Sept. 7, 1937. J. BAUMFALK 2,092,495

TELEPHONE SYSTEM

Filed Oct. 16, 1935 3 Sheets-Sheet 1

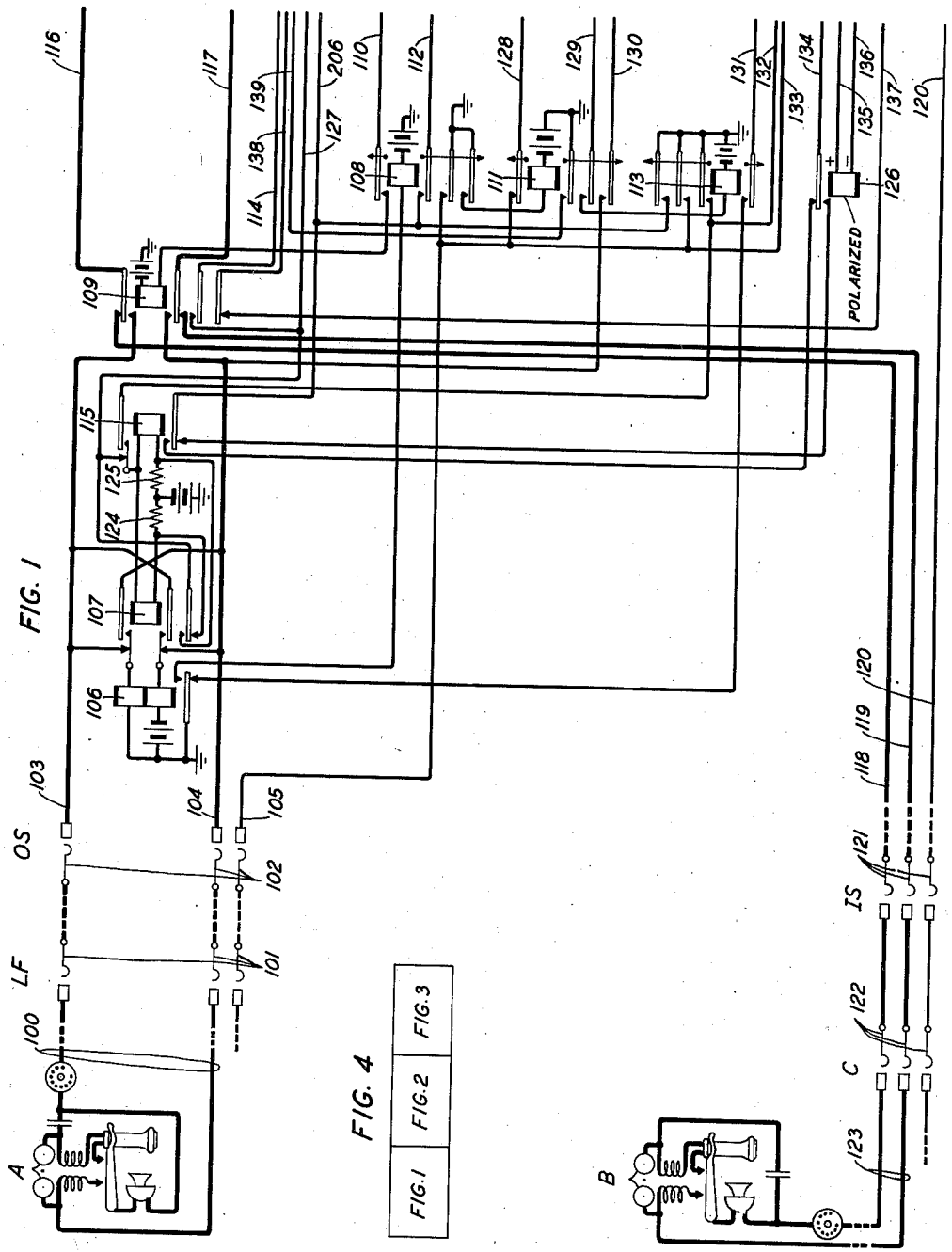

FIG. 1

FIG. 4

FIG. 1	FIG. 2	FIG. 3

