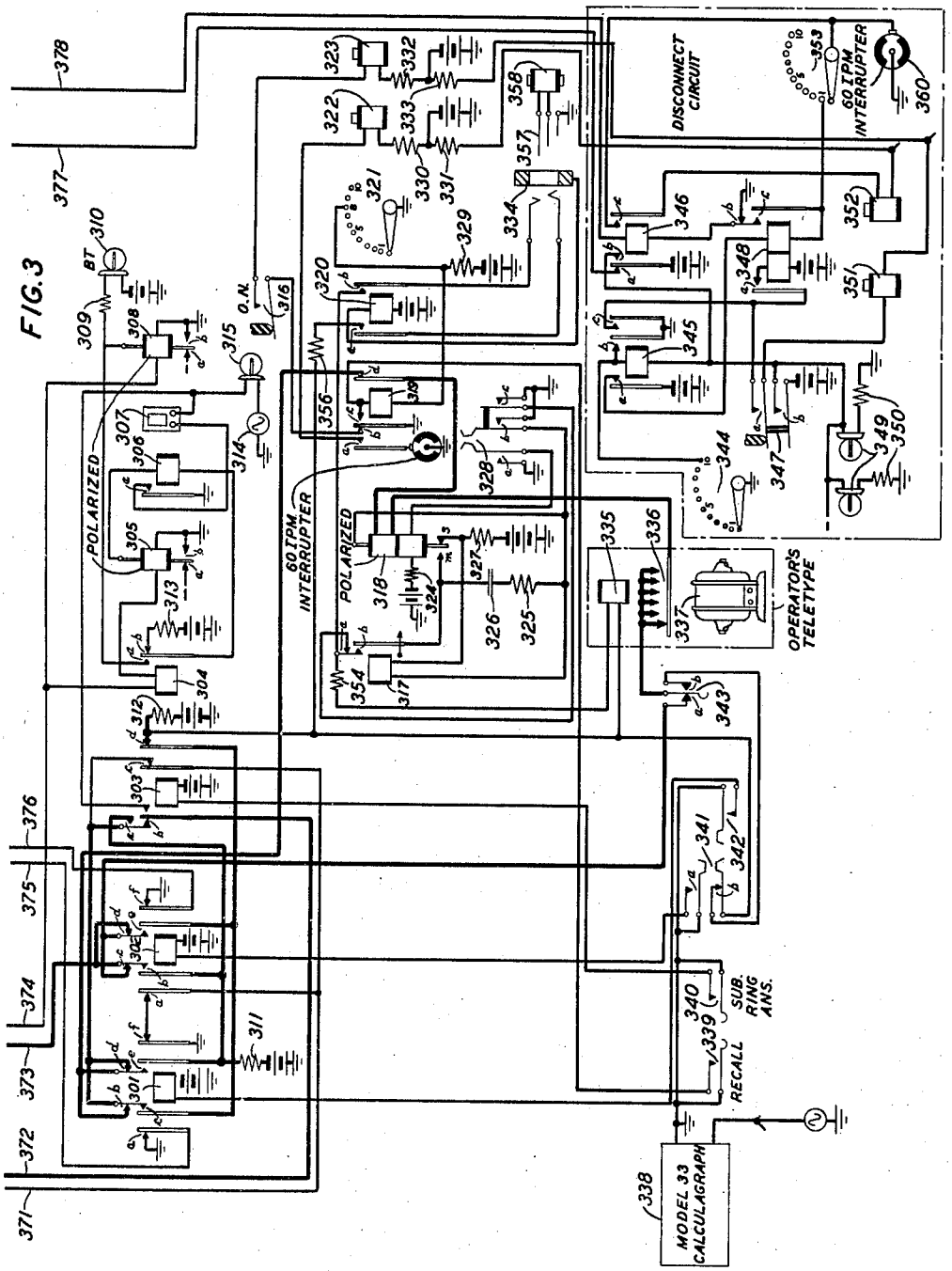

FIG. 3

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TELETYPEWRITER SWITCHING SYSTEM

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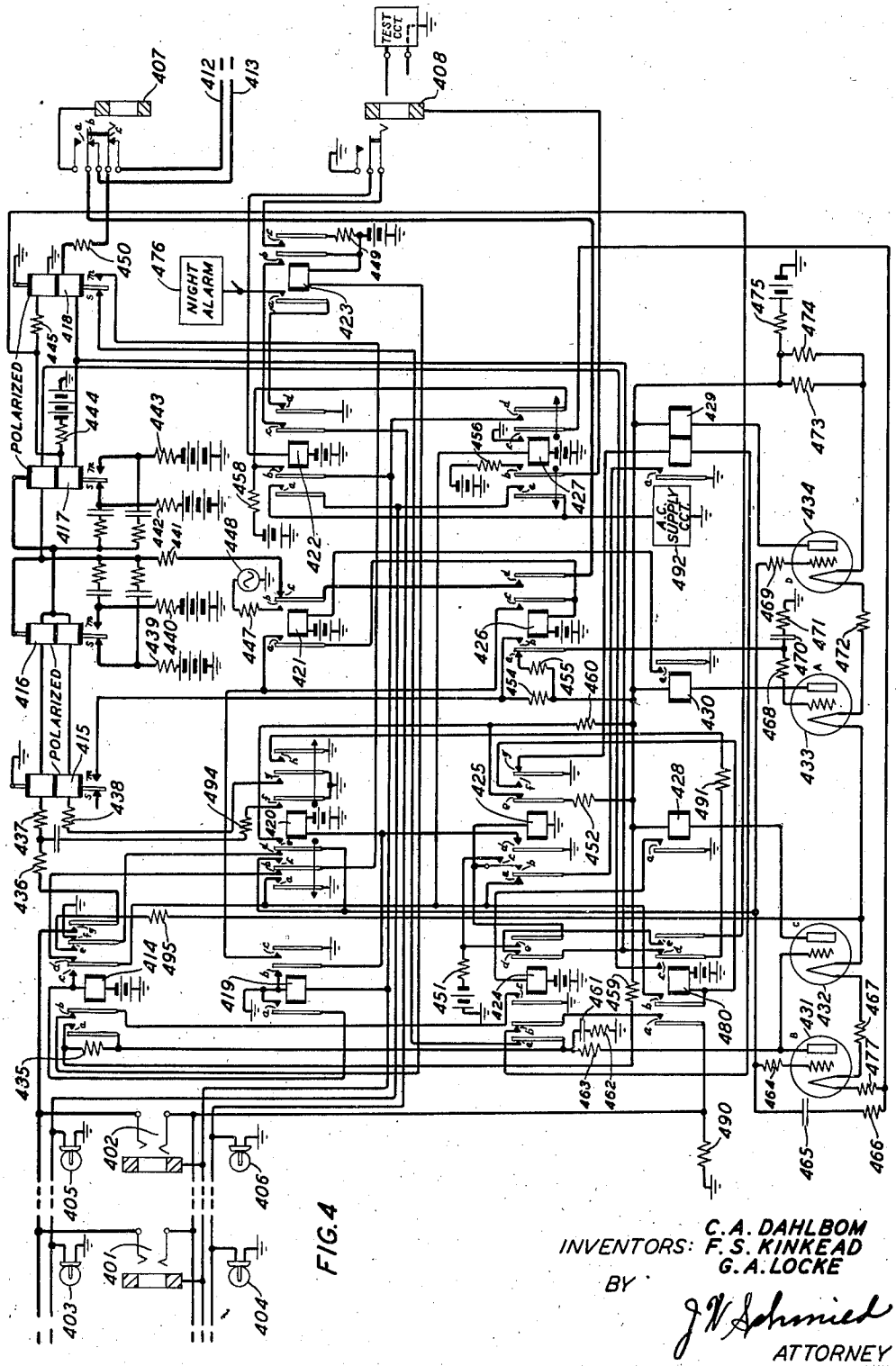

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TELETYPEWRITER SWITCHING SYSTEM

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FIG. 6

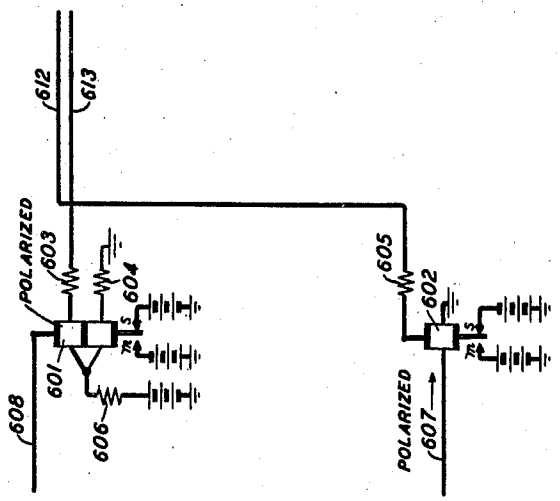
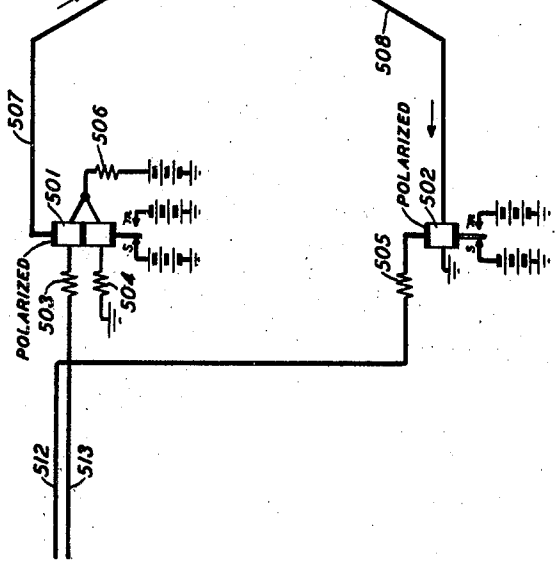


FIG. 5



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TELETYPEWRITER SWITCHING SYSTEM

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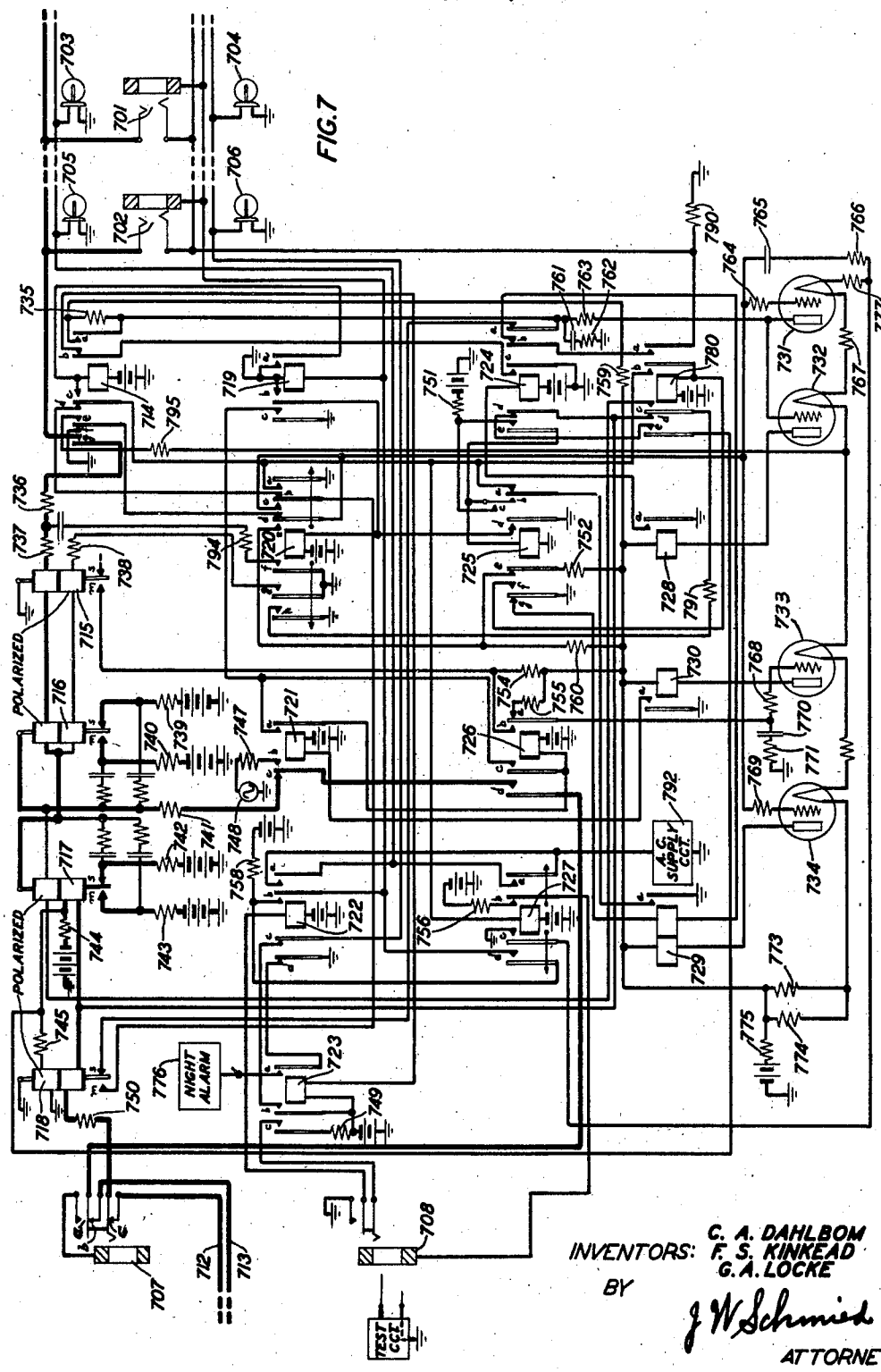
FIG. 7



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TELETYPEWRITER SWITCHING SYSTEM

Filed Dec. 26, 1941 7 Sheets-Sheet 7

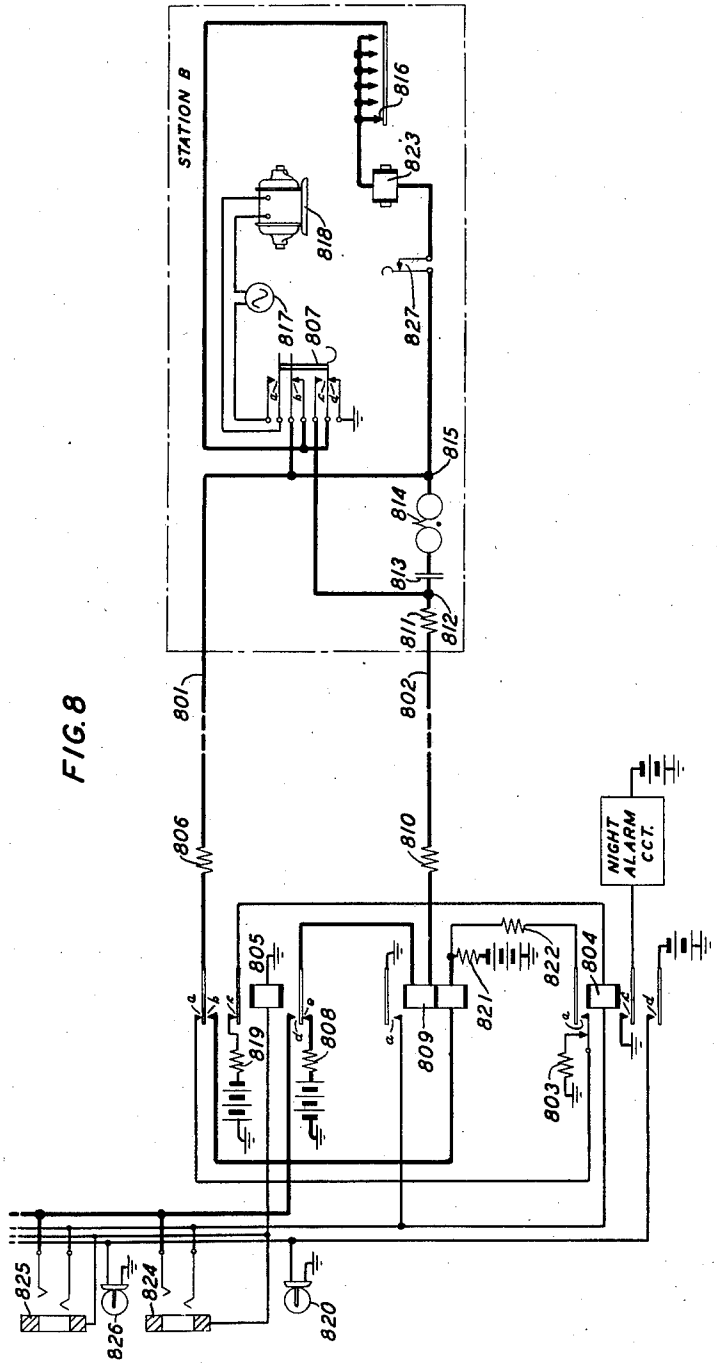

FIG. 8

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Patented May 23, 1944

2,349,539

UNITED STATES PATENT OFFICE

2,349,539

TELETYPEWRITER SWITCHING SYSTEM

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Application December 26, 1941, Serial No. 424,436

29 Claims. (Cl. 178—2)

This invention relates to manual teletypewriter switching systems. An object of the invention is to provide improved manual straightforward teletypewriter switching circuits. A feature of the invention is a group of cooperating teletypewriter switching circuits arranged to provide what is known in the art as automatic through and inward service.

It is desirable, in the operation of manual teletypewriter switching systems, in cases where calls are extended through more than one central switching station, that an operator at one of the central switching stations only should control the call. It is preferable that the operator at the switchboard where the call originates should control the call. In order to do this, switching information governing the progress of the call through succeeding central stations and the connection of the call ultimately to the called subscriber should be transmitted from the originating office by the originating central station operator. It is preferable also that means for ringing the called subscriber should be under control of the operator at the originating station. Disconnect signals should be registered also at the originating office in response to disconnection by the subscriber without the necessity for intervention by any of the operators at the other central stations through which a toll call may pass in tandem. It is preferable also that recall signals be recorded at the originating office. Reference is made to F. J. Singer Patent 2,228,890, issued January 14, 1941, which discloses a manual straightforward teletypewriter switching system.

