May 14, 1968 W. A. FISCHER ET AL 3,383,470

AUXILIARY LINE CIRCUIT

Filed July 30, 1964 3 Sheets-Sheet 1

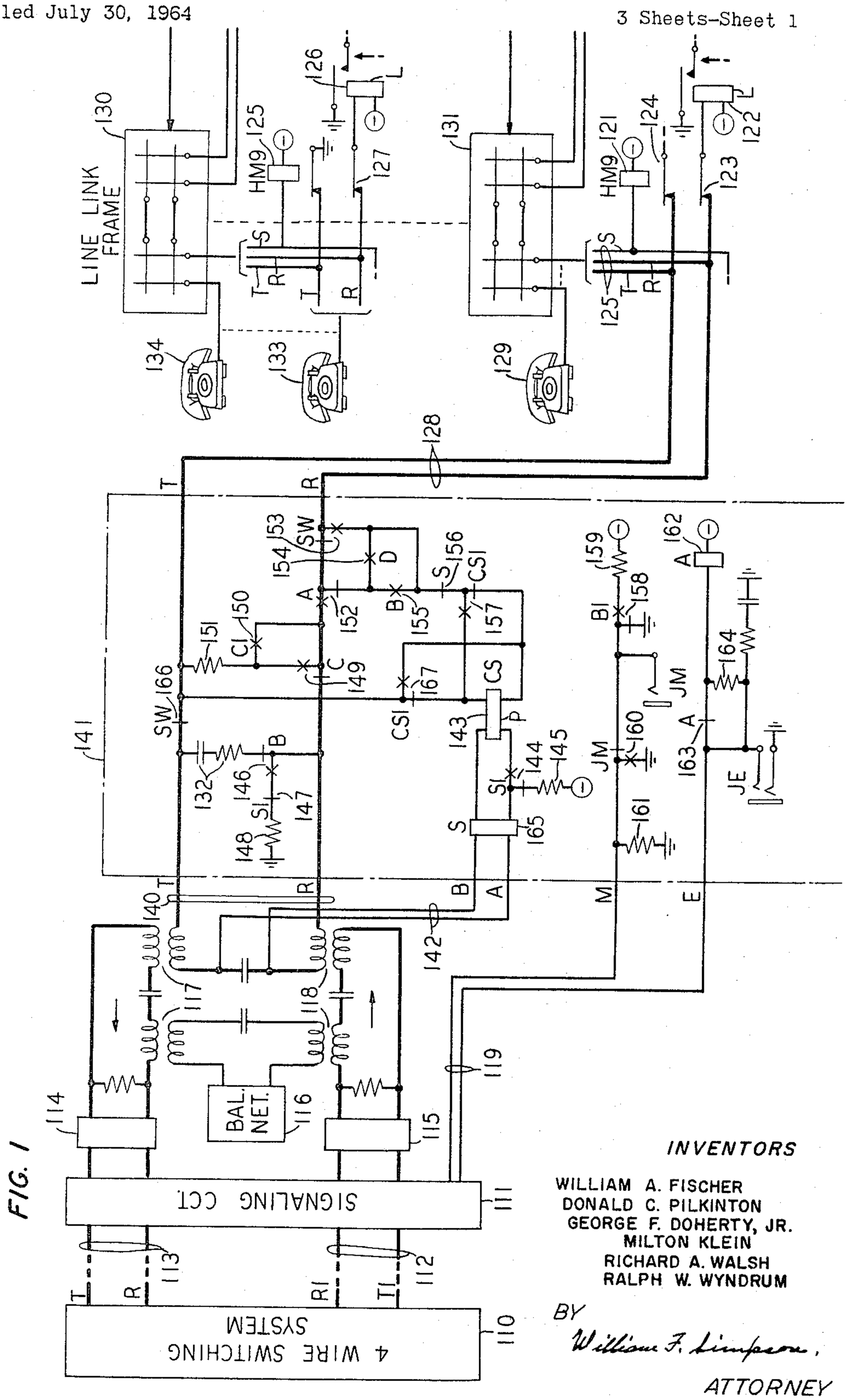

FIG. 1

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AUXILIARY LINE CIRCUIT

Filed July 30, 1964 3 Sheets-Sheet 2

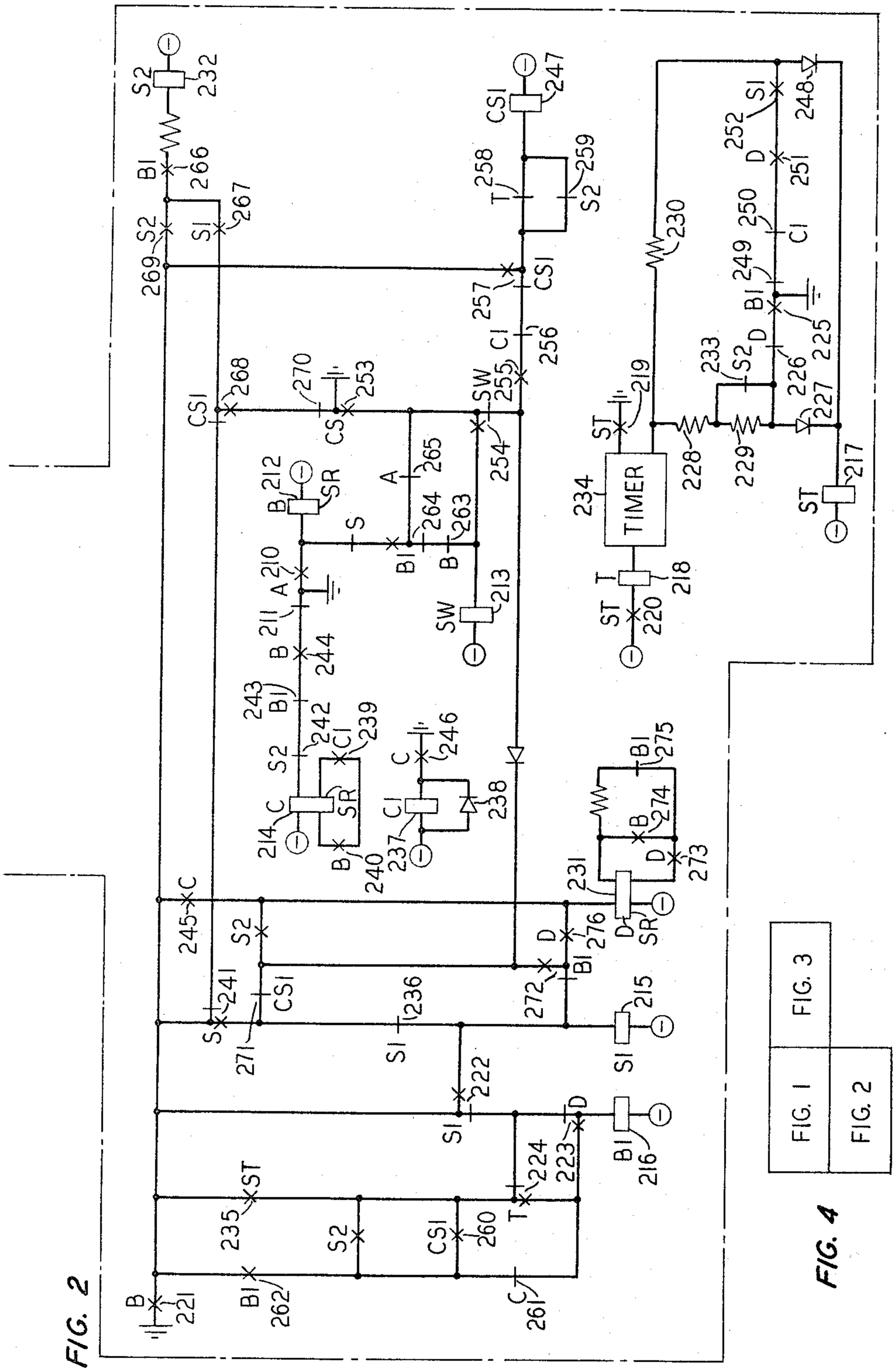

FIG. 2

FIG. 1	FIG. 3
FIG. 2	

FIG. 4

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AUXILIARY LINE CIRCUIT

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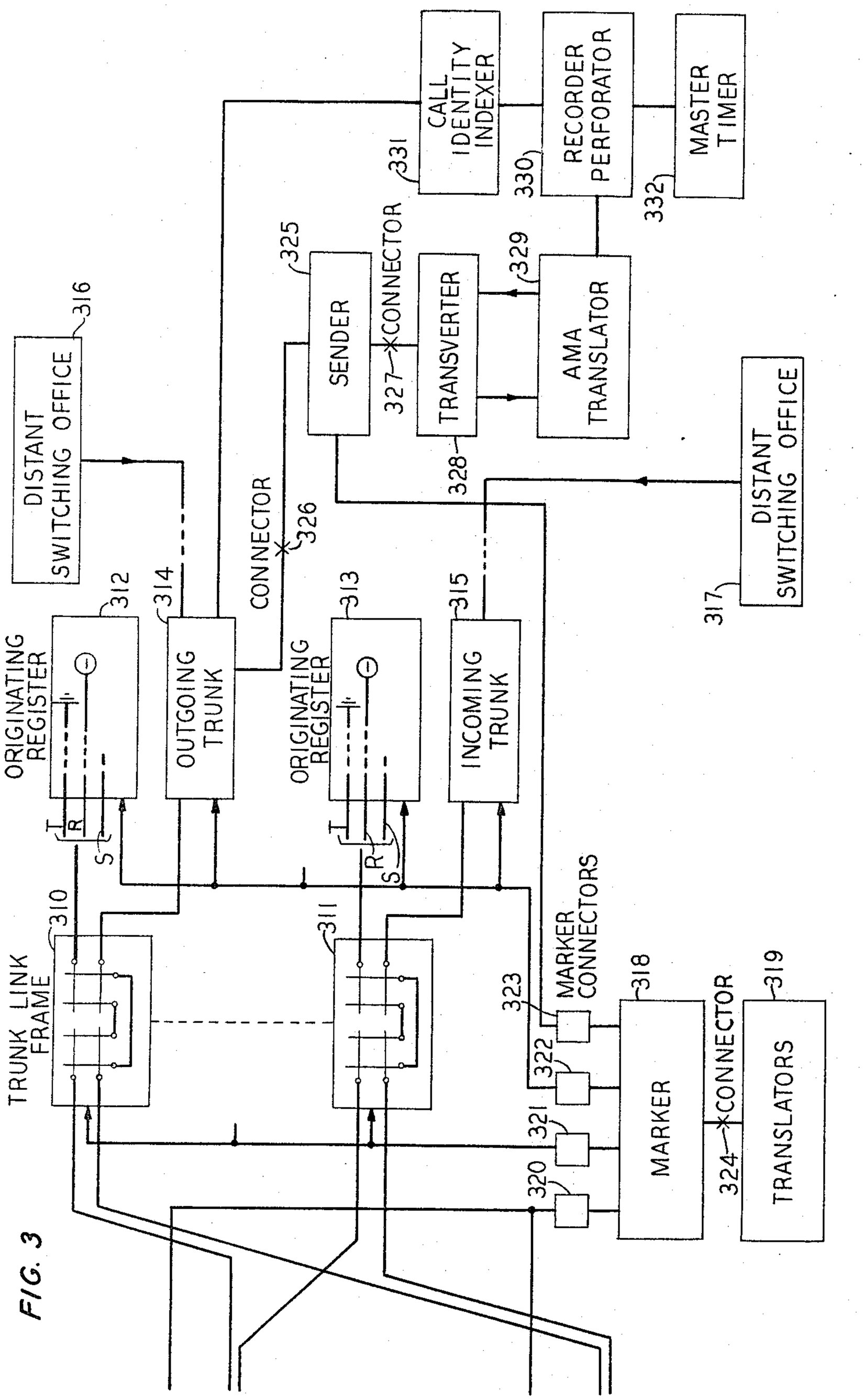

FIG. 3

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AUXILIARY LINE CIRCUIT

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4 Claims. (Cl. 179—18)

ABSTRACT OF THE DISCLOSURE

Calling connections from a private line switching network are afforded the use of charging and recording equipment in a commercial switching system by an auxiliary line circuit which is arranged to initiate a dial tone request in the commercial system in response to the enabling of an associated trunk in the private system. The auxiliary line circuit returns a ready signal to the private line network upon the connection of a register and the termination of a predetermined time interval. An answer signal is subsequently transmitted by the auxiliary line circuit to the private network a predetermined interval after the completion of signalling.

This invention relates to an auxiliary line circuit for interconnecting automatic switching centers and, more particularly, for interconnecting switching centers of a private wire switching network with a switching center of a public or commercial communication switching network.