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TELEPHONE SYSTEM

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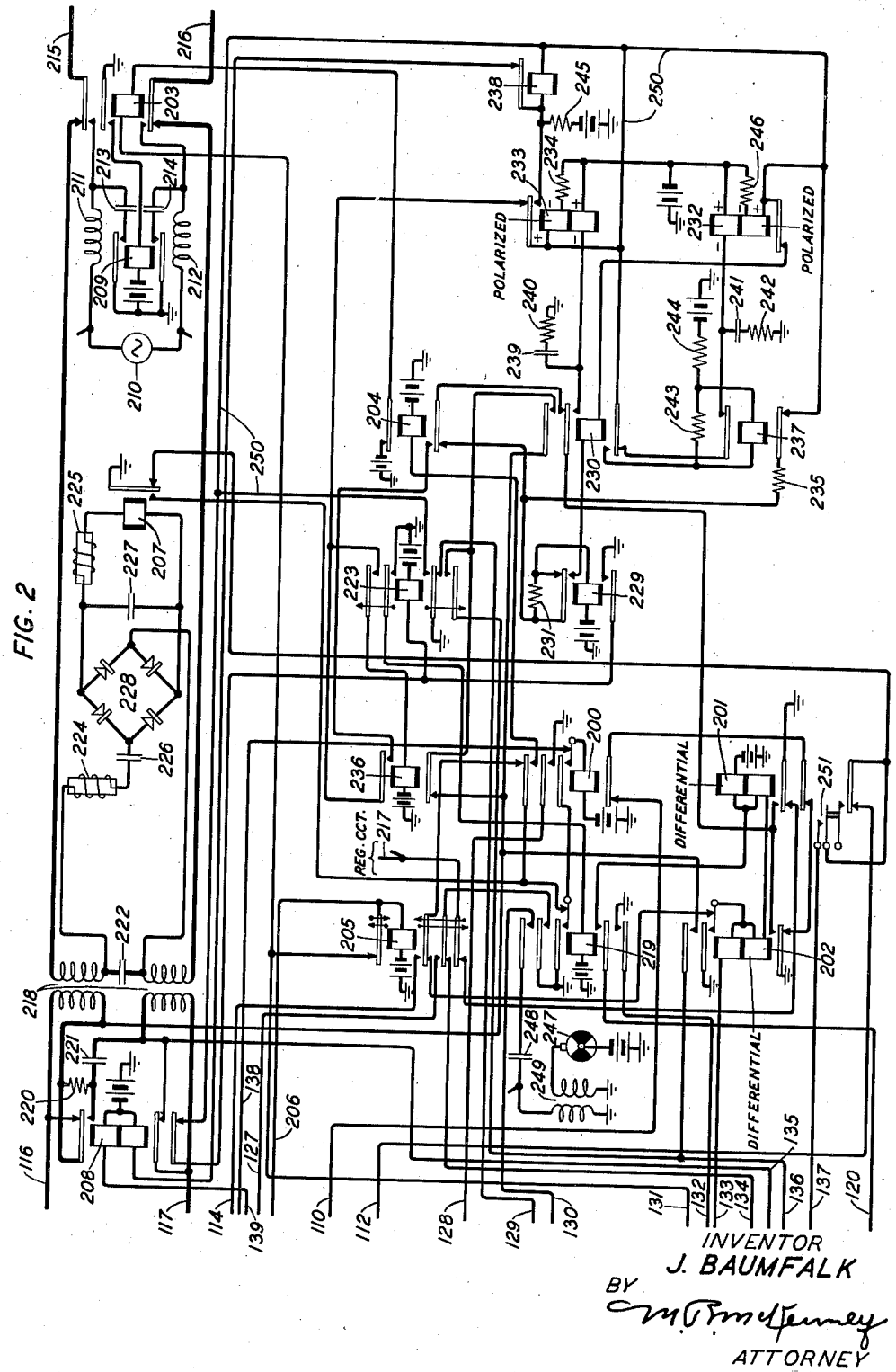