An object of the invention described herein is to provide features of operation, which, in certain respects are improvements over those disclosed in Patent 2,228,890.

Among these improvements is more positive control of a supervisory relay and attendant modifications whereby the full operating advantage of such more positive control is obtained.

The nature of these improvements will become more apparent in the following description and will be particularly pointed out in the appended claims.

In the drawings:

Fig. 1 shows a subscriber's station circuit, shown at the left of the figure, which is connected by two conductors to a station line terminating circuit, shown at the right of the figure located at a teletypewriter central switching station to be known as office 1;

Fig. 2 shows a teletypewriter cord circuit which is assumed to be located at office 1 for use in establishing connections at the central station;

Fig. 3 represents an operator's position circuit which cooperates with the cord circuit per Fig. 2 to provide means so that the central station operator at office 1 may communicate by means of a teletypewriter to circuits connected to either end of the cord. Fig. 3 includes also means for transmitting supervisory signals through the cord;

Fig. 4 is an automatic intertoll terminating circuit located at office 1;

Fig. 5 is a telegraph repeater circuit located also at office 1, to which Fig. 4 connects:

Fig. 6 is a telegraph repeater circuit identical with Fig. 5, except that it is shown in reverse, located at a second central switching office to be known as office 2, to which the outgoing end of the repeater per Fig. 5 is connected by means of conductors interconnecting office 1 and office 2;

Fig. 7 is an automatic intertoll trunk terminating circuit identical with Fig. 4, except that it is shown in reverse, located at office 2, to which the incoming end of the repeater circuit per Fig. 6 at office 2 is connected;

Figs. 4, 5, 6 and 7 when connected together in numerical sequence constitute an automatic intertoll trunk circuit interconnecting two central teletypewriter switching offices, office 1 and office 2;

Fig. 8 is a station line circuit and subscriber's station circuit which is identical electrically with Fig. 1 except that it s shown in reverse. It is assumed to be connected to office 2; and

Fig. 9 is a diagram which shows the manner in which Figs. 1 to 8 herein are arranged in relation, each to the other, in order to conform to the accompanying text.

As shown in Fig. 9, a subscriber's station A, shown at the left of Fig. 1, is connected by means of two conductors to a station line circuit at a first central switching station. The station line circuit is terminated at the central station in multiple jacks and lamps as indicated in Fig. 1 of which only one jack is indicated in Fig. 9. It is pointed out that many subscriber's station circuits and station line circuits, such as Fig. 1, will be connected to the switchboard at the first central station. Fig. 2 represents a cord circuit. The cord circuit has two ends terminated in plugs called answering and calling plugs. The answering plug, indicated at the left, is used in answering an incoming call. The calling plug, indicated at the right, is used in extending a call which has been answered. Ordinarily, there are about fifteen cord circuits such as Fig. 2 located at a

particular position. Any one of the cord circuits may be used on a particular call. An operator's position circuit per Fig. 3 is shown connected to the cord circuit. Although there may be approximately fifteen cords such as Fig. 2 at a particular position, there is only one operator's position circuit at each position. The circuits are arranged so that the operator's position circuit may be connected temporarily to the cord circuit per Fig. 2 while switching information is obtained and it may remain connected to the cord until the call is established. Thereafter the operator's position circuit per Fig. 3 is disconnected from the cord so as to be available for connection to other cords. The first central station office 1 and the succeeding central station office 2 in a tandem connection are interconnected by means of Fig. 4, Fig. 5, Fig. 6 and Fig. 7. Figs. 4 and 5 are assumed to be located at the first central station. Fig. 5 at the first central station is connected to Fig. 6 at the second central station by means of two conductors indicated by the dotted line. The trunk circuit incoming to the second central station passes through the repeater per Fig. 6 which is identical with the repeater per Fig. 5 and then through the relay equipment of the automatic intertoll trunk terminating circuit per Fig. 7. It is pointed out that Fig. 5 and Fig. 6 provide for half duplex operation between offices. The repeaters shown in these figures may be replaced by full duplex repeaters in which case only one conductor interconnecting office 1 and office 2 would be required. It is terminated in a jack indicated at the right of Fig. 7 in switchboard at the second central switching station office 2. A cord circuit identical with Fig. 2 and an operator's position circuit identical with Fig. 3 are shown at the second central switching station. The cord circuit at office 2, shown in Fig. 9, and described herein, is used to complete a call to a station line circuit and subscriber's station circuit per Fig. 8. Fig. 8 is identical with Fig. 1 except that it is reversed. The cord circuit per Fig. 2 instead of being used for terminating a call to a subscriber's station line circuit may be used in again extending a call through trunk facilities such as Fig. 4, Fig. 5, Fig. 6 and Fig. 7 to a third central station, if desired. This is not indicated in Fig. 9 and is not described, but the manner in which it may be performed may be understood from the description herein, as the trunk, cord and position circuits will operate in the same manner on successive connections to other offices as described herein.

The cord circuit per Fig. 2 and the operator's position circuit per Fig. 3 may be used with trunk circuits other than those disclosed herein. The trunk circuit disclosed herein is an automatic signaling intertoll trunk. Figs. 2 and 3 will function also with ringdown trunks. Although the ringdown trunks per se are not described in this application, the manner in which certain supervisory and ringing signals may be transmitted by the operator's position circuit when it cooperates also with ringdown trunks is described herein.

Subscriber originates call

The manner in which the subscriber at station A calls the central station will now be described.

The circuit per Fig. 1 is shown as arranged in its idle condition. For this condition a circuit may be traced from ground at the central station through resistance 103, through relay contact 104*b*, relay contact 105*a*, resistance 106, conductor 101, key contacts 107*b* and 107*d* to ground. Both ends of conductor 101 are grounded, it may be observed, while the circuit per Fig. 1 is idle. A circuit may also be traced from positive battery through resistance 108, relay contact 105*e*, top winding of relay 109, resistance 110, conductor 102 and resistance 111 to terminal 112. At terminal 112 parallel branches are formed. One branch extends to key contact 107*c* which is open. The other branch extends through condenser 113 and ringer 114 to terminal 115. From terminal 115 parallel branches extend. One branch extends through key contacts 107*b* and 107*d* to direct ground. This branch short-circuits the branch extending through break key 127 teletypewriter receiving magnet 123 and teletypewriter transmitting contacts 116 which also extends to ground through key contacts 107*b* and 107*d*. Since one branch extending from terminal 112 is open at contact 107*c* and the other branch extends through a condenser 113, no current will flow through conductor 102 from the direct current source connected to resistance 108 while the circuit per Fig. 1 is idle.

In order to initiate a call the subscriber at station A operates key 107 to its alternate position. This closes contact 107*a*. This establishes a circuit from a source of alternating current 117 through teletypewriter motor 118 and key contact 107*a* to the opposite side of power source 117 starting the motor. The operation of key 107 also opens contacts 107*b* and 107*d*. This removes direct ground from conductor 101 and also removes ground from the ringer circuit. Conductors 101 and 102 are interconnected over a circuit which extends from terminal 112 through key contact 107*c*, teletypewriter transmitting contacts 116, teletypewriter receiving magnet 123, break key 127 and terminal 115 to conductor 101. When conductors 101 and 102 are interconnected through the teletypewriter circuit the circuit from battery through resistance 108 is completed to ground through resistance 103. This energizes the top winding of relay 109, operating relay 109. The operation of relay 109 establishes a circuit from ground through contact 109*a*, winding of relay 104, contact 105*c* and resistance 119 to battery operating relay 104. The operation of relay 104 establishes a circuit from battery through contact 104*d* and the filament of lamp 120 to ground lighting lamp 120 as a signal that the subscriber at station A is calling. The operation of relay 104 also disconnects ground through resistance 103 and contacts 104*b* from conductor 101 and replaces it by negative telegraph battery through resistances 121 and 122 and contact 104*a*. The operation of relay 104 also connects ground to the night alarm circuit through contact 104*c*. With negative battery connected to conductor 101 and positive battery connected to conductor 102 full marking current flows around the subscriber's loop circuit and through the winding of receiving magnet 123. This current in the receiving magnet 123 maintains the subscriber's teletypewriter marking condition.

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 201 of Fig. 2 into jack 124 of Fig. 1 associated with the calling line. The sleeve conductor of the answering plug 201 in Fig. 2 is connected to ground through the winding of relay 135 in the sleeve circuit of the calling

line per Fig. 1 and the circuit extends from the sleeve, or bottom conductor, of plug **201**, through contacts **208***b*, left-hand winding of relay **205** and the winding of relay **204** to battery. Relay **105** in Fig. 1 and relays **205** and **204** in the cord circuit per Fig. 2 operate.

The operation of relay **105** opens contacts **105***c*, disconnecting battery from the winding of relay **104**. Relay **104** releases. The release of relay **104** opens contact **104***d* extinguishing lamp **120**. The release of relay **104** opens contact **104***c* disconnecting the night alarm circuit. The release of relay **104** opens contact **104***a* disconnecting negative battery through resistances **121** and **122** from conductor **101**. Contact **104***b* is reclosed connecting ground through resistance **103** through contact **104***b*, but this performs no function at this time as relay **105** is operated.

The operation of relay **105**, by opening contact **105***a*, transfers conductor **101** from the path to negative battery through contact **104***a* and connects it instead to negative battery through the bottom winding of relay **109** and resistance **121**. The opening of contact **105***e* disconnects positive battery through resistance **108** from conductor **102** and extends conductor **102** through contact **105***d* to the tip or top conductor of jack **124**.

Attention is called to the fact that conductor **101** is terminated in negative battery through the bottom winding of relay **109**. Conductor **102** extends through the top winding of relay **109** and contact **105***d* to the tip conductor of jack **124**. The tip circuit in the cord extends to positive battery, as will be seen when that circuit is subsequently traced. The effects of the current in the top and bottom windings of relay **109** for this condition are equal and opposed. Relay **109** releases. Contact **109***a* opens. The ring or middle conductor of jack **124** is open therefore for this condition as both contacts **105***c* and contacts **109***a* are open.

In Fig. 2 the operation of relay **204** establishes a circuit from ground through contact **204***b* and the winding of relay **213** to battery operating relay **213**. The operation of relay **213** opens contact **213***b* which when closed provides a path for the operation of a busy test and cord interference signal in the operator's position circuit per Fig. 3, to be described below. It also closes the telegraph transmission path for the answering end of the cord at contact **213***c*. The operation of relay **213** also operates relay **221** from battery through contact **213***a*, resistance **245** and the left-hand winding of relay **221** to ground. The operation of relay **221** closes ground to the artificial line circuits of repeater relays **222** and **223**. The operation of relay **221** also provides holding battery for the line windings of relays **222** and **223**, when required, to hold the armatures of these relays on their marking contact. This will now be described in more detail.

Relays **222** and **223** are shown with their armatures in engagement with their spacing contacts. Before plug **201** is inserted in jack **124** and before relay **221** is operated, no current flows through any of the windings of relay **222** and **223**. When plug **201** is inserted into jack **124** the tip of plug **201** 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 loop conductor is terminated in Fig. 1 in negative battery connected to resistance **121**. From the tip of plug **201** the circuit extends through contact **213***d*, resistance **239**, contacts **219***a* and **219***e* *in* parallel, contacts **220***b* and **220***e* in parallel and the bottom winding of relay **222** to the armature of relay **223**. When the armature of relay **223** is in engagement with its spacing contact **223***s*, as shown, the circuit extends through resistance **253** 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 **222** is deenergized. With relay **221** operated a circuit may be traced from ground through contact **221***a*, resistance **244**, top winding of relay **222**, armature of relay **223**, contacts **223***s* and resistance **253** to negative battery. The current flowing in this path energizes the top winding of relay **222** and its effect actuates the armature of relay **222** to engage with its marking contact **222***m*. The operation of relay **221** also provides a path from negative battery through resistance **249**, contact **221***d*, resistance **242**, contact **217***c*, contact **218***a*, resistance **243** and the bottom winding of relay **223** to the armature of relay **222**. When the armature is in engagement with its marking contact **222***m*, the circuit is extended through resistance **250** 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 **223**. A circuit may also be traced from ground through contact **221***b*, resistance **245** and the top winding of relay **223** to the armature of relay **222**. When the armature of relay **222** is in engagement with its right-hand or marking contact **222***m*, the circuit extends through resistance **250** to positive battery. The effect of current flowing in the bottom or line winding of relay **223** tends to actuate the armature of relay **223** 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 **223** which effect is tending to actuate the armature of relay **223** to engage with its right-hand or spacing contact **223***s*. The effect of the current in the bottom or line winding of relay **223** preponderates for this condition and the armature of relay **223** is actuated so as to engage with its left-hand or marking contact **223***m*. When the armature of relay **223** engages with marking contact **223***m*, the subscriber's loop is terminated in the circuit extending through resistance **251** to positive battery. For the marking condition, therefore, when the subscriber's loop circuit is closed, conductor **101** is permanently terminated in negative battery through resistance **121** and conductor **102** is extended through the transmission conductor of the answering side of the cord and is terminated in positive battery through resistance **251**. The telegraph signaling batteries at each end of this transmission path, therefore, are in series-aiding relationship for the marking condition. Full line current, therefore, flows through the bottom or line winding of relay **222** and telegraph receiving magnet **123** for the marking condition. The effect of this current in relay **222** will maintain the armature of relay **222** in engagement with its right-hand or marking contact **222***m*. The direction of current flow through the top winding of relay **222** is reversed when the armature of relay **223** engages with its marking contact. The effect of current in the top winding of relay **222** for this condition tends to actuate the armature of relay **222** towards its left-hand or spacing contact **222***s*,

but it is ineffectual, since the effect of current in the bottom or line winding of relay 222 is dominant and the armature of relay 222 is maintained in engagement with its right-hand or marking contact 222*m*. When the armature of relay 222 is in engagement with its right-hand or marking contact 222*m*, the direction of the flow of current through the top winding of relay 223 is reversed. This tends to actuate the armature of relay 223 to engage with its spacing contact 223*s*, but the effect of current in the bottom or line winding of relay 223*s*, tending to actuate the armature of relay 223 towards contact 223*m*, is dominant and the armature of relay 223 is maintained in engagement with its left-hand or marking contact 223*m*.

In tracing the sleeve circuit in the cord, it was shown to extend through the left-hand winding of relay 205 and the winding of relay 204 to negative battery. This is a high resistance path. After relay 205 has been operated, a parallel low resistance locking path for relay 205 is established extending through the right-hand winding of relay 205 and resistance 233 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. This will now be described in more detail.

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

The manner in which interference is prevented when in response to the simultaneous lighting of a number of line lamps, such as 120 and 126 at different operator's positions, more than one cord circuit, such as the cord per Fig. 2 herein, are connected through multiple jacks such as jacks 124 and 125, simultaneously to the same line circuit, such as Fig. 1, will now be described.

If a second cord circuit, such as Fig. 2 is plugged into one of the multiple appearances of jack 124 such as jack 125, while one cord per Fig. 2 is already connected to jack 124, the relay corresponding to relay 204 in the second or interfering cord will operate, but the relay in the interfering cord corresponding to relay 205, which is a marginal relay, will not operate, owing to the shunting effect of the low resistance sleeve circuit through the right-hand winding of relay 205, resistance 233 and contact 205*a* to battery in the first cord. Relay 204 of the interfering cord, when operated, operates relay 213 of the interfering cord in the same manner as described above. The operation of relay 204 in the interfering cord also operates relay 203 in the interfering cord, over a circuit corresponding to that which may be traced from ground through contact 204*a*, winding of relay 203 and contact 205*b* to battery. As explained above, the relay corresponding to relay 205 in the interfering cord is not operated, and therefore the path through contact 205*b* is available for operating the relay corresponding to relay 203 in the interfering cord.

The operation of relay 213 in the interfering cord closes the transmission path in the interfering cord through contact 213*d*. It also operates relay 221 in the interfering cord. The corresponding path has heretofore been traced. This energizes the biasing windings of the polar repeater relays corresponding to relays 222 and 223 in the interfering cord. It also supplies negative battery to the right-hand terminal of the bottom or line winding of the relay corresponding to relay 223 in the interfering cord. In the interfering cord the operation of relay 203 establishes a circuit which may be traced from positive battery through resistance 251, contact 203*a*, resistance 239, contacts 219*a* and 219*e* in parallel, contacts 220*b* and 220*e* in parallel and the bottom or line winding of relay 222 to the armature of relay 223. For this condition the armature of the polar relay in the interfering cord corresponding to relay 223 will be actuated so as to engage with its marking contact. The armature of the relay corresponding to relay 222 in the interfering cord will be actuated so as to engage with its spacing contact. This prevents transmission through the interfering cord. This will now be explained in detail.

The explanation of this is as follows. Positive potential through resistance 251 and contact 203*a* has been connected to the left-hand terminal of the bottom winding of relay 222. Ordinarily as described above for the normal condition, with one cord circuit connected to one line jack, when the line circuit, per Fig. 1, is closed, negative battery through resistance 121 in Fig. 1 is connected to the left-hand terminal of relay 222. If the armature of relay 223 is in engagement with its left-hand or marking contact under such condition, positive battery through resistance 251 is connected through contacts 223*s* to the right-hand terminal of relay 222. For the normal marking condition therefore the full line current flows through the bottom winding of relay 222 in a direction to actuate the armature of relay 222 to the right to engage its marking contact 222*m*. The effect of the current in the biasing winding of relay 222 opposes this and tends to actuate the armature of relay 222 toward the left, to engage its spacing contact 222*s*, but the effect in the bottom winding is dominant and the armature of relay 222 engages contact 222*m*.