Previously interconnecting circuits between switching centers extended from a first switching center to a second switching center and at the second switching center the circuits terminated on a trunk frame or in switches which avoided the line finding or concentrating stages of the network. These arrangements have been economical because the trunks are provided on such a basis that they are used a large percentage of the time during the busy hour so it does not pay to provide concentration circuits between the trunks and the switching equipment at the incoming end.

In these prior arrangements the record of the calls is obtained either at the originating switching station or at some tandem switching station. This arrangement has been extended in a patent application of R. C. Avery, Ser. No. 177,815, filed Mar. 6, 1962, now Patent No. 3,157,743, dated Nov. 17, 1964, to obtain and maintain a record at the originating station of each of the switching centers through which a call is routed. When a call is diverted from a private wire switching network to a public or commercial network the station or switching center at which the call is diverted is likewise transmitted to the originating station and recorded thereat as part of the record of the call.

None of these arrangements leave any record of the call in the public or commercial switching system and thus provide no independent check or record of such calls for charging purposes in the public or commercial switching network.

It is an object of our invention to provide an interconnecting auxiliary circuit for permitting connection between the switching center of a private network and switching center of a public or commercial switching network in which a record of the call is obtained in the public or commercial switching network either at the station at which the call enters the public or commercial network or at some tandem switching center and in the same manner as a corresponding record is obtained from

the stations in the public or commercial communication network.

A feature of our invention relates to auxiliary line circuits which may be connected between an incoming trunk circuit from a switching center of a private wire switching network and terminals of a public or commercial network which are similar to terminals normally interconnected with subscriber lines.

A feature of our invention relates to interconnections such that a call incoming from a distant switching center is recorded in the same manner as calls from ordinary subscribers.

When incoming trunks are terminated on subscriber line terminals either through an auxiliary line circuit, such as in accordance with this invention, or otherwise, a record of the call will be made at the incoming central office or a tandem central office, and in addition an appropriate class of service may be assigned to the incoming trunk or calls. However, sufficient time must be allowed for the line finding equipment or similar equipment in the incoming office to function and to connect a dial pulse or signal receiving circuit to the designated terminals and thus to the incoming trunk circuit through the auxiliary line circuit. The time required for the line finder or equivalent equipment to function is variable over wide limits depending upon the traffic or calling rate of the office at the particular time the incoming call is received.

In accordance with an exemplary embodiment of our invention the incoming call is first acknowledged and then the distant office signaled to start transmission of dial or calling signals only after a lapse of a predetermined interval of time and the establishment of a path from the trunk circuit to a suitable signal receiver capable of receiving the incoming pulses or signals which pulses or signals are employed to designate the desired called station.

When the call is routed through a tandem switching center of the public or commercial network and a record of the call obtained at such switching center, the answer signal is usually not relayed through this tandem switching center. Consequently, it is desirable if not necessary to generate such an answer signal in the auxiliary line circuit in accordance with the exemplary embodiment of our invention described herein to properly condition the circuits of the private wire switching network to be switched or conditioned for the transmission or communication conditions thereof. Such an answer signal is generated at a predetermined interval of time after the transmission of the dial pulses or other signals designating the called subscriber's station.

Another feature of the auxiliary line circuit in accordance with an exemplary embodiment of our invention relates to protective means which will accept a second incoming call over a trunk circuit before the first call is fully disconnected but prevents this second call from interfering with the disconnection of the first call.

In addition the circuits of the exemplary embodiment of our invention described herein are arranged so that the distant central office is not signaled to start transmission of the calling signals until a previous call has been fully disconnected and a pulse or signal receiver at the incoming switching center interconnected with the incoming trunk over which the call is transmitted to the public or commercial switching network.

The foregoing and other objects and features of our invention may be more readily understood from the following description of FIGS. 1, 2 and 3 when positioned in accordance with FIG. 4.

FIGS. 1 and 3 show details of the manner in which the auxiliary line circuit in accordance with our inven-

tion may be interconnected between a trunk extending from a four-wire No. 5 crossbar switching system and a switching center of a public or commercial switching network. FIG. 1 also shows part of the switching and control circuits of such an auxiliary line in accordance with an exemplary embodiment of our invention while FIG. 3 shows portion of a typical switching system with which an exemplary embodiment of our invention is arranged to cooperate; and

FIG. 2 shows a number of the control circuits of the auxiliary line circuit in accordance with an exemplary embodiment of our invention.

Referring to FIGS. 1, 2 and 3 now when arranged as shown in FIG. 4, the rectangle **110** represents a four-wire switching system such as disclosed in the copending application of J. W. Gorgas, G. A. Hurst, J. S. Pfrommer, W. H. Scheer, Ser. No. 134,633, filed Aug. 29, 1961, now Patent No. 3,150,236 dated Sept. 22, 1964. This switching center is connected by means of a four-wire trunk **112** and **113** to the switching center represented in the remaining portion of FIGS. 1 and 3. This switching system may be of any suitable type.

As shown in the drawing the switching system shown in FIGS. 1 and 3 includes the primary and secondary crossbar switches **130** and **131** on the line link frame. The subscribers' stations **129, 133** and **134** are connected to the primary crossbar switches. Each of the subscriber stations **129, 133** and **134** has a hold magnet such as **125** and a line relay such as **126** individual to it.

An auxiliary line circuit is interconnected with terminals **125** which terminals are similar to the terminals to which the subscriber stations are connected.

This switching center also includes the primary and secondary crossbar switches **310** and **311** on the trunk link frame. The crossbar switches on the line link frames and on the trunk link frames are interconnected in the usual manner.

The originating registers are represented by two such registers such as **312** and **313** which are connected to crossbar switches on the trunk link frames. The outgoing trunks are represented by trunk **314** and the incoming trunks by trunk **315**. The trunk **314** is shown interconnected with a distant switching center **316** and trunk **315** with the distant switching center **317**. These distant switching centers may be the same or different switching centers and either or both may be similar to the switching center shown in FIGS. 1 and 3 or they may be of any other type including tandem switching centers.

The marker **318**, translator **319**, the marker connectors **320, 321, 322** and **323** and connector **324** are employed in establishing connections through the various crossbar switches.

The sender **325** and sender connector **326** are employed in extending connections over the outgoing trunk **314** to and through other switching centers such as **316**.