FIG. 2

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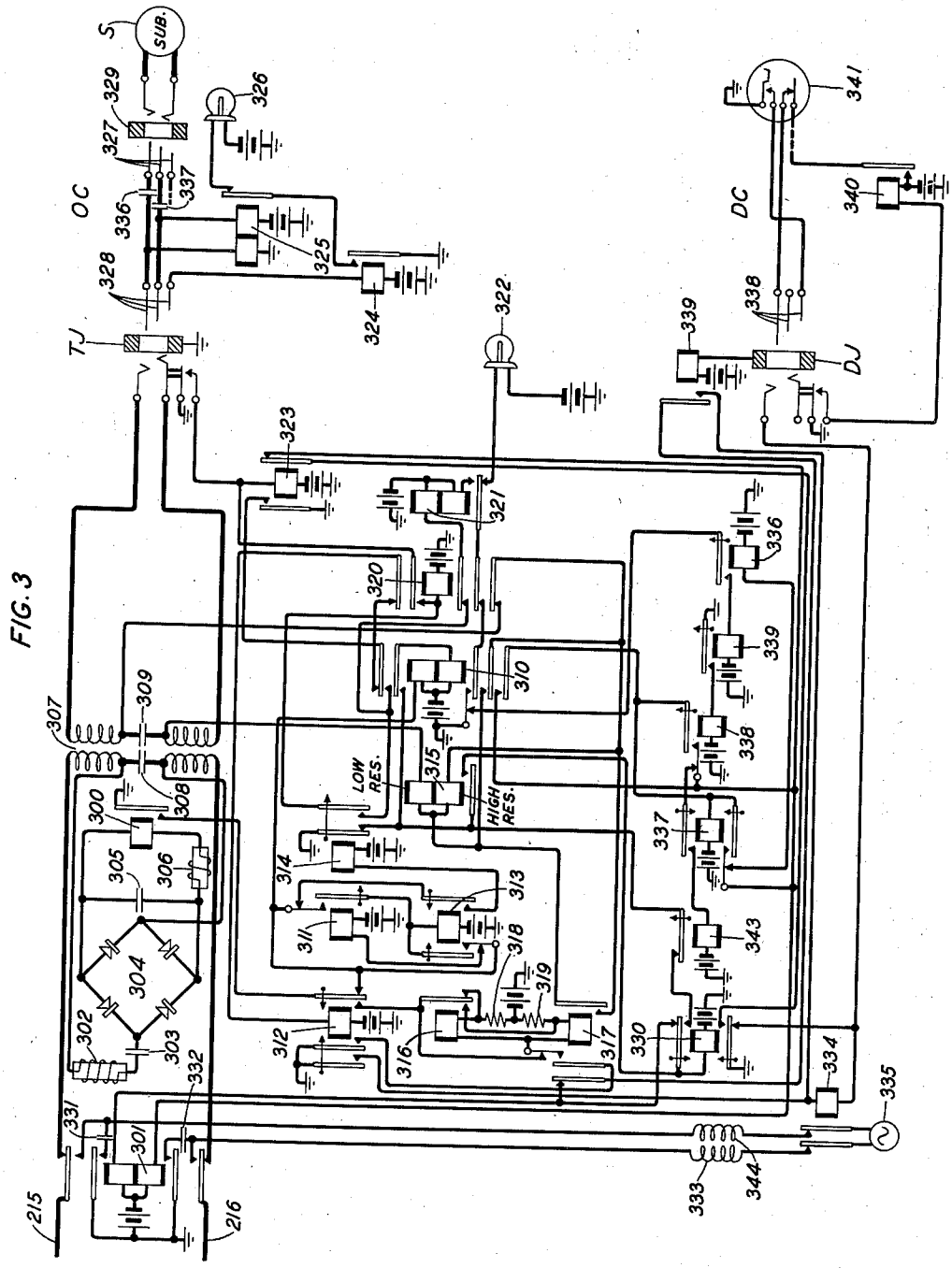

FIG. 3

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UNITED STATES PATENT OFFICE

2,092,495

TELEPHONE SYSTEM

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Application October 16, 1935, Serial No. 45,186

7 Claims. (Cl. 179—27)

This invention relates to telephone systems and particularly to those involving trunking arrangements for the extension of calls between exchanges.

The objects of this invention are to enable a more efficient use of trunk lines and particularly those used for making calls in either direction, to give a preference to calls made in one direction in the event of an attempt to extend calls at the same time in both directions over the trunk, to permit the reseizure of a trunk at one end prior to its release at the other end without interfering with the supervisory signals at said other end indicating that the trunk should be released, to hold in suspense the signal indicating a new call over the trunk as a result of said reseizure at one end until it is released at the other end and then to display said signal, and otherwise to improve systems of this character.

Systems have been designed in the past in which calls made in one direction over a two-way trunk are given preference under certain conditions over calls in the other direction. It has also been proposed to give a signal in the form of a busy tone to the parties at both ends of a two-way trunk in the event both seize their respective ends at the same time. Furthermore, it is old in the art, particularly in trunks of the type that terminate in a plug at a completing operator's position and provided with a guard and disconnect lamp, to enable the reseizure of the trunk at the distant end without extinguishing said lamp when burning as a disconnect signal, and to cause the continued burning of said lamp to indicate the new call when the completing operator frees the trunk by removing the plug from the jack.

According to a feature of the present invention improvements are secured over these prior arrangements by means of a novel two-way trunk having a test circuit involving a differential relay so connected that when the outgoing end of the trunk is seized said relay fails to operate, although included in the test circuit, thereby permitting the calling line to be operatively connected to the outgoing end of the trunk and to send switch operating and supervisory impulses thereover to the distant end, whereas a calling signal incoming from the distant end, although arriving simultaneously with the seizure of the outgoing end of said trunk, causes the operation of said relay to arrest the outgoing call and give preference to the incoming call. As a result of the operation of said differential relay a tone is given the unsuccessful subscriber so that he may release his connection and make another attempt.

Another feature of the invention is a two-way trunk terminating at one end in a jack at an operator's position having a calling lamp that lights in response to an incoming call signal when the trunk is seized at the distant end and having means responsive to a disconnect signal sent over the trunk from the distant end to control a supervisory lamp in the operator's cord connected to the trunk jack, and having means such that, if the distant end is released and reseized before the operator disconnects from her end of the trunk, the incoming call signal caused by the reseizure will neither cause the trunk lamp to light nor interfere with the supervisory lamp in the cord but will set up a condition at the incoming end of the trunk such that, when the operator does disconnect, the trunk lamp will light in the usual manner to indicate that another call is waiting the operator's attention.