When, for the cord interfering condition, positive battery is connected through resistance 251 and contact 203*a* to the left-hand terminal of the bottom winding of relay 222, if the armature of relay 223 is in engagement with its spacing contact 223*s*, negative battery through resistance 253 and contact 223*s* is connected to the right-hand terminal of the bottom winding of relay 222. Full line current flows through the bottom winding of relay 222, but its direction is now reversed from its direction for the normal marking condition and the armature of relay 222 for this condition will be actuated to engage with its left-hand or spacing contact 222*s*. The effect of the current flowing through the top or biasing winding of relay 222 for this condition would tend to actuate the armature of relay 222 to its marking contact, but the effect in the bottom winding of relay 222 would be dominant. Thus for the cord interfering condition if the armature of relay 223 is in engagement with its spacing contact the armature of relay 222 will be actuated to engage with its contact 222*s*.

Let it be assumed that the cord interfering condition prevails, but that the armature of relay 223 is in engagement with contact 223*m*. For this condition positive battery through resistance 251 and contact 203*a* is connected to the left-hand terminal of the bottom winding of relay 222 and the same battery through resistance 251, contact 223*m* and the armature of relay 223 is connected to the right-hand terminal of the bottom winding of relay 222. No current therefore flows in the bottom winding of relay 222. The direction of the current flowing in the top winding of relay 222 is reversed as negative battery instead of positive battery is connected to ground through the top

winding of relay 222. Now, therefore, the effect of the biasing current in the top winding of relay 222 prevails and the armature of relay 222 is actuated to engage with its spacing contact 222s.

So, no matter on which contact the armature of relay 223 may be, the armature of relay 222 is actuated to engage contact 222s for the cord interfering condition.

Therefore, for the cord interfering condition, negative battery will be connected through contact 222s to the left-hand terminal of the bottom winding of relay 223. The right-hand terminal of the bottom winding of relay 223 has been shown to be connected through resistance 243, contact 218a, contact 217c, resistance 242, contact 221d and resistance 249 to negative battery. No current, therefore, flows in the bottom winding of relay 223. With the armature of relay 222 on contact 222s, the left-hand terminal of the top winding of relay 223 is connected to negative battery. The right-hand terminal, as has been shown, connects to ground through resistance 245 and contact 221b. Since positive battery connected to the left-hand terminal of relay 223 tends to actuate its armature toward contact 223s, unopposed negative battery connected to the left-hand terminal of the bottom winding of relay 223 will operate its armature to contact 223m where it, during the cord interfering condition, will be maintained.

Thus, in the interfering cord, relay 222 will be maintained in a spacing condition and relay 223 will be maintained in the marking condition whenever there is an interfering cord condition. This prevents transmission through the cord.

While this condition persists the subscriber's line circuit per Fig. 1 will be held in the marking condition as positive battery will continue to be impressed on the tip conductor of the subscriber's line jack over parallel paths. One path is through resistance 253, contact 223s and the tip transmission conductor to the tip of plug 201. The other path is through resistance 251, contact 203a, resistance 239, contact 213d to the tip of plug 201.

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 224 or key 225 will operate relay 219 or relay 220 over obvious circuits. This connects the operator's position circuit at the home or adjacent position to the interfering cord depending upon which key is operated. A circuit is then established from negative battery through resistance 232, contact 203b, and contact 219g or contact 220g depending upon which key is operated. The armature associated with each of these contacts is connected to a relay in its associated operator's position circuit which lights a lamp, to indicate the interfering condition. The circuit will be traced hereinafter. Upon observing 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 251 and contact 203a to the tip transmission conductor, to operate the armature of polar relay 222 in the interfering cord to spacing and prevent transmission through the interfering cord, was impressed also through contact 213d of the interfering cord, relay 213 being operated, on the tip of the plug such as 201 of the interfering cord. The tip of the interfering cord is connected to the tip of one of the subscriber's line jacks, such as jack 125. The subscriber's line jacks of a particular line are all connected in multiple as shown in Fig. 1. 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 222 of the original cord is also actuated to its spacing contact and maintained thereon as long as the interfering cord remains connected. The battery conditions in the windings of the polar repeating relays 222 and 223 and their effects are the same in the original cord as described above for the interfering cord. 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 222 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

As mentioned above, 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 such as Fig. 3. 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.

Each cord circuit at a particular position is provided with two keys such as 224 and 225. One key, key 224, connects the operator's position circuit located in the same position at which the cords are located to the particular cord. The other key, key 225, 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 224 is operated. This establishes a circuit from ground through contact 224a and the winding of relay 219 to battery operating relay 219. The operation of relay 219 opens the transmission path interconnecting the tip of plug 201 and the bottom winding of polar relay 222 at two points, namely, at contacts 219a and contacts 219e and connects the transmission circuit of the operator's position circuit in series between continuity contacts 219b and 219f. Alternatively the operation of key 225 establishes a circuit from ground through contact 225f and

the winding of relay 220 to battery operating relay 220. This inserts the transmission circuit of the operator's position circuit at an adjoining position between the tip of plug 201 and the bottom winding of polar relay 222. Contacts 220b and 220e in parallel 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 220a and 220f. The operation of relays 219 and 220 perform other switching functions which will be described hereinafter.

Circuit conditions in cord and line circuits for busy test

A busy test is made by touching the tip of either answering plug 201 or calling plug 211 to the 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, such as Fig. 2 to one of the multiple appearances of jack 124, such as jack 125, at another position 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.

The circuit may be traced from negative battery over parallel paths. The first path extends through the winding of relay 204 and the left-hand winding of relay 205. The second path extends through contact 205a, resistance 233 and the right-hand winding of relay 205. The paths join and the circuit continues through contacts 203b and the sleeve of plug 201 to the sleeve of jack 125 which is connected in multiple to the sleeve of jack 124. If, instead of an answering plug, such as 201, a calling plug, such as 211, of a cord circuit similar to the cord circuit per Fig. 2 herein has already been inserted in one of the multiple appearances of jack 124, negative battery is supplied through the winding of relay 217 and resistance 263 in parallel through the sleeve of plug 211 to the sleeve of the jack to which calling plug 211 is connected, which sleeve is also connected in parallel to the sleeve of jack 124. 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 224 or key 225 in the particular cord to its alternate position.

It will be assumed first that the testing is performed by touching the tip of plug 201 to the sleeve of a jack such as 124 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 201, contact 213b and, if key 224 has been actuated, through contact 219g and over a conductor which extends into the home operator's position circuit, through the winding of a relay connected thereto, to light a lamp in the position circuit as an indication of the busy condition. The manner in which lamp in the operator's position circuit is lighted will be described in detail below. If key 225 has been operated so that relay 220, rather than relay 219, has been operated, to connect the operator's position of the adjacent position to the particular cord, the circuit extends through contact 220g to corresponding apparatus in the adjacent operator's position circuit.

If the calling plug 211 is to be used in establishing a connection, the busy test will be made by first touching the tip of plug 211 to the sleeve of the jack. If the jack circuit is already busy, negative battery will be impressed through the tip of plug 211, contact 235b of ringing key 235, contact 208d, contact 217b and through either contact 219g or 220g to light the busy lamp in the position circuit.

Operator's position circuit

As indicated in Fig. 9, Fig. 3 connects to Fig. 2. The leads shown extending to the bottom margin of Fig. 2 connect to conductors in corresponding positions extending to the upper margin of Fig. 3. Thus conductors 271 to 278 in Fig. 2 connect to conductors 371 to 378 in Fig. 3.

For the following description before key 224 is operated to operate relay 219 and connect the operator's position circuit per Fig. 3 of the home position to the cord circuit per Fig. 2 key 328 in Fig. 3 is assumed to be operated, so as to close its contacts 328a, 328b and 328c. The closure of contact 328a establishes a circuit which may be traced from battery through resistance 324, bottom winding of relay 318 and key contact 328a, to ground, energizing the bottom winding of relay 318. The energization of the bottom winding of relay 318 actuates its armature to engage with its contact 318s. The top winding of relay 318 is not energized as the transmission circuit of the operator's position circuit per Fig. 3 which extends through the top winding of relay 318 is open at relay contacts 219b and 219f as key 224 and relay 219 are assumed to be not yet operated. A circuit may also be traced from negative battery through resistance 327, winding of relay 317, and contact 328b, to ground, energizing the winding of relay 317. The path previously traced through contact 318s, armature of relay 318 and through contact 328b to ground shunts the path through the winding of relay 317. Relay 317 is a slow-to-release relay. Relay 317 does not release while relay armature 318 is in engagement with its contact 318s for normal spacing signals. However, if the armature of relay 318 remains in engagement with its contact 318s for a protracted period, relay 317 will release.

It will now be assumed that key 224 in Fig. 2 is operated. When relay 219 operates in response to the operation of key 224, contacts 219a and 219e are opened. The path which extends from the tip of plug 201 to the repeater relays 222 and 223 was shown heretofore to extend through contacts 219a and 219e. Contacts 219b and 219f are closed. The teletypewriter transmission circuit of the operator's position circuit, Fig. 3, is inserted in series between these points. This path will now be traced. The path extends through contact 219b, conductor 272, conductor 372, contact 303b, contacts 301d and 301b in parallel, contact 319d, top winding of relay 318, teletypewriter contacts 336, key contact 343a, contacts 302d and 302c in parallel, conductor 373 and conductor 273 to contact 219f. This inserts the transmission path of the operator's position circuit in series with the main transmission path of Fig. 1 and Fig. 2. Negative battery through resistance 121 in Fig. 1 is connected to one end of this path. Positive battery through resistance 251 in Fig. 2 is connected to the other end of this path. The top or line winding of relay 318 will

be energized. The effect of the energization of the top winding of relay **318** is to actuate the armature of relay **318** to engage with its contact **318***m*, as the effect of current in the top winding of relay **318** preponderates over the effect of current in the bottom winding of relay **318**. The effect of the current in the bottom winding continues to tend to actuate the armature of relay **318** to engage with contact **318***s*.

As teletypewriter contacts **116** are actuated at the subscriber's station A in Fig. 1, the armature of relay **318** will be actuated between its marking and spacing contacts. Attention is again called to the fact that during the transmission of ordinary teletypewriter signals relay **317** will remain operated. Since contact **317***a* is therefore open, ground is disconnected from one side of the teletypewriter receiving magnet **335** so that the magnet may follow the received signals. These signals are impressed on the teletypewriter receiving magnet **335** in the following manner. With contact **317***b* closed instead of contact **317***a*, the circuit for the teletypewriter magnet may be traced from positive battery through resistance **312**, winding of the teletypewriter receiving magnet **335**, resistance **354** and contact **317***b* to the marking contact **318***m* of relay **318**. When the armature of relay **318** is in engagement with its right-hand or spacing contact **318***s*, the circuit through the teletypewriter magnet **335** is open. When the armature of relay **318** engages with its left-hand or marking contacts **318***m* the circuit is extended through the armature of relay **318** and through contact **328***b* to ground, energizing teletypewriter magnet **335**. Thus in response to marking and spacing signals received by relay **318**, the teletypewriter magnet **335** will be energized and deenergized. The necessary switching information to enable the operator at the central office to complete or extend the call will be transmitted to the central station operator in this manner.

Splitting feature in operator's position circuit

Keys **341** and **342** are provided so that, when both the answering and calling ends of the cord per Fig. 2 are connected to cooperating circuits, the operator may communicate with the line connected to either the calling or answering end of the cord circuit as desired and prevent the signals from being transmitted through the opposite end which is meanwhile held in the marking condition to prevent the transmission of a false spacing signal. Operation of key **341** or **342** operates the corresponding relay **302** or **301** which splits the connection to the desired direction and provides a termination for the holding cord. This will now be described in detail.

If key **341** is operated, a circuit may be traced from ground through contact **341***a* and the winding of relay **302** to battery, operating relay **302**. When the transmitting path through the operator's position circuit per Fig. 3 was traced it was shown to extend through contacts **302***c* and **302***d* in parallel. When relay **302** is operated these contacts are opened. In order to hold the repeater in the cord circuit in the marking condition, negative battery is connected through resistance **311** and contact **302***b* to conductor **373**. The negative battery connected through resistance **311** takes the place of negative battery connected through resistance **121** in Fig. 1. Another circuit is established which may be traced from positive battery through resistance **312**, contact **303***d*, contact **302***e*, contact **343***a* and contacts **336** to the top winding of relay **318**. This positive battery takes the place of positive battery connected through resistance **251** to the marking contact of relay **223**.

With the circuit arranged in this fashion, the top or line winding of relay **318** and teletypewriter transmitting contacts **336** are connected in series with the transmission path of the answering side of the cord which is connected to the transmission path of station A.

Thus the operator may communicate with the subscriber at station A. The signals will not be transmitted over the calling side of the cord, as the calling side of the cord will be maintained in the marking condition.

When the calling side of the cord is connected to a cooperating circuit, in a manner to be described later, the operator may connect her position teletypewriter apparatus to the calling side of the cord and communicate with a party connected thereto.

In order to do this, the operator actuates key **342** instead of key **341**. This establishes a circuit which may be traced from ground through the contacts of key **342** and the winding of relay **301** to battery, operating relay **301**.

When relay **301** is operated, contacts **301***b* and **301***d* are opened. Positive battery is connected through resistance **312**, contact **303***d*, contact **301***c*, contact **303***b*, conductor **372**, conductor **272**, contact **219***b*, resistance **239** and contact **213***d* to the tip of plug **201**. This positive battery takes the place of positive battery heretofore supplied through resistance **251** and the marking contact of relay **223**. The apparatus at the subscriber's station in Fig. 1 is therefore held in the marking condition. A circuit may also be traced from negative battery through resistance **311**, contact **301***e*, contact **319***d*, top winding of relay **318**, teletypewriter transmitting contacts **336**, key contacts **343***a*, contacts **302***c* and **302***d* in parallel, conductor **373**, conductor **273**, contacts **219***f*, contacts **220***b* and **220***e* in parallel, bottom winding of relay **222**, armature and contact **223***m* of relay **223** and resistance **251** to positive battery. The negative battery supplied through resistance **311** takes the place of negative battery formerly supplied through resistance **121** in Fig. 1. The teletypewriter transmitting and receiving apparatus in the operator's position circuit per Fig. 3 is connected to the calling side of the cord. Thus communication may be carried on exclusively through the calling end of the cord while the subscriber's circuit per Fig. 1 is held to marking.

Recall signal transmitting apparatus in operator's position circuit

The operator's position circuit per Fig. 3 is arranged so that it may transmit a timed recall signal to a certain kind of trunk circuit, such as a ring-down trunk circuit, to which the cord circuit per Fig. 2 may at times be connected. In transmitting a timed recall signal to such a trunk the transmission path through the operator's position circuit is opened for a definite measured interval. In order to do this key **339** in Fig. 3 is operated. This establishes a circuit which may be traced from ground through the contacts of key **339**, winding of relay **319** and resistance **329** to battery, operating relay **319**. When relay **319** operates it locks through contact **319***c* to ground which takes the place of the ground formerly supplied through key **339**. The operation of relay **319** opens the transmission circuit

through the operator's position circuit at contact 319d. When contact 319a closes ground interrupted at 60 times per minute is connected through contact 319a, the winding of the selector rotor magnet 322 and resistance 330 to battery, energizing rotor magnet 322. Rotor magnet 322 steps the switch arm of the single bank selector 321 successively around its contacts from No. 1 to No. 8 in eight seconds. When the switch arm of selector 321 reaches contact 8, the path to ground through the winding of relay 319 is shunted by direct ground through the selector brush arm and relay 319 releases. During the interval while the brush arm of selector 321 is moved from its normal idle position, off-normal contacts 316 are closed. When relay 319 releases a circuit is established from ground, through contact 319b, contact 316, winding of selector release magnet 323 and resistance 332 to battery, energizing magnet 323. When magnet 323 is energized it restores switch arm 321 to normal. Relay 319 has thus been energized and operated for a measured interval of eight seconds and then released. During the interval that relay 319 was operated, contact 319d was open, which opened the transmission path through the operator's position circuit. The opening of the transmission path resulted in a spacing signal of eight seconds duration being transmitted as a recall signal over any circuit connected to the answering and calling cord.

The operation of recall key 339 and splitting key 341 or 342 enables a recall signal to be sent over a circuit connected to one or the other end of the cord while the opposite end is held to marking if desired. A recall signal will be sent only over a trunk circuit. But, as shall be explained below, either end of the cord per Fig. 2 may at times be connected to a trunk circuit.

Busy, out of order, interference and practice indications in the position circuit

As mentioned above, the circuits herein are arranged to provide busy indications for both ends of the cord circuit for Fig. 2. The manner in which the position circuit cooperates to indicate the busy condition will now be explained.

If any of the subscribers' lines or trunk circuits are busy as explained above, battery is supplied to the sleeve of the corresponding jack. In order to make a busy test with the answering cord the operator as explained above, touches the tip of plug 201 to the sleeve of the jack. Similarly, the tip of plug 211 will be connected to the sleeve of one of the multiple line jacks. The tips of both plugs are connected in parallel to contact 219g. The circuit for plug 201 was traced from the tip of plug through contact 213b to contact 219g. The circuit for plug 211 was traced from the tip of plug 211 through contact 235b, contact 298d and contact 217b to contact 219g. From contact 219g the circuit extends through conductor 274, conductor 374 and the winding of relay 308 to ground, operating the armature of relay 308 to engage with its contact 308b. A circuit may then be traced from ground through contact 308b, armature of relay 306, resistance 309 and the filament of lamp 310 to battery, lighting lamp 310. This provides an indication that the tested line is busy. It should be pointed out that negative battery is supplied to the sleeve of the busy jack and that the armature of relay 308 is actuated to engage with contact 304b when negative battery is supplied to the left-hand terminal of the winding of relay 308.