Automatic message accounting equipment is provided for automatically recording various calls. This equipment includes connector **327**, transverter **328**, the AMA translator **329**, call identity indexer **331**, recorder perforator **330** and master timer **332**.

This switching center may be of the type shown in Patent 2,585,904, granted to A. J. Busch, Feb. 19, 1952. If it is desired to record calls incoming to such a switching system at a tandem switching center instead of at this switching center, reference may be made to Patent No. 2,848,543, granted to R. N. Breed et al., Aug. 19, 1958. If it is desired to make a record of the call at the incoming office shown in FIGS. 1 and 3, then reference is made to Patent No. 2,688,658 granted to W. W. Carpenter et al. on Sept. 7, 1954.

While the above three patents describe crossbar switching systems, our invention will work equally well with either panel or step-by-step switching systems or with other automatic switching systems.

The equipment shown within the dot-dash-line **141** represents an auxiliary line circuit in accordance with an exemplary embodiment of our invention and is interconnected between the subscriber line termination of the switching system shown in the right-hand portion of FIGS. 1 and 3 and the four-wire switching system shown in the left-hand portion of FIG. 1.

The four-wire switching trunk comprises the circuits **113** and **112** which terminate in a four-wire terminating circuit comprising the repeat coils **117** and **118**, balancing network **116** and the matching or attenuation pads **114** and **115**. Similar four-wire terminating circuits are shown and described in greater detail in Patent No. 2,024,592 granted to J. B. McKim on Dec. 17, 1935.

It is assumed that the signaling over the four-wire transmission circuits **112** and **113** is of the type designated E and M. This signaling circuit is represented by the rectangle **111** with the E and M leads **119** extending therefrom. Such signaling circuits are described in greater detail in an article published in the Bell System Technical Journal, vol. 39, pp. 1381–1444, November 1960, entitled, "Signaling Systems for Control of Telephone Switching," by C. Breen and C. A. Dahlbom. This article also describes other types of signaling which may be substituted for the E and M signaling system in the manner described. All these various switching systems, signaling systems and lines and trunks operate in a normal and usual manner in cooperation with the auxiliary line circuit in accordance with our invention.

In order to determine that a pulse receiving circuit has been attached by the switching equipment shown in FIGS. 1 and 3 in the manner described in the above-identified patents, ground has been removed from the contact **124** of the hold magnet **121**, thus normally removing ground from the tip conductor of the trunk circuit **128**. As shown in FIG. 1 described in greater detail in the above-identified patent of Busch and the above-identified patent of Carpenter the tip and ring terminals **125** are connected to a vertical of the crossbar switch in a manner similar to the manner in which subscribers' lines are connected to verticals of crossbar switches on the line link frame.

When the four-wire switching system **110** initiates a call intended for some switching station of the public or commercial switching network, or when a call is transferred from the four-wire system to the public system, the four-wire system will transmit a signal over the four-wire circuits **112** and **113** to the signaling equipment **111** which in turn causes a ground to be applied to the E conductor thus completing a circuit for the operation of the A relay **162**.

The operation of the A relay **162** causes contacts **163** to open and this in turn causes the resistor or network **164** to be inserted in the circuit of the A relay **162**.

The operation of relay **162** also causes contacts **210** to close and contacts **211** to open. Closure of contacts **210** completes an obvious circuit for the operation of the B relay **212**.

The operation of the B relay **212** causes contacts **221** to close and complete a circuit for the operation of the B1 relay **216** from ground through the operated contacts **221** of the B relay **212**, the normal contacts **222** of the S1 relay **215** and the normal contacts **223** of the D relay **231** to battery through the winding of the B1 relay.

The operation of the B1 relay **216** operates contacts **225** and completes a circuit for the operation of the ST relay **217** from battery to the winding of the relay **217**, the decoupling diode **227**, the normal break contacts **226** of the D relay **231** and the operated contacts **225** of the B1 relay **216** to ground. The ST relay **217** in operating causes contacts **219** and **220** to close and start the operation of the timer **234**. The timer **234** is controlled by the value of the resistor **228** which is connetced to ground through the break contacts **233** of the S2 relay **232**, the break contacts **226** of the D relay **231** and the operated contacts **225** of the B1 relay **216**. With resistor **228** thus controlling the

timer 234, the T relay 218 will operate approximately 150 milliseconds after the operation of the ST relay 217.

The operation of the ST relay 217 also causes contacts 235 to be closed and complete a holding circuit for maintaining the B1 relay 216 operated from ground through the operated contacts 221 of the B relay 212, contacts 235 of the ST relay 217 and the break contacts 224 of the T relay 218 to battery through the winding of the B1 relay 216.

The operation of the B1 relay 216 causes contacts 158 to be actuated. As a result ground is removed from the M conductor 119 and battery through resistor 159 and contacts 158 connected to the M lead and to ground through the resistor 161. Thus, a battery potential is applied to the M conductor extending to the signaling circuit 111. This battery is employed to signal the distant four-wire switching system 110 and acknowledge the operation of the A relay 162. The four-wire switching system will not further respond to this battery potential at this time but will await a further signal, as described herein, before transmitting dial pulses over the four-wire signaling circuit.

The operation of the B relay 212 actuates contacts 146 and removes the network 132 from across the tip and ring conductors of the trunk circuit 128.

The operation of the A relay 162 causes contacts 152 to be operated and the operation of the B relay 212 causes contacts 146 of the B relay to be operated. The operation of these two sets of contacts completes a circuit for the operation of the L relay 122 of the switching system shown in the right-hand portion of FIG. 1 and in FIG. 3. The circuit for the operation of the L relay extends from battery through the winding of the L relay 122, the break contacts 123 of the hold magnet 121 assigned to the trunk conductors 128. From contacts 123 the circuit extends over the R conductor, through the normal contacts 153 of the SW relay 213, the operated contacts 152 of the A relay 162, a break contact 149 of the C relay 214, the operated contacts 146 of the B relay 212 and the break contacts 147 of the S1 relay 215 to ground through the resistor 148.

The operation of the L relay 122 initiates the operation of the switching system shown in the right-hand portion of FIG. 1 and in FIG. 3. The operation of this system then causes a path to be established through crossbar switches 131 on the line link frame and through crossbar switches on the trunk link frame to an originating register, for example through switches 310 to the originating register 312. Upon the establishing of such a path a circuit is completed for the operation of the S relay 165 from battery through resistor 145, the break contacts 144 of the S1 relay 215, the lower winding of the S relay 165 and then through the winding of the repeat coil 117, the T conductor 140, the break contacts 166 of the SW relay 213 and over the tip conductor of the auxiliary line circuit 128 and then through the switching system to ground in the incoming register or pulse receiving circuit 312.