These and other features of the invention will be described more fully in the following specification and will also be set forth in the appended claims.

Referring to the drawings, Figs. 1, 2 and 3, when taken in the order illustrated in Fig. 4, disclose a telephone system employing a two-way trunk for establishing connections in either direction between a dial private branch exchange and a manual private branch exchange.

Fig. 1 shows a portion of the outgoing end of the trunk located at the dial exchange, a calling subscriber's station A, and line finder and outgoing selector switches LF and OS by means of which connections between station A and the trunk may be established on an outgoing connection. Fig. 1 also shows a called subscriber's station B, and incoming selector and connector switches IS and C by means of which calls incoming from the distant manual exchange may be completed to station B.

Fig. 2 shows the remainder of the outgoing end of the trunk located at the dial exchange.

Fig. 3 shows that portion of the trunk located at the manual exchange, an operator's cord circuit OC and associated talking jack TJ for establishing connections between the trunk and a manual subscriber's station S, and a dialing cord circuit DC and associated dialing jack DJ by means of which the operator controls the selective operations of the switch circuits at the dial exchange on an outgoing call to station B.

The subscriber's stations A and B are provided with the usual subscriber's set, including a dial

for controlling the establishment of desired connections. The line finder switch LF is of the well-known Strowger type and may be similar to that disclosed in Patent 1,711,682, issued May 7, 1929, to H. Hovland, the brushes 101 corresponding to one of the two sets of brushes shown in the Hovland patent. The selector switches OS and IS and the connector switch C are also of the well-known Strowger type, and reference may be had to pages 53 to 67 inclusive of the 2nd edition of "Automatic Telephony" by Smith and Campbell for a detailed description of the operation of the circuits associated with these switches. The operator's cord circuit OC and the dialing cord circuit DC show only such portions of these respective circuits as is necessary to illustrate the manner in which connections over the trunk are established and controlled therewith. The dial private branch exchange and manual private branch exchange portions of the trunk are shown in detail, and the operation thereof is fully set forth in the following description of calls from station A at the dial exchange to station S at the manual exchange, and from station S at the manual exchange to station B at the dial exchange.

While the exchanges interconnected by the two-way trunk are referred to herein as private branch exchanges, the invention is not so limited but may be applied to systems involving other kinds of exchanges and offices.

Assuming now that the receiver is removed from the switch-hook at station A to originate a call, the line finder LF hunts for and extends line 100 over its multiple brushes 101 to the outgoing selector OS. When the calling subscriber at station A dials the first digit of the number of the called subscriber's station, the brushes 102 of the outgoing selector are advanced to a corresponding group of terminals, and the outgoing selector thereupon automatically hunts for and seizes an idle set of terminals in the selected group.

Assuming that the selected set of terminals are connected to the outgoing end of the trunk shown in Fig. 1, relay 106 of that trunk is energized in a circuit traceable from ground and battery through its windings, over the normally closed contacts of relay 107, tip and ring conductors 103 and 104, brushes of selector OS and line finder LF, and over the tip and ring conductors of line 100 and the closed pulsing contacts of the dial at the subscriber's station A. Relay 106, in operating, operates relay 108 in a local circuit. The operation of relay 108 operates relay 111 in a local circuit, grounds the sleeve or test conductor 105 to the outgoing selector bank terminal to make this selected set of terminals test busy to other selectors and also to hold the preceding switch circuits, and operates relay 109 in a circuit traceable from battery through the winding of that relay, upper front contact of relay 108, conductor 110, lower back contact of relay 200, middle back contact of relay 201, to ground over the lower back contact of relay 202. The operation of relay 108 also operates relay 203 in a circuit traceable from battery over the upper back contact of relay 204, winding of relay 203, upper back contact of relay 205, conductor 206, lower inner front contact of relay 108, conductor 112, outer back contact of relay 201, to ground over the back contact of relay 207. Relay 205 is also energized in a circuit to this ground over the back contact of relay 207 but, since it has slow-to-operate characteristics, it does not operate immediately.

Relay 111, in operating, operates relay 208 in a circuit from ground over the inner front contact of relay 111, over conductor 139 and through the upper winding of that relay; operates relay 113 over conductor 129 to ground over the back contact of relay 223; and closes the ring conductor 104 over its lower outer front contact and over conductor 130 to the upper outer front contact of relay 219 thereby partially completing a tone circuit the function of which will be discussed later. The operation of relay 113 connects a supplementary ground to the outgoing selector test terminal conductor 105; and, in addition, supplies a future locking ground for relay 115 to the upper armature of that relay.