It was pointed out above also that a lamp was lighted in the position circuit to indicate that two cords are connected simultaneously to the same subscriber's line circuit. This lamp is lighted in the operator's position circuit connected to the interfering cord only. It was pointed out that relay 203 was operated in the interfering cord only. This establishes a circuit from negative battery through resistance 232, contact 203b and contact 219g. Negative battery connected to contact 219g, as has been pointed out, results in the operation of the armature of relay 308 in the operator's position circuit per Fig. 3 to engage with its contact 308b. This in turn lights lamp 310 as an indication of the interfering condition. Thus the lighting of lamp 310 may indicate either a busy condition or a cord interfering condition.

Of course a line should be tested before the plug of a cord is completely inserted in a jack. If a line is busy the operator will observe the lighted lamp. If she fails to test for busy, however, and inserts her plug such as 201 in a jack, to a multiple appearance of which another cord is already connected, lamp 310 will be lighted in the interfering cord and the operator will remove the interfering cord.

If a line when tested is busy due to being connected up for practice, a positive potential will be present on the sleeve of the line and relay 305 which is connected in parallel with relay 308 over a circuit which may be traced, through the winding of relay 304 and the winding of relay 305 in series to ground, will operate. The current for this condition is not sufficient to operate relay 304. The armature of relay 305 is actuated so as to engage with contact 305b. A circuit may then be traced from ground through contact 305b and the armature of relay 305, winding of relay 306, contact 304b and resistance 313 to battery, operating relay 306. The operation of relay 306 establishes a circuit from ground through contact 306a, winding of buzzer 307, filament of lamp 315 and power supply 314 to ground, lighting lamp 315 and operating buzzer 307. The simultaneous operation of buzzer 307 and lamp 315 indicates to the operator that she has tested a circuit which is connected up for practice and she will plug in notwithstanding the indication to seize the line.

If a line when tested is out of order, a positive potential will be present on the sleeve of greater magnitude than in the case of a circuit which is being used for practice. Under this condition both relays 304 and 305 will operate. The armature of relay 305 will be actuated so as to engage with contact 305b. A circuit may now be traced from battery through the filament of lamp 310, resistance 309, contact 304a, winding of relay 306 and armature and contact 305b of relay 305 to ground. Lamp 310 will light and relay 306 will operate. The operation of relay 306 will establish a circuit from ground through contact 306a, buzzer 307, filament of lamp 315 and power source 314 to ground. Signals provided under these conditions will indicate the out-of-order condition.

Disconnect circuit

It is pointed out that the operator's position circuit per Fig. 3, when connected to the cord circuit per Fig. 2, functions with a number of different kinds of trunk circuits. Supervisory signals are transmitted over these different kinds of trunk circuits in different manners. With certain connecting trunks the supervisory signals

are transmitted on a timed basis. Disconnect signals over certain trunks are open signals of ten seconds duration. In transmitting such signals the calling end of the cord is open for a period of ten seconds and then reclosed. A disconnect circuit shown in the lower right-hand corner of Fig. 3 is provided in order to cooperate with relays in the cord circuit to perform this function. This will now be described in detail.

Although the operator's position circuit per Fig. 3 is equipped individually with selector apparatus to provide a recall signal, the disconnect apparatus which transmits a timed disconnect signal is provided only once per position and is connected to each of the cord circuits at the positions as required by the operation of a key in the cord.

First the transmission path through the calling end of the cord circuit per Fig. 2 will be traced and then the manner in which the disconnect circuit in Fig. 3 functions to open this path for an interval of approximately ten seconds to transmit a disconnect signal over certain kinds of trunks will be described.

When plug **211** is connected to a trunk, ground over the sleeve of the trunk is connected through the sleeve of plug **211** to battery through the winding of relay **217** and resistance **263** in parallel, operating relay **217**. This closes contact **217***d*. The circuit for the transmission path through the calling end of the cord may now be traced from the tip or top conductor of calling plug **211** through contact **235***b*, contact **208***d*, contact **217***d*, contact **218***a*, resistance **243**, bottom winding of relay **223**, armature and right-hand or marking contact **222***m* of relay **222** and resistance **250** to positive battery. It is to be understood, in the cooperating trunk the tip conductor extends to negative battery through a telegraph repeater for this condition.

In order to connect the disconnect circuit and transmit a disconnect signal, the operator will operate key **34**. A circuit may now be traced from ground through contact **234***a*, left-hand winding of relay **218**, conductor **277**, conductor **377**, and contact **346***a* to battery operating relay **218**. The operation of relay **218** opens the transmission path through the calling end of the cord by opening contact **218***a*. When relay **218** operates it locks over a path which may be traced from battery through the right-hand winding of relay **218**, contact **218***c*, conductor **278**, conductor **378**, winding of relay **346** and contact **348***b* to ground. Relay **346** operates.

The operation of relay **346** provides an operating circuit for the disconnect signal, selector rotor magnet **352**. This circuit may be traced from battery through resistance **331**, winding of rotor magnet **352**, contact **346***c* and interrupter **360** to ground. The interrupter provides ground interrupter by open circuits at 60 times per minute. Rotor magnet **352** drives the brushes of the selector banks **344** and **353** off their normal positions of rest as indicated and then from terminal to terminal until the brushes of each bank reach terminal **10**. During the interval that relay **346** is operated, a lamp such as lamp **349**, will be lighted at the operator's position as an indication that the disconnect circuit is in use. The lamp circuit may be traced from battery through contact **346***b* and through the filaments of lamps **349** and resistances **350** in parallel to ground.

When the brush of selector bank **344** reaches terminal **10**, a circuit is established from ground through the brush and terminal **10** of bank **344**, winding of relay **345** and contact **346***b* to battery operating relay **345**. When relay **345** is operated, it is held operated, over a locking circuit through its contact **345***b*, by which ground is supplied to the top terminal of the winding of relay **345** to take the place of ground formerly supplied thereto through the brush and contact **10** of selector bank **344**.

If an operator at another position disregards the lamp such as **349** at her position, indicating that the disconnect circuit is busy, and attempts to use the disconnect circuit by operating a key corresponding to key **234** in a cord at her position, the disconnect circuit will not be connected to the new cord, as battery is disconnected from the circuit to the new cord by the operation of relay **346** in the single disconnect circuit. The disconnect circuit will therefore not be available for use by any other operator at another position until relay **346** in the disconnect circuit releases. While relay **345** is operated, a circuit is provided for the energization of the release magnet **351** of the selector. This circuit may be traced from ground through contact **345***c*, contact **347***a* of the selector off-normal springs, winding of release magnet **351** and resistance **333** to battery. It should be pointed out that while the brushes of the selector are moved off their idle positions, as shown in Fig. 3, springs **347***a* and **347***b* are closed by the selector mechanism in a well-known manner. During the next interval that the path through the interrupter **360** to ground is open, at which time the selector rotor magnet **352** is deenergized, the energization of release magnet **351** will be effective to restore the brushes of selector bank **344** and **353** to their normal idle position as shown in Fig. 3. As soon as the circuit to ground through the interrupter is again closed, the rotary magnet **352** is once more energized and brushes of selector banks **344** and **353** are again stepped. This time, however, the brushes step but one position only. It is pointed out that when the brush associated with selector bank **353** first passed over its associated terminal **1**, the path to battery through the right-hand winding of relay **348** and contact **345***a* was not available, as relay **345** was not operated. When the brush of selector bank **333** engages terminal **1** the second time, however, a path is established which may be traced from ground through the brush and terminal **1** of selector bank **353**, right-hand winding of relay **348** and contact **345***a* to battery, energizing and operating relay **348**. When relay **348** operates it locks over a path which may be traced from battery through the left-hand winding of relay **348**, contact **348***a* and contact **345***c* to ground. The operation of relay **348** opens the path to ground through contact **348***b* over which relay **218** in Fig. 2 was held operated. As soon as the next open period of the interrupter occurs, ground will be removed from the path through the winding of relay **346** and the winding of relay **218** in the cord circuit and relays **346** and **218** will release. The release of relay **218** in the cord reestablishes the transmission path through the calling end of the cord, which has been open for approximately ten seconds. The release of relay **346** also opens the path over which relay **345** has been held operated at contact **346***b* and relay **345** releases. The release of relay **345**, by opening contact **345***c* opens the holding path for relay **348** and relay **348** releases. As soon as ground was disconnected by interrupter **360** from

the path through rotor magnet 352 and before relay 345 released, the winding of release magnet 351 was energized and it was effective to restore the two brushes of selector banks 344 and 353 to normal. In order to eliminate the possibility of the release of relay 345 before the release magnet 351 has restored the selector brushes to normal, relay 345 is maintained operated by battery from the off-normal spring contact 347b until the selector brushes have been returned to normal.

Toll ringing from operator's position circuit

The circuits herein are arranged so that a ringing signal may be transmitted from the position circuit per Fig. 3 through the cord circuit per Fig. 2 over certain of the trunks to which calling plug 211 may at times be connected. These particular cooperating trunks are arranged so that in response to the opening of the transmission path of the position circuit for a definite interval when it is connected in series with the repeater relays in the cord a ringing signal will be registered at the distant end of the trunk. While the calling end of the cord and position circuit is opened the answering end of the cord and position circuit will be closed to positive battery to hold the circuit associated with the answering end of the cord in the marking condition.

In order to perform the above functions the armature of key 343 is actuated so as to close contact 343b. This opens contact 343a. This opens the circuit which may be traced from open contact 343a through contacts 302c and 302d in parallel, conductor 373, conductor 273, contact 219f, contact 220b and contact 220e in parallel, bottom winding of relay 222, armature of relay 223, contacts 223m and resistance 251 to positive battery. As a result of the opening of contact 343a the bottom winding of relay 222 will be deenergized. The armature of relay 222 will be operated to engage with its spacing contact 222s and a spacing signal will be transmitted over the transmission path associated with the calling end of the cord to the connected toll trunk circuit as a ringing signal. While the armature of key 343 is in engagement with contact 343b a circuit may be traced from positive battery through resistance 312, contact 341b, contact 343b, teletypewriter transmitting contacts 336, top winding of relay 318, contact 319d, contacts 301b and 301d in parallel, contact 303b, conductor 372, conductor 272, contact 219b, resistance 239 and contact 213d to the tip of plug 201. From this point the circuit has been traced around the subscriber's loop and back to negative battery through resistance 121. This holds this circuit in the marking condition while the ringing signal is being transmitted over the calling end of the cord through the connected toll trunk circuit.

Under certain circumstances, as shall be explained, the answering end of the cord circuit per Fig. 2 may be connected to a toll trunk. Under such circumstances it may be desired to transmit a toll call signal on the answering cord. In order to do this, splitting key 341 is first operated and then toll ringing key 343 is actuated so as to close contact 343b. The operation of key 341 establishes a circuit from ground through contact 341a and the winding of relay 302 to battery operating relay 302. As has been shown above, when relay 302 is operated the calling cord transmission path is held to marking by negative battery connected through resistance 311, contact 302b, conductor 373, conductor 273, contact 219f, contact 220b, bottom winding of relay 222, contact 223m and resistance 251 to positive battery. Operation of key 341 and relay 302 also connects positive battery through resistance 312 and contact 302e to the answering end of the cord but the operation of toll ringing key 343 will under this condition, open the operator's position circuit transmission path connected in series with the answering cord. An open signal is therefore transmitted over the answering end of the cord and the toll trunk connected thereto as a ringing signal.

Monitoring on operator's position circuits

The circuits herein are arranged so that a supervisor may monitor on any one of the various operator's position circuits in the switchboard. A jack such as jack 334 is associated with each operator's position circuit. These jacks all appear at a supervisor's position and are wired to the various position circuits. A three-conductor plug 357 may be inserted in jack 334 to connect the monitoring circuit. This establishes a circuit from ground, through the sleeve of plug 357, sleeve of jack 334 and through the winding of relay 320 to battery. A circuit may be traced from the left-hand or marking contact 318m through contact 317b and contact 320b to the tip of jack 334. A circuit may also be traced from positive battery through resistance 312, resistance 356 and contact 320a to the ring conductor of jack 334. The tip and ring conductors of plug 357 inserted in jack 334 connect to the opposite terminals of teletypewriter receiving magnet 353 in the supervisor's monitoring circuit. This magnet is, therefore, connected in parallel with magnet 335 in the operator's position circuit. When the armature of relay 318 is operated so as to engage with its marking contact 318m, ground through key contacts 328b and the armature of relay 318 will be connected to this circuit to energize the teletypewriter magnet in the supervisor's monitoring circuit simultaneously with the energization of the teletypewriter receiving magnet 335 in the position circuit. As the armature of relay 318 follows the operation of teletypewriter transmitting contacts 336 all signals received in the operator's position circuit per Fig. 3 and transmitted from the operator's position circuit per Fig. 3 will be registered in the supervisor's monitoring circuit.

Extending call from cord circuit over automatic signaling intertoll trunk

The reader is reminded that the central office at which the call from subscriber's station A originates is called office 1. The distant central office through which the call is to be extended is called office 2.

Figs. 4, 5, 6 and 7 arranged as indicated in Fig. 9 form an automatic signaling intertoll trunk. The trunk terminating circuit, per Fig. 4, and the repeater circuit, per Fig. 5, are located at office 1. The repeater circuit, per Fig. 6, and the trunk terminating circuit, per Fig. 7, are at office 2. There are also other kinds of trunks, such as ringdown trunks terminated at the operator's position in office 1. The cord circuit, per Fig. 2 and the position circuit, per Fig. 3, as mentioned above, are arranged to function with all of the trunks terminated at the operator's position.

In the following description the manner in which the call incoming from station A in Fig.

1 is extended from office 1 to office 2 through the cord circuit, per Fig. 2, over an automatic signaling intertoll trunk circuit per Figs. 4, 5, 6 and 7 will be described first in a general way to describe the physical arrangement of the units and then in detail.

The jacks 401 and 402 shown at the upper left of Fig. 4 together with their associated lamps 403, 404, 405 and 406 are located in a teletypewriter switchboard at office 1. The jack 402 and its associated lamps 405 and 406 will appear at one operator's position. The jack 401 and its associated lamps 403 and 404 will appear at another operator's position, providing what is known as a multiple appearance of jack 402 and lamps 405 and 406. The leads extending toward the left-hand margin of Fig. 4 indicate that the jacks and lamps appear also at other operators' positions.

At the right-hand end of Fig. 4 two jacks 407 and 408 are shown. These jacks appear at a telegraph test board in office 1. After passing through the telegraph test board the two transmission conductors 412 and 413 extend by means of conductors 512 and 513 through a telegraph repeater shown in Fig. 5. The telegraph repeater, per Fig. 5, is located at office 1. From the telegraph repeater per Fig. 5, two transmission conductors 507 and 508 extend from office 1 to office 2. They connect to conductors 607 and 608, respectively, at office 2. At office 2 the two conductors 607 and 608 connect to another telegraph repeater shown in Fig. 6. The telegraph repeater is connected by two conductors 612 and 613 to conductors 712 and 713 in Fig. 7 which extend to a telegraph test board at office 2. Jacks 707 and 708 shown at the left of Fig. 7 appear at the telegraph test board at office 2. From the telegraph test board at office 2 the path continues through the trunk terminating equipment, per Fig. 7 to the jacks and lamps shown at the upper right of Fig. 7. These jacks and lamps are arranged in the switchboard at office 2 in a manner corresponding to that described for the jacks at the upper left of Fig. 4 in the switchboard at office 1.

Key 224 in Fig. 2 will remain operated to its alternate position and Fig. 3 will remain connected to Fig. 2.

Please refer now to Figs. 4, 5, 6 and 7. These circuits are shown with the armatures of all of the various polar relays in engagement with their spacing contacts. When the trunk circuit is idle no current flows in any of the windings of the polar relays shown in Fig. 4 and Fig. 7 except in the top winding of relay 418 in Fig. 4 and in the top winding of relay 718 in Fig. 7. The armatures of these two relays are actuated to engage their spacing contacts as shown. The armatures of relays 415, 416 and 417 of Fig. 4 and 715, 716 and 717 in Fig. 7 are assumed to be in engagement with their spacing contacts, as shown, before their windings are energized. The armatures of relays 501 and 502 in Fig. 5, 601 and 602 in Fig. 6 are all operated to engage their spacing contacts. No current flows in the top windings of relays 501 and 601 and their armatures are actuated to engage their spacing contacts by the effect of current flowing through their bottom windings. The armatures of relays 502 and 602 are actuated to engage their spacing contacts by the effect of current supplied from the spacing contacts of relays 501 and 601, respectively. None of the vacuum tubes in Figs. 4 and 7 are activated. Relay 418, when its armature is on its spacing contact, will keep condenser 461 discharged by connecting ground to its top contact through contact 424*a*. Similarly, relay 718 will keep condenser 761 discharged by connecting ground to its top contact through contacts 724*a*.

After testing jack 402, in the manner described above, plug 211 will be inserted in jack 402. This establishes a circuit from ground through the winding of relay 419 in Fig. 4, sleeve of jack 402 and the sleeve of plug 211 to negative battery through the winding of relay 217 and resistance 263 in parallel. Relays 419 and 217 operate. A circuit is also established from ground through resistance 490, ring of jack 402, ring of plug 211 and the winding of relay 216 to battery. Relay 216 does not operate at this time as resistance 490 is of too high a value. The operation of relay 217 establishes a circuit from battery through contact 217*a*, resistance 262 and the winding of relay 209 to ground operating relay 209. The operation of relay 217 also closes the transmission circuit of the calling end of the cord at contact 217*d*. The operation of relay 209 establishes a circuit from ground through contact 209*c* and the right-hand winding of relay 206 to battery operating relay 206. The operation of relays 209 and 206 performs no useful function at this time.

It is pointed out that as relay 216 is not operated supervisory lamp 231 remains unlighted at this time.