The operation of the S relay 165 at this time indicates that the pulse receiving circuit has been interconnected with the auxiliary trunk circuit 141 and thus ready to receive incoming calling or dialing signals. The operation of the S relay 165 causes contacts 241 to close and complete a circuit for the operation of the S1 relay 215 from battery through the winding of the S1 relay 215, the break contacts 236 of the S1 relay 215 and the operated contacts 241 of the S relay 165 to ground through the operated contacts 221 of the B relay 212. The S1 relay 215 in operating closes contacts 222 which completes a locking circuit for maintaining itself operated under control of the B relay 212. This locking circuit extends from battery through the winding of the S1 relay 215, the operated contacts 222 of the S1 relay 215 to ground through the operated contacts 221 of the B relay 212.

At the end of approximately 150 milliseconds timer 234 causes the T relay 218 to operate and actuate contacts 224. The operation of the contacts 224 of T relay 218 and the operation of the contacts 222 of the S1 relay 215 interrupt both of the above-described circuits of the B1 relay 216.

The release of the B1 relay 216 described above causes the contacts 225 to release and interrupt the operating circuit of the ST relay 217. This relay releases and causes its contacts 219 and 220 to release with the result that the T relay 218 is released and the timer circuit 234 restored to its idle or initial condition.

Thus, if the S1 relay 215 is operated during the 150 milliseconds indicating that the originating register has been interconnected with the T and R conductors 128 of the auxiliary line circuit 141, then the operation of the T relay 218 at the end of the 150 millisecond time interval causes the B1 relay 216 to release.

If the S1 relay 215 has not operated by this time then the B1 relay 216 does not release until an originating register is interconnected with the T and R conductors 128 of the auxiliary line circuit 141 by the switching system shown in the right-hand portion of FIG. 1 and in FIG. 3.

In response to the operation of both the T relay 218 and the S1 relay 215 the B1 relay releases and releases the contacts 158. The release of these contacts reconnect ground to the M lead extending to the signaling circuit 111 which signal is then repeated over the four-wire trunk circuit to the four-wire switching system 110. This signal indicates to the four-wire switching system that a pulse receiver has been interconnected with the other end of the trunk and that this equipment is in condition to receive the dial pulses or calling signals.

The operation of the S1 relay 215 also opens contacts 147 and thus removes the resistor 148 from the ring conductor in the auxiliary line circuit 141. The operation of the S1 relay however also closes contacts 144 with the result that battery through the resistor 145 is removed from the tip conductor and a loop circuit is established from the T conductor 125, through break contacts 166 of the SW relay 213, the winding of the repeat coil 117, the lower winding of the S relay 165, the operated contacts 144 of the S1 relay 215, the left-hand winding of the CS relay 143, the upper winding of the S relay 165, winding of the repeat coil 118, ring conductor of the auxiliary line circuit 141, the break contacts 149 of the C relay 214, the operated contacts 152 of the A relay 162 and the break contacts 153 of the SW relay 213 to the R conductor 128. The T conductor extends to ground in the originating register and the R conductor extends to battery in this originating register through this switching system shown in the right-hand portion of FIG. 1 and in FIG. 3 as described in the above and in the above-identified patents. Current flowing through both windings of the S relay 165 causes this relay to be maintained in its operated condition at this time. The current flowing through the left-hand winding of relay 143 however does not cause this relay to operate. Relay 143 is a polarized relay and the current flowing through its left-hand winding at this time is in the direction so that this relay does not operate at this time.

In the response to the transmission of the signal due to the release of the B1 relay 216 and the release of the contacts 158, the four-wire switching system 110 will start the transmission of dial pulses over the four-wire trunk 112 and 113 to the signaling circuit 111. As a result the dial pulses are transmitted over the E conductor 119.

In response to the first dial pulse the A relay 162 releases and closes its contacts 163 thus short circuiting the resistor 164. In addition the release of the A relay 162 causes contacts 152 to be restored to their unoperated condition so that the pulse is repeated over the T and R conductors 128 to the originating register 312 attached thereto through the switching system of FIGS. 1 and 3.

Release of the A relay 162 also causes contacts 210 to release and interrupt the circuit of the B relay 212. The

B relay **212** however is a slow release relay so that it remains operated during the dial pulses repeated by the A relay **162**.

The release of the A relay **162** also releases contacts **211** which contacts close and complete a circuit for the operation of the C relay **214** from battery through the upper winding of the C relay **214**, the break contacts **242** of the S2 relay **232** and the break contacts **243** of the B1 relay **216**, the operated contacts **244** of the B relay **212** to ground through the break contacts **211** of the A relay **162**.

The operation of the C relay **214** closes contacts **246** which in turn completes an obvious circuit for the operation of the C1 relay **237**. The operation of the C1 relay **237** causes contacts **239** to close and these contacts together with contacts **240** on the B relay **212** short circuit the lower winding of the C relay **214**, thus causing this relay to be a slow-release relay so that it will remain operated during each train of dial pulses representing the various digits of the called designation or number transmitted from the four-wire switching system **110**.

The C1 relay **237** has diode **238** connected in parallel with its winding which likewise causes this relay to be slow in releasing.

The operation of the C relay **214** closes contacts **245** which in turn completes a circuit for the operation of the D relay **231** from battery to the winding of the D relay **231**, the operated contacts **245** of the C relay **214** to ground through the operated contacts **221** of the B relay **212**.

The D relay **231** in operating closes contacts **273** which contact together with the operation of contacts **274** of the B relay **212** short circuit the right-hand winding of the D relay **231**, thus making this relay slow in releasing. The operation of D relay **231** also closes contacts **276** which in turn complete a holding circuit from battery through the left-hand winding of the D relay **231**, its operated contacts **276**, the break contacts **272** of the B1 relay **216**, the operated contacts **222** of the S1 relay **215** to ground through the operated contacts **221** of the B relay **212**.

The operation of the C relay **14** also operates contacts **149** which contacts interrupt the circuit for the S relay **165** and connect the resistor **151** across the tip and ring conductors in the auxiliary trunk circuit **141** thus providing a low impedance dialing circuit. The operation of the C1 relay **237** also closes contacts **150** which contacts are in parallel with the operated contacts **149** which contacts further maintain the resistor **151** connected across the tip and ring conductors during the remainder of each of the digits dialed or pulsed from the four-wire switching system **110**.