Upon the previous operation of relay 108 a circuit was completed from ground over its lower middle front contact and over conductor 133, through the two windings of relay 202 in series, to battery through the two windings of relay 201 in series. A supplementary ground is also placed on conductor 133 by the operation of relay 113. Neither the differential test relay 201 nor relay 202 operates at this time however since they are both differentially wound relays, that is, the two windings of each relay exert opposing forces on the relay and therefore have no effect when energized simultaneously.

Relay 203, in operating as set forth above, operates relay 209 in a local circuit and transfers the tip and ring conductors 215 and 216 respectively, which extend to the distant manual exchange, from the right windings of repeating coil 218 to a source of alternating current 210 through the windings 211 and 212 of a retardation coil. Relay 209, in operating, grounds condensers 213 and 214, the other sides of which connect to one side of the retardation coil windings 211 and 212. The function of condensers 213 and 214 is to absorb acoustic shocks upon the subsequent release of relay 203. After an interval, the previously energized slow-to-operate relay 205 operates and opens the operating circuit for relay 203. Relay 203 thereupon releases and removes the alternating current from conductors 215 and 216. Relay 209 releases upon the release of relay 203 and removes the ground from condensers 213 and 214 thereby restoring the signaling circuit to normal. The pulse of alternating current, the duration of which is determined by the operating time of relay 205, over conductors 215 and 216 causes a lamp to be lighted at the distant manual exchange, as an indication of an incoming call at that exchange. The manner in which this signal is given at the manual exchange end of the trunk will be set forth later.

Relay 109, operating over a previously traced circuit, disconnects the incoming selector tip and ring conductors 118 and 119 from the tip and ring conductors 116 and 117 of the trunk, and closes through the outgoing selector tip and ring conductors 103 and 104, over conductors 116 and 117, to the left windings of repeating coil 218. Relay 208, operating over a previously traced circuit, removes the short circuit from each of the left windings of repeating coil 218, short-circuits resistance 220 and connects condenser 221 between the two left windings of repeating coil 218, thereby completing the transmission circuit at this end of the trunk.

The pulse of alternating current connected to the tip and ring conductors 215 and 216 by the operation of relay 203 as hereinbefore set forth,

extends over the back contacts of relay 301 and the left windings of repeating coil 307 at the manual exchange end of the trunk and is impressed across a rectifying circuit arrangement consisting of retardation coils 302 and 306, condensers 303 and 305, and rectifying devices 304 which may be of the copper-oxide disc type. Relay 300, which is connected to the output of this aforementioned rectifying circuit, operates on the direct current obtained by the rectification of the alternating current signal pulse from the dial exchange end of the trunk, the manner in which this rectifying action is effected being well known to the art. Relay 300, in operating, operates relay 310 in a circuit from battery through the upper winding of relay 310, right back contact of relay 312, to ground over the front contact of relay 300. Lamp 322 thereupon lights in a circuit from battery through the lamp, over the back contact of relay 321, lower middle back contact of relay 320, to ground over the lower inner front contact of relay 310. Relay 310, operated, locks in a circuit from battery through its lower winding and over its upper inner front contact, to ground over the back contact of relay 314.

The manual exchange operator, in response to the lighting of lamp 322, answers the call by inserting the plug 328 of her cord OC into the talking jack TJ with which lamp 322 is associated. The lower contacts of jack TJ thereupon close and operate relay 323 in a local circuit. Relay 321 operates in a circuit traceable from battery through its upper winding, over the lower inner back contact of relay 320, upper outer front contact of the operated relay 310, to ground over the front contact of relay 323. Relay 321, in operating, opens the circuit to lamp 322 extinguishing that lamp, and locks in a circuit from battery through its lower winding and front contact, over the lower middle back contact of relay 320, to ground over the lower inner front contact of relay 310. Relay 324 of the cord circuit OC operates in local circuit to ground on the sleeve element of jack TJ and connects ground to the armature of the cord circuit supervisory relay 325.

With the plug 328 of the cord circuit fully inserted into the jack TJ a circuit is completed from battery through the right winding of relay 325, ring conductor of the cord OC, ring element of plug 328, ring spring of jack TJ, right lower winding of repeating coil 307, upper, low resistance winding of relay 315, lower middle front contact of relay 310, lower outer back contact of relay 320, right upper winding of repeating coil 307, tip spring of jack TJ and tip element of plug 328, to ground through the left winding of relay 325, thereby operating both relays 315 and 325. Relay 325, in operating, opens the circuit to the operator's cord lamp 326, thereby keeping this lamp extinguished. Relay 315, in operating, closes a circuit from ground over the back contact of relay 314, front contact of relay 315, to battery through the winding of relay 330. This ground also extends over the upper back contact of relay 330 to battery through the upper winding of relay 301. Relay 330 is of the slow-to-operate type and does not operate immediately. Relay 301, however, operates at once and connects a pulse of alternating current to conductors 215 and 216 for the purpose of signaling the dial end of the trunk that the call has been answered by an operator at the manual end. The circuit for this pulse may be traced from the source of alternating current 335, over the back contacts of relay 334, to the lower winding of transformer 333 from which point it is induced through the upper winding of that transformer and over the upper and lower outer front contacts of relay 301 to the tip and ring trunk conductors 215 and 216. The slow-to-operate relay 330 operates after an interval, locks over its upper front contact and the back contacts of relays 343 and 314, and opens the circuit through the upper winding of relay 301 which releases and thereby terminates the alternating current pulse.