Refer now to Fig. 4. The operation of relay 419 establishes a circuit which may be traced from ground through contact 419*b* and the winding of relay 420 to battery operating relay 420. The operation of relay 419 also establishes a path from ground through contact 419*a* and the winding of relay 414 to battery operating relay 414. The operation of relay 420 establishes a path from ground through contact 420*g*, resistance 438, bottom winding of relay 415, bottom winding of relay 416 to the armature of relay 417.

The operation of relay 420 also established a circuit which may be traced from battery through resistance 444, bottom winding of relay 417, contact 480*d*, resistance 491 and contact 420*h* to ground. The effect of current flowing in this path actuates the armature of relay 417 to the right to engage it with its marking contact 417*m*. A circuit may now be traced from negative battery through resistance 443, contact 417*m*, armature of relay 417, top winding of relay 416, top winding of relay 415, resistance 437, resistance 436, contact 414*g*, tip of jack 402, tip of plug 211, contact 235*b*, contact 208*d*, contact 217*d*, contact 218*a*, resistance 263, bottom winding of relay 223, armature of relay 222, contact 222*m* and resistance 250 to positive battery. Full line current will flow through the top windings of relays 415 and 416. The effect of this current actuates the armatures of relays 415 and 416 to the right to engage their respective marking contacts 415*m* and 416*m*, as the effect of full line current in the top windings of these relays is dominant over the effect of current in the bottom or biasing windings of these relays which is tending to actuate the armatures of these relays toward the left to engage their respective spacing contacts 415*s* and 416*s*. Relay 414 is locked over a path from battery through the winding of relay 414, contact 414*c* and contact 420*a* to ground. The operation of relay 420 also establishes a path from ground through contact 420*a* and the winding of relay 427 to battery operating relay 427. The operation of relays 420 and 427 also provides a

charging path for condenser 465 as follows: When relay 427 operated ground was connected through contact 427c and resistance 466 to the bottom terminal of relay 465. A circuit may also be traced from battery through resistance 475 to parallel branches. One branch extends through resistance 452 and contact 425e. The other extends through resistance 460. The branches join and the circuit continues through contact 420e to the top terminal of condenser 465. Condenser 465 will be charged. The operation of relay 427 also established a path for the lighting of the filaments of vacuum tubes 431, 432, 433 and 434. This path may be traced from battery through resistance 475, resistances 473 and 474 in parallel, filament of tube 434, resistance 472, filament of tube 433, filament of tube 432, resistance 467, filament of tube 431, resistance 477 and contact 427c to ground. The operation of relay 427 also lights each of the busy lamps 405, 403, etc., associated with the jack multiple circuit in the various operators' positions in the switchboard as a warning that the circuit is in use so that no operator at the other positions where the multiple jacks appear will attempt to establish a connection through the multiple jacks. The lamp circuit may be traced from ground through the filament of lamps 405, 403, etc., in parallel and contact 427a to an alternating current supply circuit 492. The operation of relay 427 also establishes a circuit which may be traced from battery through resistance 456 and contact 427b to the sleeve of jack 408. Jack 408 is a test jack located in the toll test board at office 1. Battery connected to the sleeve of the jack serves as a busy test battery supply. It is impressed on the circuit whenever relay 427 is operated so that the test man at the telegraph test board will not take over the circuit for test when the circuit is in use. As long as relay 480 remains unoperated current through the bottom winding of relay 417 will maintain the armature of relay 417 on its marking contact. The transmission circuit interconnecting the cord per Fig. 2 and Fig. 4 will thus be maintained in the marking condition.

During the interval while the filaments of the tubes are heating, positive battery has been connected through resistance 475, resistance 455, and contact 426a to a parallel circuit. One branch connects to the left-hand terminal of condenser 470, the right-hand terminal of which is connected through resistance 471 to ground. The other branch extends through resistance 468 to the grid of tube 433. Condenser 470 has become charged. As soon as the filaments of the tubes are heated, tube 433 becomes conductive. A circuit is then established from positive battery through resistance 475, winding of relay 430, anode of tube 433, cathode of tube 433 to ground through contact 427c operating relay 430. The operation of relay 430 establishes a path from ground through contact 430a and the winding of relay 421 to battery operating relay 421. The operation of relay 421 establishes a path from battery through the winding of relay 426, contact 421a and contact 419c to ground operating relay 426. When relay 426 operates it locks over a circuit from battery through the winding of relay 426, contact 426c and contact 419c to ground. The operation of relay 426 establishes a circuit from ground through contact 415m, contact 426b and resistance 468 to the grid of tube 433. Tube 433 becomes non-conductive. Relay 430 releases. The release of relay 430 in turn releases relay 421. During this time condenser 465 will have become charged to full potential. Tube 431, the grid of which is connected to the top terminal of condenser 465 through resistance 464, then becomes conductive. The grid of tube 432 is connected to the anode of tube 431 and when tube 431 becomes conductive tube 432 is maintained non-conductive.

A circuit may now be traced from negative battery through resistance 440, contact 416m, resistance 441, contact 421c, contact 426d, contact 407b, conductor 413 into Fig. 5 where it connects to conductor 513 and the circuit continues through resistance 503, top winding of relay 501 and resistance 506 to positive battery. Full line current flows through the top winding of relay 501 and it is effective to actuate the armature of relay 501 to engage with its marking contact 501m as the effect of the line current dominates over the effect of biasing current flowing from positive battery through resistance 506, bottom winding of relay 501 and resistance 504 to ground tending to actuate the armature of relay 501 toward its spacing contact 501s. A circuit may be traced from negative battery through contact 501m and conductor 507 into Fig. 6 where it connects to conductor 607 and the circuit continues through the winding of relay 602 to ground. The armature of relay 602 is actuated to engage with its marking contact 602m. A circuit may be traced from positive battery through contact 602m, resistance 605 and conductor 612 into Fig. 7 where it connects to conductor 712 and the circuit extends through contact 707c, resistance 750, bottom winding of relay 718, bottom winding of relay 717 and resistance 744 to negative battery operating the armature of relays 717 and 718 to the left to engage their marking contacts. When the armature of relay 718 disengages from its spacing contact 718s it permits condenser 761 to start charging over a circuit corresponding to that traced for condenser 461 in Fig. 4. When the armature of relay 718 engages with its marking contact 718m, a circuit is established from ground through contact 718m, contact 720b, contact 714d and the winding of relay 727 to battery operating relay 727. The operation of relay 727 will establish a circuit to light the filaments of tubes 731, 732, 733 and 734 in the same manner as described for Fig. 4. The operation of relay 727 will also supply negative battery through resistance 756 and contact 727b to the sleeve of jack 708 as a busy potential. The operation of relay 727 will apply negative battery through resistance 758 and contact 727d to the sleeves of jacks 701, 702, etc., as a busy potential. The operation of relay 727 will connect an alternating current supply circuit 792 through contact 727a and the filaments of busy lamps 703, 705, etc. to ground lighting the busy lamps. When the filaments of the vacuum tubes are energized tube 733 is activated and relay 730 is operated as heretofore described. This in turn operates relay 721 which has also been described.

When the marking signal is in excess of one-half second condenser 761 will be charged sufficiently to permit tube 732 to function as the positive potential impressed on its top terminal will be impressed through resistance 763 on the grid of tube 732. Relay 728 will operate over a circuit from positive battery through resistance 775, winding of relay 728, anode of tube 732, cathode of tube 732 to ground through contact 727c. This in turn will establish a circuit through contact

728*a* and the winding of relay 724 to battery operating relay 724.

The operation of relay 724 will open the circuit from the spacing contact of relay 718 at contact 724*a* so that tube 732 will remain conductive. The operation of relay 724 will establish a circuit from ground through contact 724*c*, contact 714*b* and the winding of relay 723 to battery operating relay 723. The closing of contact 724*e* will establish a circuit from battery through resistance 751, contact 724*e* and the winding of relay 725 to ground operating relay 725. When relay 725 operates it will lock over a path from ground through the winding of relay 725, contact 725*c* and resistance 751 to battery. The operation of relay 725 establishes a circuit from ground through contact 725*d* and the winding of relay 720 to battery operating relay 720. The operation of relay 725 also establishes a circuit from ground through contact 725*f* and the winding of relay 780 to battery operating relay 780. The operation of relay 720 will close the biasing circuits of relays 715, 716 and 717. The circuit for relays 715 and 716 extends from ground through contact 720*g*, resistance 738 and the bottom windings of relays 715 and 716 to the armature of relay 717, which is in engagement with contact 717*m*. The circuit for relay 717 extends from the armature of relay 716, which engages its spacing contact, through the top winding of relay 717, contact 780*c*, resistance 791 and contact 720*h*. The operation of relay 720 will hold relay 727 operated over a path from battery through the winding of relay 727 and contact 720*a* to ground. The operation of relay 723 will establish a circuit from ground through contact 722*d* and contact 723*a* to the night alarm circuit operating the night alarm circuit. The operation of relay 723 also establishes a circuit from battery through contact 723*b*, contact 722*c* and the filaments of lamps 704, 706, etc. in parallel to ground lighting the lamps as a signal that a call is incoming from office 1. The operation of relay 723 will connect battery through resistance 749 and contact 723*c* to the tip of jack 708. When relay 780 operates it locks over a circuit from battery through the winding of relay 780, contact 780*b* and contact 720*a* to ground. The operation of relay 780 prepares the lead extending from the ring of jacks 701, 702, etc., which connects to resistance 790 in parallel with contact 780*a* for future supervisory conditions.

Abandoned call

If the incoming call is abandoned before the operator at office 2 answers, by removing plug 211 from jack 102, the transmitting path from office 1 to office 2 is returned to spacing. When the armature of relay 718 breaks from its contact 718*m* ground is disconnected from the top terminal of condenser 765. The circuit may be traced from the top terminal of condenser 765 through contact 720*c* to contact 718*m*. This permits condenser 765 to charge over a circuit which may be traced from positive battery through resistance 775, resistance 760 and contact 720*d* to the top terminal of condenser 765. After the condenser has charged for one-third second tube 731 will become conducting and carry the grid of tube 732 to a potential which is negative with respect to its filament so as to make tube 732 non-conducting. Relay 728 will release. This releases relay 724. The release of relay 724 in turn releases relay 723. The release of relay 723 extinguishes line lamps 704, 706, etc. at the switchboard. Two-thirds of a second after tube 731 has become conducting tube 734 will become conducting due to the increased potential of condenser 765 which is impressed on the grid of tube 734. This establishes a path from positive battery through resistance 775, left-hand winding of relay 729, anode of tube 734, and the cathode of tube 734 which extends to ground through contact 727*c* operating relay 729. The operation of relay 729 will establish a circuit from battery through resistance 751 and contact 725*c* to parallel branches. One branch extends through the winding of relay 725 to ground. The other branch extends through contact 725*b* and contact 729*a* to ground. This applies direct ground to the top terminal of the winding of relay 725 shunting the path through the winding of relay 725. Relay 725 releases. The release of relay 725 in turn releases relay 720 by opening contact 725*d*. The release of relay 720 establishes a path from the top terminal of condenser 765 through contact 720*d* to ground through contact 714*f* discharging condenser 765. This causes tube 734 to become non-conductive. This in turn releases relay 729. The release of relay 729 will in turn release relay 780. The release of relay 780 will release relay 727 restoring the circuit at office 2 to normal.

Operator at office 2 answers call incoming over trunk

If the call is not abandoned the operator at office 2 will respond to the lighted line lamp at her position by connecting the answering plug 201 of a cord circuit such as Fig. 2 in her position at office 2 to the trunk line jack at her position. It will be assumed that plug 201 is connected to jack 702. The cord circuit at office 2 is identical with that at office 1. The tip ring and sleeve conductors of plug 201 are connected to the tip ring and sleeve conductors of jack 702. A circuit is established from ground through high resistance 790, ring of jack 702, ring of plug 201, winding of relay 202, winding of relay 212 to battery operating relay 202. Relay 212 does not operate due to the high value of resistance 790. A circuit is established also which extends from ground in Fig. 7 through the winding of relay 719, sleeve of jack 702, sleeve of plug 201, contact 208*b*, left-hand winding of relay 205 and the winding of relay 204 to battery. Relays 719, 205 and 204 will operate. In the cord per Fig. 2, the operation of relay 204 will operate relay 213. This in turn will operate relay 221. The operation of relay 221 will energize the biasing and holding circuits of relays 222 and 223. Key 224 and relay 219 will be operated. These operations are the same as explained for office 1. The operation of relay 719 in Fig. 7 will establish a circuit from ground through contact 719*c*, contact 721*a* and the winding of relay 726 operating relay 726. The operation of relay 719 also establishes a circuit from ground through contact 719*a* and the winding of relay 714 to battery operating relay 714. When relay 714 operates it locks over a path from battery through the winding of relay 714, contact 714*c* and contact 720*a* to ground. The operation of relay 714 releases relay 723 by opening contact 714*b*. The operation of relay 714 also changes the charging path of condenser 761 from a high resistance to a low resistance path by closing contact 714*a* which short-circuits resistance 735. The operation of relay 714 also closes the transmission path of the tip conductor at contact 714*g*. This path may be traced from negative battery through

resistance 743, contact 717*m*, top winding of relay 716, top winding of relay 715, resistance 737, resistance 736, contact 714*g*, tip of jack 702, tip of plug 201, contact 213*d*, resistance 239, contacts 219*a* and 219*e* in parallel, contacts 220*b* and 220*e* in parallel, bottom winding of relay 222, contact 223*m* and resistance 251 to positive battery. Full line current will flow in this path as the batteries at its ends are in series-aiding relationship. In Fig. 2 the armature of relay 222 will engage contact 222*m*. The armature of relay 223 will be actuated to engage contact 223*m* in the manner explained for office 1. In Fig. 7, relay 723 upon releasing will extinguish lamps 706, 704, etc. The release of relay 723 also disconnects the night alarm circuit 776. The release of relay 723 also disconnects battery from the tip conductor of jack 708. The armatures of relays 715 and 716 will be actuated to engage their marking contacts 715*m* and 716*m*. When the armature of relay 715 engages contact 715*m*, it establishes a path from ground through contact 715*m* and contact 726*b* to the right-hand terminal of condenser 770, discharging condenser 770. Tube 733 is made non-conducting. Relay 730 is then released. The release of relay 730 in turn releases relay 721.

The release of relay 721 by closing contact 721*c* establishes the outgoing transmission path from office 2 to office 1. The circuit may be traced from negative battery through resistance 740, contact 716*m*, resistance 742, contact 721*c*, contact 726*d*, contact 707*b*, conductor 713, conductor 613, resistance 603, top winding of relay 601 and resistance 606 to positive battery. The armature of relay 601 is actuated so as to engage with its marking contact 601*m*. This establishes a circuit from negative battery through contact 601*m*, conductor 608, conductor 508 and the winding of relay 502 to ground operating the armature of relay 502 to engage with its marking contact 502*m*. This establishes a circuit from positive battery through contact 502*m*, resistance 505, conductor 512, conductor 412, contact 407*c*, resistance 450, bottom winding of relay 418, bottom winding of relay 417 and resistance 444 to negative battery operating the armatures of relays 417 and 418 to engage with their right-hand or marking contacts. When the armature of relay 418 is actuated to engage with its right-hand contact 418*m*, condenser 465 is discharged and tube 431 becomes non-conducting. After 0.04 second, condenser 461 will have charged sufficiently to cause tube 432 to become conducting. This operates relay 428 over a circuit from positive battery through resistance 475, winding of relay 428 through tube 432 to ground at contact 427*c*. Relay 428 in turn operates relay 424 over an obvious circuit. Relay 424 in turn operates relay 425 from battery through resistance 451, contact 424*e* and the winding of relay 425 to ground. The operation of relay 425 establishes a circuit from ground through contact 425*f* and the winding of relay 480 to battery, operating relay 480. When relay 480 operates it locks over a circuit which may be traced from battery through the winding of relay 480, contact 480*b* and contact 420*a* to ground.

It is pointed out that relay 424 is operated before relay 480 is operated. The operation of relay 424 prevents the establishment of a low resistance path from the ring of relay 402 in parallel with resistance 490. This path may be traced from the ring of jack 402 to parallel branches. One branch extends through resistance 490 to ground. Resistance 490 is of relatively high value. The low resistance parallel branch which has been maintained open by the operation of relay 424 would extend through contact 480*a*, contact 424*b*, left-hand winding of relay 429 and contact 425*g* to ground.

In the cord circuit per Fig. 2 at office 1 the ring circuit extends from the ring of plug 211 through the winding of relay 216. Relay 216 will remain released and the supervisory lamp 231 will remain extinguished for this condition. The operation of relay 480 will establish the normal biasing condition for relay 417. This circuit may be traced from positive battery through resistance 440, contact 416*m*, top winding of relay 417, contact 480*c*, resistance 491 and contact 420*h* to ground.

It is particularly pointed out that in this invention the supervisory lamp 231 associated with the calling end of the cord at office 1 remains extinguished when the operator at office 2 responds to the incoming call. Supervisory lamp 231 will not be lighted until the operator at office 2 completes the connection to the called party's line. In the case of a connection which is extended through a series of central offices over a number of automatic signaling intertoll trunks such as Figs. 4, 5, 6 and 7, no supervisory signal will be received at the originating office until the calling plug of the cord at the final office is connected to the calling subscriber's line. The position circuit in the originating office will remain connected to the cord circuit per Fig. 2. The operator at each succeeding office in responding to a call will connect her position circuit to the cord circuit with which she has answered the call at her particular office and will operate her teletypewriter to transmit a signal to the originating office. The necessary switching information to enable the operator at each succeeding office to extend or complete the call will thereupon be transmitted by the operator at the originating office by means of the teletypewriter in her position circuit. This information will be recorded on the teletypewriter in the position circuit at each succeeding office.