The release of the A relay **162** together with the release of the S relay **165** connects a high resistance right-hand winding of the CS relay **143** between the tip and ring conductors in the auxiliary line circuit **141**. The circuit for this winding extends from the tip conductor through the break contacts **167** of the CS1 relay **247**, the right-hand winding of the CS relay, the break contacts **157** of the CS1 relay **247**, break contacts **156** of the S relay **165**, the operated contacts **155** of the B relay **212** and the break contacts **152** of the A relay **162** to the ring conductor of the trunk **128** through the break contacts **153** of the SW relay **213**.

The resistance of the right-hand winding of the CS relay **143** is sufficiently high that it does not interfere with the transmission of the open or break dial pulse from the contacts **152** of the A relay **162** to the register circuit **312**. However, current flowing through this winding is in a direction to operate the CS relay **143**. Thus, this relay is operated when the A relay **162** is released and this relay is relased when the A relay **162** is operated.

At the end of the first dial pulse the A relay **162** is reoperated and contacts **152** in turn operated with the result that the T and R are now closed through the resistor **151**, contacts **149** of the C relay **214** in parallel with contacts **150** of the C1 relay **237**, the contacts **152** of the A relay **162**, contacts **153** of the SW relay **213** and then to the T and R conductors **128** extending through the switching equipment to the originating register **312** or pulse receiving circuit, thus terminating the first pulse repeated to this switching system.

The reoperation of the A relay **162** closes contacts **210** which maintain the B relay **212** operated. The reoperation of the A relay **162** again opens the break contacts **211** and interrupts the circuit of the C relay **214**. This relay is slow released at this time due to closure of the contacts **240** of the B relay **212** and contacts **239** of the C1 relay **237**. These relays are slow in releasing and remain operated during each series of dial pulses representing the respective digit of the called subscriber's number. As described above the reoperation of the contacts **152** interrupt the circuit through the right-hand winding of the CS winding **143** thus causing this relay to remain released at this time.

The succeeding dial pulses representing the first digit are repeated by the A relay **162** in the manner described above. The B relay **212**, the C relay **214** and the C1 relay **237** remain operated during the entire series of pulses. Likewise the D relay **231** remains locked operated in the circuit described above. Likewise the S relay **165** remains released because its windings are opened at the contacts **149** of the C relay **214**. The S1 relay **215**, however, remains operated due to the above-described circiut through its operated contacts **222**.

At the end of the first train of dial pulses representing the first symbol, digit, or denominational order of the called subscriber's number or station identification the A relay **162** will remain operated for a longer interval of time so that the C relay **214** and the C1 relay **237** release. The release of these relays removes the resistor **151** from across the tip and ring conductors of the auxiliary circuit **141** and substitutes the above-described path through the windings of the S relay **165** and the left-hand winding of the CS relay **143**. The S relay **165** operates in this circuit but the current flowing through the left-hand winding of the CS relay **143** is in a direction to maintain this relay nonoperated.

The release of the C1 relay **237** at this time completes a circuit for reoperation of the ST relay **217**. The operating circuit for this relay at this time extends from battery through the winding of the ST relay **217**, diode **248**, the operated contacts **252** of the S1 relay **215**, the operated contacts **251** of the D relay **231**, the released contacts **250** of the C1 relay **237** and the break contacts **249** of the B1 relay **216** to ground. The operation of the ST relay **217** closes contacts **220** and **219**. The closure of these contacts together with a circuit from the timer **234** through resistor **230** to ground through the operated contacts **252** of the S1 relay **215**, the operated contacts **251** of the D relay **231**, the break contacts **250** of the C1 relay **237** and the break contacts **249** of the B1 relay **216**, condition the timer **234** to start a timing interval of approximately one second.

Inasmuch as the pulses are being transmitted from a sender or other similar circuit at the four-wire switching system **110** and not from a subscriber, the next series of pulses representing the next symbol, digit, or denominational order of the called subscriber's designation will be transmitted to the auxiliary line circuit **141** before the expiration of the one second time interval timed by the timer **234** at this time. Consequently, the A relay **162** will respond to these succeeding dial pulses and cause the operation of the C relay **214** and the C1 relay **237** in the manner described above. As a result the contacts **250** of the C1 relay **237** open and interrupt the circuit of the ST relay **217** and also the circuit through the resistor **230**. The release of the ST relay **217** opens the contacts **219** and **220** with the result that the timer **234** is restored to its original condition. Likewise the circuit through the

winding of the S relay **165** is interrupted and the circuit through the right-hand winding of the CS relay **143** again closed during the time the A relay **162** is released. The circuits respond to the succeeding pulses of this digit or designation in the manner described above. At the end of this digit the timer **234** is again set into operation but interrupted by the pulses of the succeeding digit in the same manner as described above.

At the completion of the transmission of all of the dial pulses representing the called subscriber's station or designation, the A relay **162** will remain operated for a period of time longer than one second. If the called subscriber answers during this one second interval and, if in addition, reverse battery supervision in response to the subscriber's answering is repeated from or through the switching shown in FIGS. 1 and 3 to the auxiliary line circuit **141**, then the CS relay **143** will operate in response to this reverse current from battery and ground applied to the T and R conductors **128** and flowing through its left-hand winding in response to the subscriber's answering the call.

As a result contacts **253** close and complete a circuit for the operation of the CS1 relay **247** from ground through the operated contacts **253** of the CS relay **143**, the break contacts **254** of the SW relay **213**, the operated contacts **255** of the A relay **162**, the break contacts **256** of the C1 relay **237**, break contacts **257** of the CS1 relay **247** and either the break contacts **258** of the T relay **218** or the break contacts **259** of the S2 relay **232** to battery through the winding of the CS1 relay **247**.

The operation of the CS1 relay **247** completes a circuit for holding itself operated from battery through the winding of the CS1 relay **247**, the break contacts **258** of the T relay **218** or the break contacts **259** of the S2 relay **232**, and the operated contacts **257** of the CS1 relay **247** to ground through the operated contacts **221** of the B relay **212**.

The operation of the CS1 relay **247** also causes contacts **260** to close and complete a circuit for the operation of the B1 relay **216**. The operating circuit for the B1 relay **216** at this time extends from battery through the winding of the B1 relay **216**, the operated contacts **223** of the D relay **231**, the break contacts **261** of the C relay **214**, the operated contacts **260** of the CS1 relay **247**, the operated contacts **235** of the ST relay **217** to ground through the operated contacts **221** of the B relay **212**.