The alternating current signal pulse from the manual exchange end of the trunk extends over the outer upper and lower back contacts of relay 203 and through right windings of repeating coil 218 at the other end of the trunk to a rectifying circuit arrangement consisting of retardation coils 224 and 225, condensers 226 and 227 and rectifying devices 228. Relay 207, the winding of which is connected to the output of this aforementioned rectifying circuit, operates in response to the signaling pulse and operates relay 115 in a circuit from ground over the front contact of relay 207, upper outer back contact of relay 200, inner front contact of relay 205, conductor 114, lower outer front contact of relay 109, upper back contact and winding of relay 115, and through resistance 125 to battery. Relay 115 in operating, locks over its upper front contact to ground over the upper inner front contact of relay 113. Relay 107 does not operate at this time since it is short-circuited by the presence of ground on both ends of its winding. When relay 207 releases at the termination of the alternating current pulse from the manual end of the trunk ground is removed from conductor 114 thereby removing the short circuit on relay 107 which now operates in a circuit from ground over the upper inner front contact of relay 113, upper front contact of relay 115, winding of relay 107, to battery through resistance 124. The operation of relay 107 reverses the battery and ground, supplied through the windings of relay 106, to the tip and ring conductors 103 and 104 which extend to the outgoing selector. This reversal of potential toward the originating circuits causes supervision to be given to those circuits in a manner well known to the art. Relay 107, operated, locks in a circuit from battery through resistance 124, winding of relay 107, upper front contact of relay 115, to ground over the upper inner front contact of relay 113.

The transmission circuit between stations A and S is now complete and conversation may ensue. This circuit may be traced from station A, line 100, over the line finder LF and outgoing selector OS, trunk conductors 103 and 104, inner front contacts of relay 109, conductors 116 and 117, left windings of repeating coil 218, and over the upper front contact of relay 208, to the transmission condenser 221. Continuing, from the right windings of repeating coil 218 connected together by transmission condenser 222, over the outer back contacts of relay 203, conductors 215 and 216, outer back contacts of relay 301 at the manual exchange end of the trunk, and through the left windings of repeating coil 307 and transmission condenser 308. Continuing, from the right windings of repeating coil 307 connected together by transmission condenser 309, tip and ring springs of jack TJ, tip and ring conductors of cord OC, to the cord circuit transmission condensers 336 and 337 and through the windings of relay 325 to ground and battery. From the other

side of transmission condensers 336 and 337, tip and ring conductors of cord OC associated with plug 327, and over the tip and ring springs of jack 329, to the called station S, the operator having inserted plug 327 into jack 329 and applied ringing current to station S after having obtained the wanted number from the calling subscriber.

Assuming that, at the termination of conversation, the subscriber at the called station S places his receiver back on the switch-hook before the calling subscriber at station A replaces his receiver, the operator withdraws plugs 328 and 327 from jacks TJ and 329 respectively in response to the lighting of a disconnect lamp (not shown) which is associated with that portion of the cord circuit OC associated with plug 327. Relays 315, 323 and 324 thereupon release. Upon the release of relay 323 a circuit is completed from ground over the lower front contact of relay 330, back contact of relay 323, to battery through the lower winding of relay 301; also from the back contact of relay 323, over the normally closed contacts of relay 337, to battery through the winding of relay 336; and also from the back contact of relay 323, over the lower outer front contact of relay 310 to battery through the winding of relay 337. Relays 301, 336 and 337 operate, relay 336 performing no useful function under this condition. Relay 301, in operating, connects alternating current to conductors 215 and 216 over a previously described circuit. This alternating current is a supervisory disconnect signal to the dial exchange end of the trunk in response to which this latter circuit functions as will subsequently be set forth. Relay 337, which is slow in operating, operates after an interval and operates relay 343 in a circuit from battery through the winding of relay 343, upper front contact of relay 337, normally closed contacts of relay 338, back contact of relay 323, to ground over the lower front contact of relay 330. The operation of relay 343 opens the last locking circuit for relay 330, the other locking circuit for this latter relay having previously been opened by the release of relay 315. Relay 330 thereupon releases releasing in turn relays 301, 343, 336 and 337. The release of relay 301 removes the alternating current from conductors 215 and 216, thereby terminating the disconnect supervisory signal pulse to the dial exchange end of the trunk.