Transmission through the trunk circuit for Figs. 4, 5, 6 and 7

The manner in which teletypewriter communication signals are transmitted through the trunk circuit per Figs. 4, 5, 6 and 7 will now be explained. In Fig. 4 when the armature of relay 417 is in engagement with its contact 417*m* a biasing current will flow through the bottom windings of relays 416 and 415. Relays 415 and 416 will follow all signals received from the cord circuit. Relay 416 will repeat the signals to the outgoing transmission path to office 2. Relay 415 will apply ground to discharge condenser 470 during all marking periods. In Fig. 5 relay 501 will follow the signals transmitted from office 1. These signals will be impressed upon relay 602 at office 2. Relay 602 will in turn impress the signals on relays 717 and 718 in Fig. 7 at office 2. Biasing current for relays 715 and 716 will be supplied from the armature of relay 717. When the armature of relay 717 is in engagement with its marking contact 717*m* the biasing current will tend to actuate the armatures of relays 715 and 716 toward their spacing contacts but it will be ineffectual as the batteries connected to the opposite end of the path through the top or line windings of relays 715 and 716 are in series-aiding relationship for the marking condition and full line current in the top winding of these relays tending to actuate the armatures to their mark-

ing contacts will be dominant. When the armature of relay 717 is in engagement with its contact 717s batteries of the same polarity and magnitude will be connected to the opposite ends of the path through the top windings of relays 715 and 716 so that no current will flow through these windings. The effect of the current in the bottom windings of relays 715 and 716 will be reversed and their armatures will be maintained in engagement with their marking contacts 715m and 716m.

When the armature of relay 716 is in engagement with its left-hand or marking contact a biasing current will flow in the top winding of relay 717 to operate the armature of relay 717 to engage its right-hand or spacing contact when no current is flowing in the incoming path. The current which flows in the incoming path through the bottom winding of relay 717 during marking conditions will operate the armature of relay 717 to the left to engage its marking contact notwithstanding the biasing current. When a spacing signal is received from the cord circuit the armature of relay 716 will operate to its contact 716s. This will reverse the direction of the current in the top winding of relay 717 and will hold the armature of relay 717 to its marking contact 717m regardless of the condition of the incoming path. This operation, therefore, provides the break feature for the repeater.

Connection to called subscriber's line

When a connection is made to a called subscriber's line a signal is transmitted back to the originating office to light supervisory lamp 231 to indicate that the connection is now extended to the called subscriber's line so that the operator at the originating office may ring.

Attention is called to the fact that the calling end of the cord at office 2 is held in the marking condition as explained heretofore by negative battery connected through resistance 249, contact 221d, resistance 242, contact 217c, contact 218a, resistance 243, bottom winding of relay 223, contact 222m and resistance 250 to positive battery. For this condition full line current flows through the bottom winding of relay 223. This holds the armature of relay 223 in engagement with its contact 223m as the effect of this current is dominant over the effect of current flowing through the top winding of relay 223 over a circuit which may be traced from ground through contact 221b, resistance 245, top winding of relay 223, contact 222m and resistance 250 to positive battery which is tending to actuate the armature of relay 223 to engage with its contact 223s.

It will be assumed that plug 211 is connected to jack 824. Fig. 8 is identical with Fig. 2. A circuit is established from ground in Fig. 8 through the winding of relay 805, sleeve of jack 824, sleeve of plug 211 to negative battery through the winding of relay 217 and resistance 263 in parallel operating relays 805 and 217. A circuit is also established from ground through contacts 807d and 807b, conductor 801, resistance 806, contact 805b, bottom winding of relay 809 and resistance 821 to negative battery operating relay 809. A circuit may then be traced from ground through contact 809a, ring of jack 824, ring of plug 211 and the winding of relay 216 to battery operating relay 216.

The operation of relay 216 establishes a circuit from ground through contact 216d and the filament of lamp 231 to battery lighting lamp 231 at office 2. The corresponding lamp 231 in Fig. 2 at office 1 is also to be lighted in a manner to be described hereinafter. Notwithstanding lamp 231 at office 2 lights, no further action is required at this time by the operator at office 2 as the ringing operation will be performed by the operator at office 1 in response to the lighting of her supervisory lamp 231 at office 1.

The operation of relay 217 opens contact 217c and closes the tip or transmission conductor of the calling end of the cord through contact 217d. When contact 217c is open and relay 216 is operated a new path is established to hold the armature of relay 223 in engagement with its contact 223m. This path may be traced from negative battery, resistance 249, contact 221d, resistance 242, contact 216a, bottom winding of relay 223, contact 222m and resistance 250 to positive battery. A circuit may be traced from ground through contacts 807d and 807b, ringer 814, condenser 813, resistance 811, conductor 802, resistance 810, top winding of relay 809, contact 805d, tip of jack 824, tip of plug 211, contact 235b, contact 208d, contact 217d, contact 218a, resistance 243, bottom winding of relay 223, contact 222m and resistance 250 to positive battery. From this it may be seen that the ringer and condenser at the called station are connected between ground and conductor 802 which is connected to the tip of the calling cord per Fig. 2 at office 2.

The operation of relay 217 establishes a circuit from battery through contact 217a, resistance 262 and the winding of relay 209 to ground operating relay 209. The operation of relay 209 establishes a circuit from ground through contact 209c and the right-hand winding of relay 206 to battery operating relay 206. When relay 206 operates it locks from battery through the right-hand winding of relay 206, contact 206b, and contact 216c to ground. When relay 206 is operated a circuit may be traced from battery through resistance 217a, resistance 241 and contact 206a to ground. This connects ground to the bottom terminal of relay 215 to prevent its operation. The operation of relay 217 also establishes a circuit from battery through contact 217a, winding of relay 207, contact 202a and contact 212a to ground operating relay 207.

It will be assumed that the operator at office 2 has restored her key 224 to normal before inserting plug 211 into jack 824 so that relay 219 is released. A circuit may then be traced from ground through contact 220c, contact 219c, contact 216b, contact 207c and the winding of relay 208 to battery operating relay 208. If key 224 has not been restored to normal relay 219 will be still operated. A circuit may then be traced from ground through contacts 301f and 302a, conductor 371, conductor 271, contact 219d, contact 216b, contact 207c and the winding of relay 208 to battery operating relay 208. Thus relay 208 will be operated no matter what the position of key 224 when plug 211 is connected to jack 824.

The operation of relay 208 opens contact 208d and closes contacts 208e and 208f. The opening of contact 208d opens the path heretofore traced through the transmission conductor of the calling end of the cord to which the ringer is connected at the called station. The closing of contact 208e prepares for the application of ringing to the called party's line in a manner to be described. The closing of contact 208f establishes a circuit which may be traced from ground

through condenser 265, winding of relay 210, contact 208f, contact 217d, contact 218a, resistance 243, bottom winding of relay 223, contact 222m and resistance 250 to positive battery. This prepares a circuit under control of the operator at office 1 by means of which ringing may be applied to the called subscriber's line in a manner to be described hereinafter. The operation of relay 208 also establishes a circuit from ground through contact 208c to the night alarm circuit.

There is one other important function which is performed by the operation of relay 208. It was shown that the sleeve circuit of plug 201 in Fig. 2 extended through contact 208b which is normally closed. When relay 208 operates this contact is opened. Contact 208a is closed to ground to hold relays 204 and 205 operated. The opening of contact 208b opens the sleeve circuit of plug 201. This initiates a chain of events which result in the lighting of lamp 231 in the cord circuit per Fig. 2 at office 1 which will now be described.

When the sleeve circuit of the calling end of the cord at office 2 is opened battery is disconnected from the winding of relay 719 and relay 719 releases. Relay 714 remains operated as it is locked through contacts 720a and 714c. The release of relay 719 opens the circuit over which relay 726 is being held operated at contact 719c and relay 726 releases. The release of relay 726 opens contact 726d. This opens the circuit which extends through contact 707b, conductor 713, resistance 603 and the top winding of relay 601. The armature of relay 601 is actuated to engage its spacing contact 601s under the influence of its biasing winding. This in turn operates the armature of relay 502 to engage its contact 502s. This connects negative battery to both ends of the circuit which extends through the bottom or line windings of relays 418 and 417. When the armature of relay 418 breaks from its contact 418m ground is disconnected from the top terminal of condenser 465 and condenser 465 starts to charge. After one-third of a second tube 431 will become conducting. It is pointed out that tube 432 has been in the conducting condition. It now becomes non-conducting. This releases relay 428. The release of relay 428 in turn releases relay 424. After an additional two-thirds of a second the charge on condenser 465 will have become sufficiently high to make the grid of tube 434 sufficiently positive so that tube 434 conducts. This energizes the right-hand winding of relay 429 and relay 429 operates. When relay 429 operates the winding of relay 425 is short-circuited as direct ground is applied through contact 429a, contact 425b and contact 425c to the battery supplied through resistance 451 and contact 425d to the top terminal of the winding of relay 425. The release of relay 425 establishes a low resistance path to ground shunting resistance 490. This path may be traced from ground through contact 425g, left-hand winding of relay 429, contact 424b and contact 480a to the right-hand terminal of resistance 490. From this point the circuit extends through the ring of jack 402, ring of plug 211 and the winding of relay 216 operating relay 216. The operation of relay 216 establishes a path from ground through contact 216d and the filament of lamp 231 to battery lighting lamp 231 as a signal that the connection has been established to the called subscriber's line. Relay 429 will be held operated over the path traced through its left-hand winding. Relay 427 will be held operated over a path from battery through its winding, contact 425a and contact 429a to ground. Relays 414 and 480 will also be held operated while relay 429 remains operated through contact 425a.

When relay 726 in Fig. 7 releases direct ground which was supplied through contact 715m and contact 726b to the right-hand terminal of condenser 770 is disconnected and a circuit is established from positive battery and resistance 775 to the junction of resistances 754 and 755. The path through resistance 754 is grounded through contact 715m. The path through resistance 755 extends through contact 726a to the right-hand terminal of condenser 770. Condenser 770 is charged. In one and one-third seconds tube 733 becomes conducting. Relay 730 reoperates. This in turn reoperates relay 721. The closing of contact 721a prepares a circuit for the reoperation of relay 726 when relay 719 is reoperated after the called subscriber answers. This permits a signal to be transmitted to office 1 to extinguish lamp 231 to be explained in detail below.

While the spacing signal is being transmitted back to the cord circuit per Fig. 2 to light the supervisory lamp 231 the transmission path through relays 715 and 716 will remain closed and their armatures will be held to their marking contacts.

Operator at office 1 rings called subscriber through office 2

When the operator at office 1 observes the lighted supervisory lamp and knows that the connection has been established to the called subscriber's line she will ring the called subscriber. To do this she will operate key 235 in her cord circuit per Fig. 2 at office 1. The operation of key 235 opens contact 235b and closes contacts 235a and 235c. The closing of contact 235a holds the repeater in the cord circuit per Fig. 2 at office 1 in the marking condition. The circuit may be traced from negative battery through resistance 249, contact 221d, left-hand winding of relay 206, contact 235a, contact 208d, contact 217d, contact 218a, resistance 243, bottom winding of relay 223, contact 222m and resistance 250 to positive battery. The closing of contact 235c establishes the ringing circuit. This circuit may be traced from ground through a source of alternating ringing current 236, filament of lamp 237, contact 235c, tip of plug 211, tip of jack 402, contact 414g, resistance 436, resistance 437, top winding of relay 415, top winding of relay 416, contact 417m and resistance 443 to negative battery. Relays 415 and 416 follow the reversals of the ringing current. Positive and negative batteries are alternately impressed through resistances 439 and 440 and contacts 416s and 416m respectively on a circuit which extends through resistance 441, contact 421c, contact 426d, contact 407b, conductor 413, conductor 513, resistance 503, top winding of relay 501 and resistance 506 to positive battery. The armature of relay 501 will follow these reversals which will be impressed on the winding of relay 602. Reversals of positive and negative current will be applied through contacts 602m and 602s on a circuit which extends through resistance 605, conductor 612, conductor 712, contact 707c, resistance 750, bottom winding of relay 718, bottom winding of relay 717 and resistance 744 to negative battery. The armatures of relays 717 and 718 will follow these reversals. Reversals of positive and negative battery will be impressed through resist-

ances 742 and 743 and contacts 717*m* and 717*s* on a circuit which extends through the armature of relay 717, the top winding of relay 716, top winding of relay 715, resistance 737, resistance 736, contact 714*g*, tip of jack 702, tip of plug 201, contact 213*d*, resistance 239, contacts 219*a* and 219*e* in parallel, contacts 220*b* and 220*e* in parallel, bottom winding of relay 222, contact 223*m* and resistance 251 to positive battery. The armature of relay 222 will follow the reversals of relay 717. This applies reversals of positive and negative battery through contacts 222*m* and 222*s* to the circuit traced through the winding of relay 210 and condenser 265 when relay 208 was operated. In response to this relay 210 will operate. This establishes a path from battery through contact 217*a*, resistance 262 and contact 210*a* to ground. By connecting direct ground to the left-hand terminal of resistance 262 the path through the winding of relay 209 to ground is short-circuited and relay 209 releases. The release of relay 209 establishes a path from ground through a source of alternating ringing current 236, filament of lamp 237, contact 209*a*, contact 208*e*, contact 235*b*, tip of plug 211, tip of jack 824, contact 805*d*, top winding of relay 809, resistance 810, conductor 802, resistance 811, condenser 813, ring 814, contact 807*b* and contact 807*d* to ground operating the ringer 814.

Subscriber at called station answers

In response to the operation of ringer 814 the subscriber at the called station will actuate his switch 807 to its alternate position. This disconnects the ringer by opening contact 807*b* and establishes the loop circuit through the called subscriber's station. When the loop is established through the subscriber's station the top and bottom windings of relay 809 will be connected in series and relay 809 will be deenergized opening contact 809*a*. This disconnects ground from the winding of relay 216 at office 2 and relay 216 releases. This in turn extinguishes lamp 231 at office 2 to indicate that the called subscriber has responded. Lamp 231 at office 1 will also be extinguished in a manner to be described below. The release of relay 216 also opens the locking circuit through the right-hand winding of relay 206 and relay 206 releases. The release of relay 216 by opening contact 216*b* releases relay 208. This disconnects the ringing supply which was connected to the cord per Fig. 2 at office 2 and reestablishes the transmission path through the calling end of the cord at office 2. When the operator at office 1 restores her key 235 to normal the transmission path connecting offices 1 and 2 will be restored to the marking condition and the armature of relay 222 at office 2 will come to rest in engagement with contact 222*m*. Positive battery through resistance 250 and contact 222*m* will be connected to one end of the called subscriber's loop. The opposite end will be terminated in negative battery through resistance 821. This will place the calling end of the cord circuit per Fig. 2 at office 2 and the called subscriber's loop per Fig. 8 in the marking condition. The release of relay 208 at office 2 disconnects the night alarm circuit when contact 208*c* is opened. The release of relay 208 also recloses contact 208*b* which reconnects negative battery to the sleeve of plug 201. This in turn reoperates relay 719 in Fig. 7. A circuit may now be traced from battery through the winding of relay 726, contact 721*a* and contact 719*c* to ground reoperating relay 726. When relay 726 is reoperated it locks over a circuit from ground through contact 719*c*, contact 726*c* and the winding of relay 726 to battery. This recloses contact 726*d*. The operation of relay 726 also closes contact 726*b*. This connects direct ground through contact 715*m* and contact 726*b* to the right-hand terminal of condenser 770 discharging condenser 770. After condenser 770 has discharged tube 733 will become non-conducting. This will release relay 730. This in turn will release relay 721. This will re-establish the transmitting path from office 2 to office 1 and restore it to the marking condition. After the transmission path from office 2 to office 1 has been restored to the marking condition ground will be connected through the armature of relay 418 to contact 418*m*. This discharges condenser 465. Tube 431 becomes non-conducting. Tube 432 will again become conducting. Within .04 second after the armature of relay 418 has been operated to contact 418*m*, relay 428 will reoperate. This will operate relay 424. The operation of relay 424 will in turn operate relay 425. This disconnects the low resistance ground which has been shunting the path to ground through resistance 490. When the low resistance shunt path is removed relay 216 at office 1 will release. This in turn extinguishes lamp 231 at office 1 as a signal that the called subscriber has answered.

Calling and called subscribers communicate

When the communication path is established between the calling and called subscriber the operators' position circuits per Fig. 3 at office 1 and office 2 are disconnected from the line. In communicating from the calling subscriber to the called subscriber teletypewriter transmitting contact 116 in Fig. 1 will be opened and closed. Relay 222 in Fig. 2 will follow these signals and impress them on relays 415 and 416 in Fig. 4 which will follow the signals. Relay 416 will repeat the signals to relay 501 in Fig. 5. Relay 501 will in turn impress the signals on relay 602 in Fig. 6 at office 2. Relay 602 will impress the signals on relays 717 and 718 in Fig. 7. Relay 717 will impress the signals on relay 222 in the cord at office 2. Relay 222 will repeat the signals to the calling subscriber's line energizing and deenergizing teletypewriter magnet 823 at the called station.

In transmitting in the opposite direction from the called subscriber, to the calling subscriber, teletypewriter transmitting contact 816 in Fig. 8 will be opened and closed. This will impress the signals on relay 223 in Fig. 2 at office 2. Relay 223 will repeat the signals to relays 715 and 716 in Fig. 7 at office 2 which will follow the signals. Relay 716 will repeat the signals to relay 601 in Fig. 6. Relay 601 will in turn impress the signals on relay 502 at office 1. Relay 502 will repeat the signals to relays 417 and 418. Relay 417 will repeat the signals to relay 223 in Fig. 2 at office 1. Relay 223 will repeat the signals to the calling subscriber's line. The teletypewriter magnet 123 at the calling station will be energized and deenergized. Although relays 415, 418, 715 and 718 will be operated during communication, their operation will be without practical effect.