If the called subscriber does not answer within the one second time interval of the timer **234** or if the answer supervision is not repeated from or through the switching system of FIGS. 1 and 3, usually when the call is an official call or when the call extends through a tandem switching center at which automatic message accounting equipment is located, then at the end of the one second time interval the timer **234** will cause the T relay **218** to be operated and this relay in turn closes contacts **224** with the result that still a different circuit is completed for the operation of the B1 relay **216**. The circuit for the B1 relay **216** at this time extends from battery through the winding of the B1 relay **216**, the operated contacts **223** of the D relay **231**, the operated contacts **224** of the T relay **218**, the operated contacts **235** of the ST relay **217** to ground through the operated contacts **221** of the B relay **212**.

The operation of the B1 relay **216** in response either to the operation of the CS relay **143** or the operation of the T relay **218** in the manner described above causes contacts **158** to again be operated and remove ground from the M lead extending from the signaling circuit **111** and causes battery through the potentiometer comprising resistors **159** and **161** to be applied to this lead. As a result, the four-wire switching system **110** is conditioned for transmission and when required an answer signal may be recorded in this system.

When the B1 relay **216** operates at the end of the one second time interval timed by the timer **234**, whether before or after or without answer supervision being transmitted to or through the switching equipment **120**, contacts **249** open and thus interrupt the operating circuit of the ST relay **217** and the circuit through resistor **230** thus restoring the timing circuit **234** to its initial condition.

The operation of the B1 relay **216** completes a circuit for maintaining itself operated independently of contacts **235** of the ST relay **217**. This circuit extends from battery through the winding of the B1 relay **216** and then through the operated contacts **223** of the D relay **231**, the break contacts **261** of the C relay **214** and the operated contacts **262** of the B1 relay **216** to ground through the operated contacts **221** of the B relay **212**.

The circuits then remain in the above-described condition until a disconnect signal is received either from the four-wire switching system **110** or from the switching system **120**.

Assume first that a disconnect signal is first received from the four-wire switching system **110**. As a result the A relay **162** releases and opens contacts **152** thus repeating the disconnect signal to the switching equipment **120**. In addition, the C relay **214** and the C1 relay **237** operate in the manner described above. The operation of the C relay **214** interrupts the operating circuit of the S relay **165** and the circuit through the left-hand winding of the CS relay **143**. As a result the S relay **164** releases as does the CS relay **143** if it had been previously operated in response to an answer signal being transmitted to it from the switching system of FIGS. 1 and 3.

The release of the A relay **162** as described above causes the break contacts **152** to close and connect the right-hand high resistance winding of the CS relay across the tip and ring conductors extending to the switching system shown in FIGS. 1 and 3. This circuit has been described above and extends from the R conductor through the break contacts **152** of the A relay **162**, contacts **155** of the B relay **212**, before this relay releases, the break contacts **156** of the S relay **165** and then through the contacts **157** and **167** of the CS1 relay **247** and right-hand winding of the CS relay **143** to the T conductor. If reverse battery supervision has not been relayed to the auxiliary circuit **141** then the CS1 relay **247** will be released so that the CS relay **143** operates as described above. If reverse battery supervision has been received by the trunk circuit **141** then the CS1 relay **247** will have been operated so that contacts **157** and **167** will be operated and reverse the winding terminals of the CS relay so that this relay will operate in the above-described circuit unless the switching system shown in FIGS. 1 and 3 has responded and opened the T and R conductors **128** within the switching system.

The release of the A relay **162** also causes contacts **210** to open and interrupt the operating circuit of the B relay **212**. This relay is a slow release relay as described above and does not immediately release. However, when a disconnect signal is received the A relay **162** will remain released sufficiently long to allow this B relay **212** to also release. The release of the B relay **212** opens contacts **221** and thus interrupts the holding or operating circuits of the B1 relay **216** and the S1 relay **215** and the D relay **231**.

If the CS relay **143** is released by the time the B relay **212** releases indicating that the T and R conductors **128** have been released in the switching system of FIGS. 1 and 3, the release of the B relay **212** releases the B1 relay **216**, the S1 relay **215** and the D relay **231** and restores the circuits to their idle or normal condition.

If, however, the CS relay **143** is not released at the time the B relay **212** releases thus indicating that the switching system of FIGS. 1 and 3 and then the other switching equipment connected thereto has not released the previously established connection, then upon the release of the B relay **212**, a circuit is completed for the operation of the SW relay **213** from battery through the winding of this relay, the break contacts **263** of the B

relay **212**, the break contacts **264** of the B1 relay **216**, the break contacts **265** of the A relay **162** and the operated contacts **253** of the CS relay **143** to ground. The SW relay **213** then operating closes its contacts **254** and thus completes a holding circuit from battery through its winding and contacts **254** to ground through the contacts **253** of the CS relay **143**.

The operation of the SW relay **213** also closes contacts **153** which complete a holding circuit for the CS relay **143** from the R conductor **128** through the operated contacts **153** of the SW relay **213** and the break contacts **156** of the S relay **165** and then through the contacts **157** and **167** of the CS1 relay **247** and the right-hand winding of the CS relay **143** to the T conductor. The operation of the SW relay also opens the R and T conductors at contacts **153** and **166**. Later when the circuit through the switching system of FIGS. 1 and 3 has been released the CS relay **143** will release and in turn release the SW relay **213** and restore the circuit to its idle or initial condition.

If a circuit is again seized by the four-wire switching system **110** prior to the release of the CS relay **143**, the A relay **162** operates and in turn operates the B relay **212** and the B1 relay **216**. This relay in turn operates the ST relay **217** and initiates the operation of the timer **234** in the manner described above. However, the SW relay **213** maintains the T and R conductors open to the switching system of FIGS. 1 and 3 thus preventing the reseizure of this equipment before the previously established path has been released. Then upon the release of this path the CS relay **143** releases as described above and releases the SW relay **213** whereupon the closure of the contacts **153, 166** and **152** complete a circuit for the initiation for another call through the switching system of FIGS. 1 and 3 and thereafter the circuits operate in the manner described above.

If a call is released or abandoned during dialing, the release of the A relay **162** causes the various relays to operate in essentially the same manner as described above which causes the previously established connections or paths to be released and the circuits restored to their initial condition.