Referring now to the dial exchange end of the trunk shown in Figs. 1 and 2, the alternating current disconnect signal pulse referred to above operates relay 207 in the manner hereinbefore set forth. Ground over the front contact of relay 207, over the upper back contact of relay 209, inner front contact of relay 205, conductor 114, lower outer front contact of relay 109, lower outer front contact of relay 107, to one side of resistance 125 and winding of relay 115, short-circuits relay 115. Relay 115 releases, relay 107 now holding over the normally closed upper contacts of relay 115 to this ground just traced from the front contact of relay 207. At the termination of the alternating current pulse from the manual end of the trunk, relay 207 releases thereby opening the holding circuit for relay 107 which also releases. The release of relay 107 again reverses the battery and ground supplied to conductors 103 and 104 for the purpose of transmitting disconnect supervision to the originating circuits.

Relay 106 releases when the connection is broken at the originating office, releasing relay 108 and operating relay 203 in a circuit traceable from ground over the lower back contact of relay 106, lower front contact of relay 113, conductor 131, through the winding of relay 203, to battery over the upper back contact of relay 204. Relay 203, in operating, connects an alternating current pulse from the source 210 to conductors 215 and 216 toward the manual exchange as a disconnect signal, the manual exchange end of the trunk thereupon functioning as will subsequently be set forth. Relay 203 also operates relay 209 the function of which has already been discussed. The alternating current disconnect pulse just discussed is of greater duration than the seizure pulse originally sent to the manual exchange end of the trunk, and is longer so that the manual end of the trunk can differentiate between a seizure and a disconnect signal and function accordingly in the manner later to be described. The length of the disconnect pulse is controlled as follows. The pulse starts with the operation of relay 203, as set forth above, following the release of relay 106 which latter relay simultaneously opens the circuit through the winding of the slow-to-release relay 108. Relay 108 releases after an interval, releasing relay 109 and opening the circuit through the winding of the slow-to-release relay 111. Relay 111 releases after an interval and opens the circuit through the winding of the slow-to-release relay 113 which releases, after an interval, and in turn releases relays 203 and 205. The release of relay 113 also removes the last ground from the outgoing selector test terminal conductor 105, the other busying ground having been removed by the release of relay 108. The release of relay 203 terminates the alternating current disconnect pulse toward the manual end of the trunk and also releases relay 209, thereby restoring the dial exchange end of the trunk to normal.

Relay 300 at the manual end of the trunk operates in response to the long pulse of alternating current described above and in turn operates relay 311 over the back contacts of relays 312 and 313. Relay 311, in operating, completes the operating circuit for relay 313 since, due to the long disconnect pulse, relay 300 has not yet released. Relay 311 releases upon the operation of relay 313 and in turn operates relay 314 in a circuit from battery through the winding of relay 314, right front contact of relay 313, normally closed contacts of relay 311, back contact of relay 312, to ground over the front contact of relay 300. Relay 314, in operating, opens the locking circuit through the lower winding of relay 310, this relay, however, still remaining operated through its upper winding, back contact of relay 312, to ground over the front contact of relay 300. At the termination of the long disconnect pulse from the dial exchange end of the trunk relay 300 releases releasing relays 310, 313 and 314. The release of relay 310 opens the holding circuit through the lower winding of relay 321 which thereupon releases and thereby restores the manual exchange end of the trunk to normal.

Should the subscriber at station A replace his receiver on the switch-hook before the subscriber at station S replaces his receiver, the dial exchange end of the trunk functions in the same manner as has just been set forth above and transmits a long pulse of alternating current to the manual exchange end of the trunk as a disconnect signal. The subsequent release of the manual end of the trunk thereupon takes place in the manner described in the subsequent

paragraphs. Relay 300 at the manual end of the trunk operates in response to the long alternating current pulse from the dial end of the trunk and operates relay 311 over a previously traced circuit. Relay 313 thereupon operates and locks under control of relay 300 and releases relay 311. Upon the release of relay 311 relay 314 operates over the right front contact of relay 313, normally closed contacts of relay 311, back contact of relay 312, to ground over the front contact of relay 300. Relay 320 thereupon operates in a circuit traceable from battery through its winding, over the front contact of relay 314, upper outer front contact of relay 310, to ground over the front contact of relay 323 which is still operated since it is assumed that the subscriber at station S has not yet disconnected and the manual operator has therefore not as yet removed cord OC from jacks TJ and 329. Relay 320, in operating, locks over its upper inner front contact to ground over the operated springs of jack TJ, opens the circuit through the windings of relay 315 which releases, opens the circuit to the winding of relay 312 to prevent the operation of relay 312 on the subsequent release of relay 310, and also opens the operating and holding circuits for relay 321 which latter relay thereupon releases. The operation of relay 320, in opening the circuit through the windings of relay 315, thereby also opens the previously traced operating circuit for relay 325 of the operator's cord circuit OC. Relay 325 releases and causes the cord circuit lamp 326 to light as a disconnect signal.