Break signals

The manner in which a break signal is transmitted from one station to another will now be explained. It will be assumed that the called subscriber is transmitting to the calling subscriber

and that the calling subscriber wishes to break. To do this the subscriber at the calling station will open break key 127. The key will be maintained open for an interval of one second or more. This will stop the flow of current in the subscriber's loop and in the answering end of the cord circuit per Fig. 2 at office 1 deenergizing the line winding of relay 222. Relay 109 will remain released. The armature of relay 222 will be actuated to engage with its spacing contact 222s. This in turn results in the actuation of the armatures of relays 415 and 416 to engage their respective spacing contacts. Relay 416 will repeat the spacing signal to the called subscriber through the connected circuit. When the armature of relay 415 breaks from its contact 415m, condenser 470 will charge. After two-thirds of a second tube 433 will become conductive. Relay 430 will operate. This in turn operates relay 421. The operation of relay 421 will remove the connection to contact 416s by opening contact 421c. When contact 421c is closed, a grounded source of 20-cycle ringing current 448 is connected through resistance 447 and contact 421b to the transmission path extending to office 2. The 20-cycle ringing current will remain connected to the transmission path connecting offices 1 and 2 for the remainder of the breaking interval.

In Fig. 7 at office 2 when the break signal is received the armature of relay 718 will be actuated to engage with contact 718s. When ground is disconnected from contact 718m which is connected through contact 720c to the top terminal of condenser 765, condenser 765 starts to charge. After one-third of a second tube 731 will become conductive and will carry the grid of tube 732 to a potential negative with respect to the filament of tube 732. This will cause tube 732 to become nonconductive. This will release relay 728 and in turn relay 724. The release of relay 724 will return the control of the grid of tube 732 to contact 718s through contact 724a. The release of relay 724 will short-circuit the bottom or line winding of relay 717. The circuit may be traced from the right-hand terminal of the bottom winding of relay 718 through contact 724d, contact 780e, relay 780 being operated at this time, through resistance 744 to negative battery. This deenergizes the bottom winding of relay 717 and the relay is actuated to engage with its spacing contact 717s where it remains notwithstanding the 20-cycle reversal transmitted from office 1. This prevents the transmission of the 20-cycle reversals toward the called station.

While the 20-cycle reversals are being received, condenser 765 will be discharged so that tube 734 will not become conductive. The marking intervals in the 20-cycle reversals are not of sufficient duration to permit tube 732 to become conductive. A continuous spacing signal substantially equal in duration to the length of time that key 127 is maintained open will be transmitted to station B deenergizing the teletypewriter circuit at station B as a signal that the calling subscriber is breaking.

At the end of the break signal the armature of relay 222 will be restored to its marking contact 222m. The armatures of relays 415 and 416 will likewise be returned to their marking contacts 415m and 416m. When the armature of relay 415 remains on its contact 415m condenser 470 will be discharged. Tube 433 will become non-conducting. Relay 430 will be released in turn releasing relay 421. This restores the transmission path from office 1 to office 2 to the marking condition. At office 2 when the armature of relay 718 is returned permanently to its contact 718m, condenser 761 will charge sufficiently in four-one-hundredths of a second to cause tube 732 to again become conductive. This reoperates relay 728 which in turn reoperates relay 724. The armatures of all relays in the transmitting path are restored to marking and the circuit is ready for transmission from subscriber A to subscriber B.

Disconnect

When the subscribers at station A and station B have finished communication the subscriber at station A will restore switch 107 to normal. The subscriber at station B will restore switch 807 to normal. The restoration of switch 107 to normal will light lamp 230 in the cord circuit at office 1. The restoration of switch 807 will light lamps 231 in the cord circuit per Fig. 2 at both offices 1 and 2. This will now be explained more fully.

When the subscriber at station A restores switch 107 to the normal idle condition, as shown, the loop through the teletypewriter circuit at station A will be reopened at contact 107c and the condenser 113 and ringer 114 will be reconnected in series with conductor 102 to ground through contacts 107b and 107d. Conductor 101 will be grounded at station A through contacts 107b and 107d in series. This establishes a circuit which may be traced from ground through contact 107d, contact 107b, conductor 101, resistance 106, contact 105b, bottom winding of relay 109 and resistance 121 to negative battery operating relay 109. The operation of relay 109 establishes a circuit from ground through contact 109a, ring of jack 124, ring of plug 201, winding of relay 202, winding of relay 212 to battery, operating relays 202 and 212. The operation of relay 212 establishes a circuit from ground through contact 212e and the filament of lamp 230 to battery, lighting lamp 230 as a signal that the subscriber at station A has disconnected.

The operation of relay 212 will also establish a circuit from ground through contact 212b, winding of relay 214, resistance 240 and contact 213a to battery operating relay 214. Relay 214, when operated will lock over a circuit from battery through contact 213a, resistance 214, winding of relay 214 and contact 214b to ground. This prepares the flashing recall circuit for operation. In the event that the restoration of switch 107 to its normal condition when idle, which results in the transmitting of a disconnect signal, is not followed by the reopening of switch 107, which completes the operation necessary for the transmittal of a recall signal, the operation of relay 214 at this time is ineffectual.

The operation of relay 212 also establishes a circuit from battery through resistance 248, contact 221c, resistance 238, contact 212d, to the transmission conductor of the answering side of the cord per Fig. 2 at office 1 which extends through the bottom winding of relay 222. In the event that the subscriber at station B has not yet restored his switch to the normal idle condition, the armature of relay 223 will still be on its marking contact 223m and the armature of relay 222 will be held in engagement with its marking contact 222m, holding the circuit toward station B in the marking condition.

The closing of contact 212c, will connect ground to the night alarm circuit operating the night alarm circuit.

In the case of station B, the restoration of key 807 in Fig. 8 will restore the called subscriber's circuit per Fig. 8 to the same condition as de-

scribed for the restoration of key 107 in Fig. 1 when a disconnect signal was transmitted. Relay 809 will operate connecting ground through contact 809a to the ring circuit of the called subscriber's line and the calling end of the cord per Fig. 2 at office 2. Further, it may be observed, the conditions prevailing in the subscriber's line circuit per Fig. 8 and the cord circuit per Fig. 2 at office 2 are the same as prevailed when plug 211 at office 2 was first connected to jack 824. This results in the lighting of lamp 231 in the cord circuit at both offices as a signal that the called subscriber has disconnected in the same manner as heretofore described.

The operator at office 1 may disconnect plug 201 from jack 124. This releases relay 105 and 109 in Fig. 1 restoring Fig. 1 to the normal idle condition as shown.

In Fig. 2, the disconnection of plug 201 from jack 124 will release relays 202 and 212 in the ring circuit and 204 and 205 in the sleeve circuit. The release of relay 204 will in turn release relay 213. The release of relay 213 will in turn release relay 214 by opening contact 213a.

As long as cord 211 remains connected to jack 402 relay 217 will remain operated. While relay 217 is operated a circuit may be traced from battery through contact 217a, resistance 247 and the right-hand winding of relay 221 holding relay 221 operated even though relay 213 has released opening contact 213a and deenergizing the left-hand winding of relay 221.

While relay 221 remains operated and when relay 213 is released a circuit may be traced from negative battery through resistance 248, contact 221c and contact 213c to hold the armature of cord repeater relay 222 to its contact 222m if relay 223 is still on its marking contact 223m.

In response to the lighting of lamp 231 the operator may disconnect plug 211 from jack 402. This releases relays 216 and 217 in Fig. 2 and relay 419 in Fig. 4. The release of relay 217 by opening contact 217a will release relays 221 and 209. The release of relay 221 will open the biasing and holding circuits of both sides of the cord circuit repeater.

The release of relay 216 will extinguish lamp 231 by opening contact 216c. Since relay 202 is released relay 207 will be released. The cord circuit per Fig. 2 will be restored to its normal idle condition.

In Fig. 4, the release of relay 419 by opening contact 419b will release relay 420. The opening of contact 419c will release relay 426. The release of relay 420 will connect the fully charged condenser 465 to a circuit which extends through contact 420d, contact 414e, resistance 495 to ground through contact 427c and the filaments of tubes 432 and 431 with their associated resistances. Resistance 495 is of very high value. After one and one-half seconds condenser 465 will have discharged sufficiently so that tube 434 will become non-conductive. This will release relay 429. The release of relay 429 will in turn release relays 456, 414 and 480, as contact 429a opens and disconnects ground from the windings of these relays in parallel. This returns the circuit per Fig. 4 to the idle condition.

The removal of the plug 211 of the cord at office 1 has resulted in the release of relay 426 opening contact 426d. This opens the tip or transmission conductor extending from office 1 to office 2 and transmits a permanent spacing signal from office 1 to office 2. The armatures of relays 717 and 718 are operated to their spacing contacts 717s and 718s. When the armature of relay 718 breaks from its marking contact ground, as has been shown, is disconnected from the circuit extending through contact 720c to the top terminal of condenser 765, permitting condenser 765 to charge, over a circuit from positive battery through resistance 775, resistance 760, contact 720d to the top terminal of the condenser. After one-third of a second tube 731 will become conductive. This will cause tube 732 to become non-conductive. Relay 728 will release. This in turn releases relay 724. After an additional two-thirds of a second tube 734 will become conductive. This will operate relay 729 through its left-hand winding in the anode circuit of tube 734. When relay 729 operates it connects direct ground through contact 729a and contact 725b in parallel with the path through the winding of relay 725 releasing relay 725. When relay 725 releases it connects a low resistance shunt to ground in parallel with resistance 790 to the ring of jack 702 which may be traced from ground through contact 725g, right-hand winding of relay 728, contact 724b, contact 780a, relay 780 being operated, to the junction with resistance 790 and then to the ring of jack 702. Relays 202 and 212 in the cord at office 2 operate. Supervisory lamp 230 is lighted as a disconnect signal through contact 212e to ground.

As long as plug 201 remains connected to jack 702 relay 729 will remain operated from battery supplied through the windings of relays 212 and 202 to the ring of plug 201 and of jack 702.

In response to the lighting of supervisory lamp 230 the operator at office 2 may disconnect plug 201 from jack 702. Opening of the ring conductor will open the right-hand winding of relay 729 but the relay will not release immediately as its left-hand winding is energized.

The opening of the sleeve conductor releases relay 719. This in turn, by opening contact 719b, releases relay 720. The opening of contact 719c breaks the path through contact 726c and the winding of relay 726 to battery, releasing relay 726. The top terminal of condenser 765 will be connected through contact 720d, contact 714e, through high resistance 795 to ground through the filament of tube 732, resistance 767, filament of tube 731, resistance 777 and contact 727c. After one and one-half seconds tube 734 will become non-conductive as condenser 765 will have discharged sufficiently to reduce the potential of the grid of tube 734 so that it is negative with respect to its filament. Relay 729 will release. The release of relay 729 by opening contact 729a removes ground from the circuit extending through contact 725a to three branches in parallel. One branch extends through contact 714c and the winding of relay 714 to battery. Another extends through the winding of relay 727 to battery. The third extends through contact 780b and the winding of relay 780 to battery. Relays 714, 727 and 780 release.

Attention is called to the fact that in the case of the cord at office 2 the operator may receive two disconnect signals. If the subscriber at station B disconnects first lamp 231 in cord 2 at office 2 lights. The operator at office 2 may be instructed to disconnect plug 211 or both plug 211 and plug 201 in response to the lighting of lamp 231 or the operator may be instructed to await the lighting of lamp 230 in response to the disconnection of plug 211 from jack 402 at office 1 before disconnecting either plug. Awaiting the

lighting of lamp 230 provides an opportunity for transmitting a recall signal.

Recall Signals

The manner in which recall signals are transmitted over this system will now be explained.

A recall signal may be transmitted by the subscriber at station A to the operator at office 1 while plug 201 is still connected to jack 124. To do this switch 107 is first restored to its normal idle position and then reoperated. The restoration of switch 107 to its normal idle position results in the conditioning of the circuit per Fig. 1 and Fig. 2 as for a disconnect signal in the manner heretofore described. Relay 109 in Fig. 1 and relays 202, 212 and 214 in Fig. 2 will operate as heretofore described for the disconnect operation. Relay 214 will lock over a circuit from battery through contact 213*a*, resistance 240, winding of relay 214 and contact 214*b* to ground.

When switch 107 is reoperated relays 109, 202 and 212 will reoperate. For the ordinary disconnect signal the circuit for lamp 230 extended from battery through the filament of lamp 230 to a permanent ground through contact 212*e*. When relay 212 releases while relay 214 remains locked the lamp circuit extends through contacts 212*f*, 214*a* and interruptor 270 to ground flashing lamp 270 as a signal that the subscriber at station A is recalling.

The operator at station A will respond by operating key 224 which in turn operates relay 219. This establishes a circuit from battery through contact 213*a* and resistance 240 to parallel branches. One branch has been traced through the winding of relay 214 and contact 214*b* to ground. A parallel low resistance branch shunting the winding of relay 214 may be traced through contact 224*d*, conductor 275 into Fig. 3 where it connects to conductor 375 and the circuit continues through contact 301*a* to direct ground. Relay 214 releases extinguishing lamp 230.

The operator's position circuit at office 1 is connected to the subscriber's transmission circuit extending through station A by the operation of key 224 and the operator and subscriber may communicate.

If a recall signal is to be sent from station B, switch 807 in Fig. 8 is opened and then reclosed. This operation will flash lamps 231 in the cords at offices 1 and 2.

The manner in which lamp 231 at office 2 is flashed will first be described.

When key 807 is restored momentarily to the position shown in Fig. 8, conductor 801 will be grounded at station B. Conductor 802 will be connected through the condenser and ringer to ground. The bottom winding only of relay 809 will be energized. Relay 809 will operate. This connects ground to the ring circuit of jack 824 which extends through the winding of relay 216 in Fig. 2. Relay 216 will operate. The operation of relay 216 will operate relay 208. This opens the sleeve circuit of plug 201 at contact 208*b*. The operation of relay 216 also establishes a circuit from battery through contact 217*a*, resistance 241, winding of relay 215, contact 206*c* and contact 216*c* to ground operating relay 215. Relay 215 locks to ground through contact 215*b*. It is pointed out that keys 224 and 225 will be in their normal released positions as shown in Fig. 2 at this time and relay 206 will be released. The low resistance path to ground shunting the winding of relay 215 will be opened so that relay 215 may operate for the flashing operation. When key 807 is restored to the position shown in Fig. 8 relay 809 will release. In turn relay 216 will release. This establishes a circuit from ground through interrupter 270, contact 215*a*, contact 216*e* and the filament of lamp 231 to battery flashing lamp 231. In response to this the operator at office 2 will actuate key 224 to supply direct ground to the bottom terminal of relay 215 releasing relay 215. This disconnects the interrupter and extinguishes lamp 231.

The manner in which the flashing recall signal is transmitted through the trunk circuit to flash lamp 231 at office 1 will now be described.

The opening of the sleeve circuit of plug 201 in Fig. 2 at office 2 when relay 208 operates releases relay 719. The release of relay 719 will in turn release relay 726. The release of relay 726 will connect condenser 770 to its charging path. After one and one-third seconds tube 733 becomes conductive. Relay 730 will operate. The operation of relay 730 in turn operates relay 721.

The reoperation of key 807 in Fig. 1 by releasing relay 809 which in turn released relay 216, released relay 208 reestablishing the sleeve circuit of plug 201 and reoperating relay 719. This establishes a circuit from ground through contact 719*c*, contact 721*a* and the winding of relay 726, reoperating relay 726.

During the interval that relay 216 was released negative battery was supplied through resistance 249, contact 221*d*, resistance 242 and contact 216*a* to the right-hand terminal of the bottom winding of relay 223 to hold the repeater in the cord circuit per Fig. 2 at office 2 in the marking condition. When the loop is reestablished through the subscriber's station per Fig. 8 by the reoperation of key 807 the marking condition will be maintained. The armature of relay 715, therefore, will be in engagement with its contact 715*m*. With relay 726 reoperated ground will be connected through contacts 715*m* and 726*b* to the right-hand terminal of condenser 770 discharging the condenser. Relay 730 will release in turn followed by relay 721. The above cycle of operations has transmitted a break signal of one and one-third sections duration through the repeaters per Fig. 6 and Fig. 5 into Fig. 4. The armature of relay 418 will be actuated to its spacing contact. This disconnects ground from the top terminal of condenser 465 and permits condenser 465 to charge. After one-third of a second condenser 465 will have charged sufficiently to permit tube 431 to become conductive. This renders tube 432 non-conductive. Relay 428 releases. This in turn releases relay 424. Two-thirds of a second later condenser 465 will have charged sufficiently to permit tube 434 to operate. This operates relay 429. The operation of relay 429 short-circuits and releases relay 425. This applies a low resistance ground to the ring circuit of jack 402 and plug 411 operating relay 216, lighting lamp 231 in the cord circuit per Fig. 2 at office 1.

The marking signal following the spacing portion of the recall signal will reoperate the armature of relay 419 to its marking contact 419*m*. When the armature of relay 418 breaks from its spacing contact 418*s* ground is disconnected from the circuit which extends through contact 424*a* to the top terminal of condenser 461. Condenser 461 is recharged. After four one-hundredths of a second the potential of the top terminal of condenser 461 and of the grid of tube 432 in parallel

will be sufficiently positive with respect to the filament of tube **432** to permit tube **432** to operate. This will operate relay **428**. The operation of relay **428** will in turn reoperate relay **424**. This in turn reoperates relay **425**. This opens the low resistance shunt to ground shunting high value resistance **490**. This again releases relay **216**. Lamp **231** in the cord circuit per Fig. 2 at office **1** will flash in response to these conditions in the same manner as described for lamp **231** in the cord circuit per Fig. 2 at office **2**. When the operator at office **1** operates key **224** a low resistance ground will be connected to the bottom terminal of relay **215** and relay **215** will release stopping the flashing of lamp **231**.

A recall signal may also be transmitted through the trunk circuit between offices **1** and **2** in either direction while a cord circuit per Fig. 2 remains connected to the opposite end of the trunk.