If the release or abandonment occurs during the timing of the one second interval by the timer **234**, the operation of the C1 relay **237** causes contacts **250** to open and thus restore the timer **234** to its initial or idle condition. The circuits then operate in substantially the same manner as described above to release the previously-established connection.

Assume now that the called subscriber disconnects first and further that answering supervision has been returned to the auxiliary line circuit **141**. Thus when the called party disconnects the CS relay **143** will release. Inasmuch as reverse battery supervision has been returned to the auxiliary line circuit **141**, the CS1 relay **247** will be operated at this time. Consequently, the release of the CS relay **143** at this time completes a circuit for the operation of the S2 relay **232** from battery through the winding of relay **232**, the operated contacts **266** of the B1 relay **212**, the operated contacts **267** of the S1 relay **215**, the operated contacts **268** of the CS1 relay **247**, to ground through the break contacts **270** of the CS relay **143**. This operation of the S2 relay **232** causes contacts **269** to close and complete a locking or holding circuit from battery through the winding of S2 relay **232**, the operated contacts **266** of the B1 relay **216**, the operated contacts **269** of the S2 relay **232** to ground through the operated contacts **221** of the B relay **212**.

With the contacts **272** of the B1 relay **216** operated and contacts **271** of the CS1 relay **247** operated at this time, the release of the CS relay **143** opens contacts **253** and thus interrupts a holding circuit for the D relay **231**. This relay is slow to release at this time due to the short circuit around its right-hand winding due to the closure of contacts **273** of the D relay **231**, contacts **274** of the

B relay **212** and contacts **275** of the B1 relay **216**. The release of the D relay **231** causes contacts **226** to close and complete an above-described circuit for the operation of the ST relay **217** through the diode **227**. In addition with the S2 relay **232** operated contacts **233** are opened so that both timing resistors **228** and **229** are connected in series to the timer **234** and as a result this timer is set for a time interval of approximately three hundred milliseconds in accordance with an exemplary embodiment of this invention.

The release time of the D relay **231** and the three hundred mililsecond time interval of timer **234** is provided at this time to prevent momentary false operations of the called subscriber's subset from disconnecting the connection.

The operation of the T relay **218** in response to timer **234** at the end of approximately 300 milliseconds, in the exemplary embodiment of our invention described herein, causes the break contacts **224** to open and interrupt the holding circuit for the B1 relay **216**. This relay releases and opens contacts **225** which in turn release the ST relay **217** and the ST relay **217** in turn opens contacts **219** and **220** thus restoring the timer **234** to its initial state.

The release of the B1 relay **216** causes contacts **266** to open and release the S2 relay **232**. In addition the release of the B1 relay **216** causes contacts **158** to open and reconnect ground to the M conductor extending to the signaling circuit **111**. This signal is then relayed to the four-wire switching system as a disconnect signal. Thereafter the four-wire switching system sends a disconnect signal to the auxiliary circuit **141** and causes the A relay **162** to release. The release of this relay first causes the C relay **214** to operate and then the C1 relay **237** to operate. Thereafter the B relay **212** releases and causes the C relay **214** and the C1 relay **237** to release in turn and restore the circuit to its idle condition.

Assume that reverse battery answer supervision had not been returned to the auxiliary line circuit **141**. Consequently, the CS relay **143** is not operated during the call. Then if it is further assumed that a disconnect signal is relayed or transmitted from the switching system of FIGS. 1 and 3 to the auxiliary line circuit **141** the S relay **165** releases. At this time neither the CS relay **143** nor the CS relay **247** are operated.

The release of the S relay **165** causes the break contacts **241** to close and complete a circuit from battery through the winding of the S2 relay **232**, the operated contacts **266** of the B1 relay **216**, the operated contacts **267** of the S1 relay **215**, the break contacts **268** of the CS1 relay **247**, the break contacts **241** of the S relay **165** to ground through the operated contacts **221** of the B relay **212**.

The release of the S relay **165** also causes the make contacts **241** to open and interrupt the holding circuit of the D relay **231** thus allowing this relay to release. The release of this relay causes contacts **226** to close and activate the timer circuit **234** in the manner described above. The operation of the T relay **218** at the end of the timing interval determined by the timer **234** causes the break contacts **224** to open and interrupt the holding circuit of the B1 relay **216** thus causing this relay to release. The release of the B1 relay **216** again connects ground to the M lead as a disconnect signal to the four-wire switching system. When this system disconnects it causes the A relay **162** to release and the circuit responds thereafter as described above.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In a crossbar telephone switching system, a switching network of crossbar switches arranged in a line link

frame switching group and a trunk link frame group, an incoming trunk circuit, an auxiliary circuit for interconnecting said incoming trunk circuit with switches of said line link frame switching group including means responsive to incoming calling signals, and means for repeating said calling signals to said crossbar telephone switching system, wherein said crossbar system includes originating registers for registering incoming calling signals, means for interconnecting said registers with incoming circuits, and means jointly responsive to the interconnection of one of said registers with said incoming trunk and to the termination of a predetermined time interval to transmit a ready signal back over said incoming trunk circuit.

2. In a crossbar telephone switching system, the combination in accordance with claim 1 wherein said auxiliary circuit includes means for generating and transmitting back over said incoming trunk circuit an answering signal.

3. In a communications switching system, a plurality of subscriber line terminals and means for establishing communication paths from said subscriber line terminals through said switching system, signal receiving means connected to said system, means for conditioning said system for selectively transmitting signals from said subscriber line terminals through said system to said signal receiver means, an incoming trunk circuit, and interconnecting means for interconnecting said incoming trunk with certain of said subscriber line terminals, wherein

said interconnecting means includes apparatus jointly responsive to said conditioning of said system and to the termination of a predetermined time interval for transmitting a ready signal back over said incoming trunk circuit, and means for generating and transmitting an answer signal back over said incoming trunk circuit.

4. In a communications switching system, a plurality of subscriber line terminals and means for establishing communication paths from said subscriber line terminals through said switching system, signal receiving means connected to said system, means for conditioning said system for selectively transmitting signals from said subscriber line terminals through said system to said signal receiver means, an incoming trunk circuit, and interconnecting means for interconnecting said incoming trunk with certain of said subscriber line terminals, wherein said interconnecting means includes apparatus jointly responsive to said conditioning of said system and to the termination of a predetermined time interval for transmitting a ready signal back over said incoming trunk circuit, and means for testing previously established paths through said system for preventing the transmission of said ready signal.

No references cited.

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