It will be assumed that the operator at office **2** wishes to transmit a recall signal to the operator at office **1** and that the cord circuit per Fig. 2 at office **1** is still connected to the trunk circuit per Fig. 4 at office **1**. In order to do this, the operator at office **2** will remove plug **201** from jack **702** at office **2** and then reinsert the plug in the jack. When plug **201** is withdrawn from jack **702** relay **719** will release. The armature of relay **715** will be actuated to engage with contact **715***s*. When plug **201** is reinserted in jack **702** relay **719** will be reoperated and the armature of relay **715** will be restored to its contact **715***m*. The electrical conditions imposed on the trunk circuit per Fig. 7 for this operation are the same as described for a recall signal transmitted from station B per Fig. 8 and the trunk circuit extending to Fig. 1 together with the calling end of the cord circuit per Fig. 2 at office **1** will operate in the same manner as described for a recall signal originating at station B.

If the operator at office **1** wishes to transmit a recall signal to the operator at office **2** she will withdraw plug **211** from jack **402** and then reinsert the plug. In response to this the trunk circuit interconnecting office **1** and office **2** and the cord circuit connected to the trunk at office **2** will respond in a manner which may be understood from the foregoing to flash lamp **230** at office **2**.

What is claimed is:

1. In a manual teletypewriter switching system, a first and a second manual central teletypewriter switching station, a first local teletypewriter station connected directly to said first central station, a second local teletypewriter station connected directly to said second central station, an automatic manual intertoll telegraph trunk circuit connecting said central stations, a manual teletypewriter cord circuit at each of said central stations, an operator's position circuit including a teletypewriter transmitter and receiver operably connectable directly to said cord circuit at each of said stations, means in said circuits for establishing a continuous operable telegraph path interconnecting said local stations through all of said circuits, supervisory signal means connected to said path at said central stations, a vacuum tube control means for said signals at each of said central stations and means responsive to electrical conditions imposed on said path for controlling said control means.

2. In a manual teletypewriter switching system, a first local teletypewriter station, directly connected to a first manual central teletypewriter switching station, a first manual teletypewriter cord circuit at said central station, a second manual central teletypewriter switching station, an automatic manual trunk circuit connecting said central stations, a second manual teletypewriter cord circuit at said second central station, a second local teletypewriter station directly connected to said second central station, a continuous telegraph path connecting said first and said second local stations through said cords and said trunk, a telegraph transmitter and receiver operably connectable directly to each of said cord circuits at each of said central stations, supervisory signal means in said cords, means for transmitting a disconnect signal from said second local station, and means including a vacuum tube circuit having a time controlled activating circuit directly responsive to the transmission of said disconnect signal for operating said supervisory signal in said first cord.

3. In a manual teletypewrter switching system, a first subscriber's teletypewriter station connected directly to a first manual central switching station, a second manual central switching station, an automatic manual telegraph trunk circuit connecting said central stations, a second subscriber's teletypewriter station connected directly to said second central station, a manual cord circuit at each of said central stations, means for establishing an operative telegraph path connecting said subscriber's stations through said circuits, telegraph transmitting and receiving means operably connectable directly to said path through each of said cord circuits at each of said central stations, a vacuum tube connected to said path, time control means for said tube connected to said path, a supervisory signal connected to said path and means including said tube and said control means for operating said signal in response to the extension of said path as said path is being established.

4. In a manual teletypewriter switching system, a first subscriber's teletypewriter station connected directly to a first manual central switching station, a second manual central switching station, an automatic manual telegraph trunk circuit connecting said central stations, a second subscriber's teletypewriter station connected directly to said second central station, a manual cord circuit at each of said central stations, means for establishing an operative telegraph path connecting said subscriber's stations through said circuits, a telegraph signal generating and receiving device operably connectable directly to said path through one of said cord circuits at one of said central stations, a vacuum tube connected to said path, time control means for said tube connected to said path, a supervisory signal connected to said path and means including said tube and said control means for operating said signal in response to the completion of an operative telegraph circuit between said subscribers' stations through said path.

5. In a manual teletypewriter switching system, a first subscriber's teletypewriter station connected directly to a first manual central switching station, a second manual central switching station, an automatic manual telegraph trunk circuit connecting said central stations, a second subscriber's teletypewriter station connected directly to said second central station, a manual cord circuit at each of said central stations, means for establishing an operative telegraph path connecting said subscriber's stations through said circuits, an attendant's telegraph set operably connectable directly to

said path through one of said cord circuits at one of said central stations, a vacuum tube connected to said path, time control means for said tube connected to said path, a supervisory signal connected to said path and means including said tube and said control means for operating said signal in response to the manipulation of disconnect signal control means at one of said subscriber's stations.

6. In a manual teletypewriter switching system, a first subscriber's teletypewriter station connected directly to a first manual central switching station, a second manual central switching station, an automatic manual telegraph trunk circuit connecting said central stations, a second subscriber's teletypewriter station connected directly to said second central station, a manual cord circuit at each of said central stations, means for establishing an operative telegraph path connecting said subscriber's stations through said circuits, an attendant's telegraph communication device operably connectable directly to said path through one of said cord circuits at one of said central stations, a vacuum tube connected to said path, time control means for said tube connected to said path, a supervisory signal connected to said path and means including said tube and said control means for operating said signal in three distinctive manners.

7. In a manual teletypewriter switching system, a first subscriber's teletypewriter station connected directly to a first manual central switching station, a second manual central switching station, an automatic manual telegraph trunk circuit connecting said central stations, a second subscriber's teletypewriter station connected directly to said second central station, a manual cord circuit at each of said central stations, means for establishing an operative telegraph path connecting said subscriber's stations through said circuits, a branch telegraph path operably connectable directly to said path through one of said cord circuits at one of said central stations, a vacuum tube connected to said path, time control means for said tube connected to said path, a supervisory signal connected to said path and means including said tube and said control means for operating said signal in different manners to distinguish between disconnect and recall signals.

8. In a manual teletypewriter switching system, a first subscriber's teletypewriter station connected directly to a first manual central switching station, a second manual central switching station, an automatic manual telegraph trunk circuit connecting said central stations, a second subscriber's teletypewriter station connected directly to said second central station, a manual cord circuit at each of said central stations, means for establishing an operative telegraph path connecting said subscriber's stations through said circuits, a local telegraph loop including a telegraph transmitter and receiver operably connectable directly to said path through each of said cord circuits at each of said central stations, a vacuum tube connected to said path, time control means for said tube connected to said path, a supervisory signal connected to said path and means including said tube and said control means for preventing the operation of said signal in response to a break signal transmitted over said path between said subscriber's stations.

9. In a manual teletypewriter switching system, a first manual central teletypewriter switching station, a first manual teletypewriter cord circuit thereat, a second manual central teletypewriter switching station, an automatic manual intertoll telegraph trunk circuit connecting said stations, a second manual teletypewriter cord circuit at said second station, a subscriber's teletypewriter station circuit, a subscriber's line circuit connecting said subscriber's circuit directly to said second central station, a supervisory signal in said first cord circuit, a vacuum tube and a time control device therefor in said trunk circuit, means connected to said circuits for establishing an operative telegraph path extending through all of said circuits to said subscriber's station, a local telegraph circuit operably connectable directly through each of said cord circuits to said path at each of said central stations, and means including said tube and said device for operating said signal as said path is being established.

10. In a manual teletypewriter switching system, a first manual central teletypewriter switching station, a first manual teletypewriter cord circuit thereat, a second manual central teletypewriter switching station, an automatic manual intertoll telegraph trunk circuit connecting said stations, a second manual teletypewriter cord circuit at said second station, a subscriber's teletypewriter station circuit, a subscriber's line circuit connecting said subscriber's circuit directly to said second central station, a supervisory signal in said first cord circuit, a vacuum tube and a time control device therefor in said trunk circuit, means connected to said circuits for establishing an operative telegraph path extending through all of said circuits to said subscriber's station, a telegraph transmitter and receiver operably connectable directly to said cord circuits at each of said central stations, and means including said tube and said device for operating said signal when a connection is established to said line circuit.

11. In a manual teletypewriter switching system, a first manual central teletypewriter switching station, a first manual teletypewriter cord circuit thereat, a second manual central teletypewriter switching station, an automatic manual intertoll telegraph trunk circuit connecting said stations, a second manual teletypewriter cord circuit at said second station, a subscriber's teletypewriter station circuit, a subscriber's line circuit connecting said subscriber's circuit directly to said second central station, a supervisory signal in said first cord circuit, a vacuum tube and a time control device therefor in said trunk circuit, means connected to said circuits for establishing an operative telegraph path extending through all of said circuits to said subscriber's station, telegraph transmitting and receiving means operably connectable directly to said path through each of said cord circuits at each of said central stations and means including said tube and said device for operating said signal in response to the conditioning of said subscriber's circuit for communication.

12. In a manual teletypewriter switching system, a first manual central teletypewriter switching station, a first manual teletypewriter cord circuit thereat, a second manual central teletypewriter switching station, an automatic manual intertoll telegraph trunk circuit connecting said stations, a second manual teletypewriter cord circuit at said second station, a subscriber's teletypewriter station circuit, a subscriber's line

circuit connecting said subscriber's circuit directly to said second central station, a supervisory signal in said first cord circuit, a vacuum tube and a time control device therefor in said trunk circuit, means connected to said circuits for establishing an operative telegraph path extending through all of said circuits to said subscriber's station, a telegraph signal generating and receiving device operably connectable directly to said path through one of said cord circuits at one of said central stations and means including said tube and said device for operating said signal in response to the manipulation of disconnect signal control means in said station circuit.

13. In a manual teletypewriter switching system, a first manual central teletypewriter switching station, a first manual teletypewriter cord circuit thereat, a second manual central teletypewriter switching station, an automatic manual intertoll telegraph trunk circuit connecting said stations, a second manual teletypewriter cord circuit at said second station, a subscriber's teletypewriter station circuit, a subscriber's line circuit connecting said subscriber's circuit directly to said second central station, a supervisory signal in said first cord circuit, a vacuum tube and a time control device therefor in said trunk circuit, means connected to said circuits for establishing an operative telegraph path extending through all of said circuits to said subscriber's station, an attendant's telegraph set operably connectable directly to said path through one of said cord circuits at one of said central stations and means including said tube and said device for operating said signal in three distinctive manners.

14. In a manual teletypewriter switching system, a first manual central teletypewriter switching station, a first manual teletypewriter cord circuit thereat, a second manual central teletypewriter switching station, an automatic manual intertoll telegraph trunk circuit connecting said stations, a second manual teletypewriter cord circuit at said second station, a subscriber's teletypewriter station circuit, a subscriber's line circuit connecting said subscriber's circuit directly to said second central station, a supervisory signal in said first cord circuit, a vacuum tube and a time control device therefor in said trunk circuit, means connected to said circuits for establishing an operative telegraph path extending through all of said circuits to said subscriber's station, an attendant's telegraph communication circuit operably connectable directly to said path through one of said cord circuits at one of said central stations and means including said tube and said device for operating said signal in a manner to indicate a recall signal.

15. In a manual teletypewriter switching system, a first manual central teletypewriter switching station, a first manual teletypewriter cord circuit thereat, a second manual central teletypewriter switching station, an automatic manual intertoll telegraph trunk circuit connecting said stations, a second manual teletypewriter cord circuit at said second station, a subscriber's teletypewriter station circuit, a subscriber's line circuit connecting said subscriber's circuit directly to said second central station, a supervisory signal in said first cord circuit, a vacuum tube and a time control device therefor in said trunk circuit, means connected to said circuits for establishing an operative telegraph path extending through all of said circuits to said subscriber's station, a branch telegraph path operably connectable directly to said path through each of said cord circuits at each of said central stations and means including said tube and said device responsive to control means in said station circuit for operating said signal in a manner to indicate that the circuits should be disconnected.

16. In a manual teletypewriter switching system, a first manual central teletypewriter switching station, a first manual teletypewriter cord circuit thereat, a second manual central teletypewriter switching station, an automatic manual intertoll telegraph trunk circuit connecting said stations, a second manual teletypewriter cord circuit at said second station, a subscriber's teletypewriter station circuit, a subscriber's line circuit connecting said subscriber's circuit directly to said second central station, a supervisory signal in said first cord circuit, a vacuum tube and a time control device therefor in said trunk circuit, means connected to said circuits for establishing an operative telegraph path extending through all of said circuits to said subscriber's station, a local telegraph loop including a teletypewriter transmitter and receiver operably connectable directly to said path through one of said cord circuits at one of said central stations and means including said tube and said device for preventing the operation of said signal in response to a break signal transmitted over said circuits.

17. In a manual teletypewriter switching system, a first manual central teletypewriter switching station, a first manual teletypewriter cord circuit thereat, a second manual central teletypewriter switching station, an automatic manual intertoll telegraph trunk circuit connecting said stations, a second manual teletypewriter cord circuit at said second station, a subscriber's teletypewriter station circuit, a subscriber's line circuit connecting said subscriber's circuit directly to said second central station, a supervisory signal in said first cord circuit, a vacuum tube and a time control device therefor in said trunk circuit, means connected to said circuits for establishing an operative telegraph path extending through all of said circuits to said subscriber's station, a local telegraph circuit operably connectable directly to said path through each of said cord circuits at each of said central stations and means including said tube and said device for preventing the operation of said signal during the transmission of telegraph code communication signals over said circuits.

18. In a manual teletypewriter switching system, a first manual central teletypewriter switching station, a first manual teletypewriter cord circuit thereat, a second manual central teletypewriter switching station, an automatic manual intertoll telegraph trunk circuit connecting said stations, a second manual teletypewriter cord circuit at said second station, a subscriber's teletypewriter station circuit, a subscriber's line circuit connecting said subscriber's circuit directly to said second central station, a supervisory signal in said first cord circuit, a vacuum tube and a time control device therefor in said trunk circuit, means connected to said circuits for establishing an operative telegraph path extending through all of said circuits to said subscriber's station, an attendant's telegraph communication circuit operably connectable directly to said path through each of said cord circuits

at each of said central stations and means including said tube and said device for preventing the operation of said signal during the transmission of a ringing signal through said circuits.

19. In a teletypewriter switching system, an automatic manual signaling intertoll telegraph trunk circuit interconnecting a first and a second manual central teletypewriter switching station, a telegraph path in said trunk extending through a half-duplex to full-duplex converting repeater also in said trunk, a supervisory signal control circuit in said trunk, a vacuum tube regulating means for said control circuit in said trunk, a time measuring input control circuit for said tube in said trunk and means connecting said input control to said telegraph path.

20. In a teletypewriter switching system, an automatic manual signaling intertoll telegraph trunk circuit interconnecting a first and a second manual central teletypewriter switching station, a manual telegraph cord circuit, means for interconnecting said trunk and said cord, a first path for the transmission of telegraph signals through said interconnection, a second path for the transmission of supervisory signals through said interconnection, a supervisory signal in said cord, a supervisory signal control means connected to said second path in said trunk, a vacuum tube in said trunk, means in said trunk for discriminating between communication and supervisory signals transmitted over said trunk between said stations, a local telegraph loop operably connectable directly to said first path through said cord circuit and means in said trunk for controlling said supervisory signal through said tube by means of said signal control means and said second path in response to said discrimination.

21. In a manual teletypewriter switching system, a manual telegraph cord circuit, a teletypewriter transmitter and receiver operably connectable directly to said cord circuit, an answering and a calling end on said cord, a manual telegraph trunk circuit interconnecting a first and a second manual teletypewriter central switching station, a telegraph path extending through said cord and said trunk, a supervisory signal path independent of said telegraph path interconnecting said calling and said answering ends through said cord, supervisory signal control means including a vacuum tube connected to said telegraph path in said trunk and means including said vacuum tube in said trunk, for receiving a supervisory signal transmitted over said trunk from one to the other of said stations and transmitting it through said supervisory path from said calling to said answering end of said cord.

22. In a manual teletypewriter switching system, a first manual central telegraph switching station, a first manual telegraph cord circuit at said station, a supervisory signal in said cord at said station, a teletypewriter transmitter and receiver connectable to said cord circuit at said station, a second manual central teletypewriter switching station, a manual telegraph trunk circuit interconnecting said stations, a second manual telegraph cord circuit at said second station, a second teletypewriter transmitter and receiver connectable to said second cord, a subscriber's line circuit connected to said second central station, means for establishing an operable telegraph path through said circuits, means for preventing the operation of said supervisory signal when said second cord is connected to said trunk as said path is being established, and means for operating said signal in response to the connection of said second cord to said line as said path is being established.

23. In a manual teletypewriter switching system, a plurality of manual teletypewriter cord circuits, means for connecting said circuits in tandem to trunk circuits interconnecting manual central teletypewriter switching stations, a teletypewriter transmitter and receiver operably connectable directly to each of said cord circuits, a supervisory signal in the first cord in said tandem connection, means in said circuits for preventing the operation of said signal as said tandem connection is extended until connection is established by the last cord in said tandem connection to a called subscriber's line and means for operating said signal in response to the connection of said last cord to said called line, as a signal to start ringing.

24. A system in accordance with claim 23 including means in said first cord for ringing the called subscriber through said tandem connection.

25. A system in accordance with claim 23 including supervisory signal means in each cord and means for preventing the operation of all said signals as said tandem connection is extended, except said supervisory signal in said first cord when said last cord is connected to said called subscriber's line.

26. A system in accordance with claim 23 including means for operating said supervisory signal in said first cord in response to the answering of said called subscriber's line.

27. A system in accordance with claim 23 including supervisory signals in each cord and means for operating said supervisory signal in said first cord only, in response to the answering of said called subscriber's line.

28. A system in accordance with claim 23 including a supervisory signal in each cord and means for operating each of said signals in response to the origination of a disconnect signal in said subscriber's line.

29. A system in accordance with claim 23 including a supervisory signal in each cord and means for operating each of said signals in a distinctive manner to indicate a recall signal by said called subscriber's line.

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