At the termination of the disconnect pulse from the dial end of the trunk relay 300 releases, in turn releasing relays 310, 313 and 314. When the operator withdraws plugs 327 and 328 from jacks 329 and TJ, respectively, in response to the lighted disconnect signal 326, relays 320, 323 and 324 release, thereby restoring the manual end of the trunk to normal.

In the event that the trunk is reselected at the dial exchange end before disconnection takes place at the manual end and therefore before plug 328 of the operator's cord OC has been withdrawn from jack TJ, the circuit functions as follows. Upon reseizure at the dial end the circuit at that end of the trunk functions in the manner hereinbefore set forth and transmits a short alternating current seizure pulse to the manual end of the trunk, operating relay 300 at that end for a short interval. Relay 300, in operating, operates relay 310 through the upper winding of that relay over a previously traced circuit. Relay 310 locks through its lower winding under control of the unoperated relay 314 but performs no other function at this time. Under this condition the call lamp 322 associated with this trunk cannot light since its circuit is open at the contacts of relay 320 which is operated and locked under control of ground over the operated springs of jack TJ. No further action takes place until the manual operator removes plug 328 from jack TJ in response to the cord disconnect signal 326 which lights upon the release of relay 325. Relays 320, 323 and 324 thereupon release. Upon the release of relay 320 a circuit is completed from ground over the lower inner front contact of the operated relay 310, lower back contacts of relays 320 and 321, to battery through the call lamp 322 which now lights to indicate the presence of a new call. From this point on the circuits function as previously described for the initial call from station A to station S.

The detailed operation of the trunk on a connection from the manual station S to the dial station B will now be described. When the subscriber at station S initiates a call, an associated line lamp (not shown) appearing in front of the manual operator is caused to light in a manner well known to the art. In response to this lighted line lamp the manual operator inserts plug 327, associated with the answering cord of her cord circuit OC, into jack 329 which is associated with the line extending to station S. The operator thereupon ascertains the number of the station to which the subscriber at station S desires connection, using for this purpose the operator's telephone circuit (not shown). Having obtained the number of the wanted station, the operator inserts plug 328 associated with her calling cord into the talking jack TJ. Relay 324 of the cord circuit operates to ground on the sleeve of jack TJ and thereby causes the cord lamp 326 to light, relay 325 being unoperated at this time. Relay 323 operates to ground over the contact springs of jack TJ. Relay 312 thereupon operates in a circuit traceable from battery through its winding, over the upper back contacts of relays 320 and 310, to ground over the front contact of relay 323.

Relay 312, in operating, transfers the conductor extending from the front contact of relay 300 from the windings of relays 310 and 311 to contacts of relays 316 and 317. Relay 312 also connects a ground over its inner front contact to the inner armature of relay 317 to provide for the future locking of relays 316 and 317, and also connects ground to the winding of pulsing relay 334. When plug 328 is fully seated in jack TJ a circuit is completed from ground through the left winding of relay 325, over the tip conductor of the cord and trunk, right upper winding of repeating coil 307, lower outer back contact of relay 320, both windings of relay 315, right lower winding of coil 307, ring conductor of the trunk and cord, to battery through the right winding of relay 325. Relay 315 operates but relay 325 of the cord circuit does not since this latter relay receives insufficient current due to the high resistance of the lower winding of relay 315. Relay 315, in operating, operates relay 301 in a circuit from ground over the back contact of relay 314, front contact of relay 315, upper back contact of relay 330, and through the upper winding of relay 301 to battery. This same ground which operates relay 301 also energizes relay 330 but since this latter relay has slow-operating characteristics it does not operate immediately. Relay 301, in operating, opens the trunk conductors 215 and 216 from the left winding of repeating coil 307 and connects alternating current to these aforementioned trunk conductors for the purpose of seizing the dial exchange end of the trunk in a manner which will subsequently be described. The circuit for this alternating current may be traced from the current source 335, over back contacts of relay 334, through the windings of retard coils 333 and 334 and over the upper and lower outer front contacts of relay 301 to conductors 215 and 216. Relay 301 also connects ground to condensers 331 and 332 the function of which is to reduce the amount of induction of alternating current to other trunks. Relay 330, which is energized simultaneously with relay 301, operates after an interval, locks over the back contacts of relays 343 and 314, and opens the operating circuit through the upper winding

of relay 301. Relay 301 releases and removes the alternating current from conductors 215 and 216 thereby terminating the seizure signal pulse transmitted to the dial end of the trunk.

Referring now to the dial end of the trunk shown in Figs. 1 and 2, the alternating current pulse which has just been discussed above is rectified in the manner previously described and operates relay 207. Ground over the front contact of relay 207, over the upper outer back contact of relay 200, lower inner back contact of relay 205, and over the upper normally closed contacts of relay 202, connects to both upper and lower windings of that relay. This ground extends through the upper low resistance winding of relay 202 and over conductor 133, to the sleeve or test conductor 105 which connects to the bank terminals of the outgoing selector OS, thereby making the dial end of this trunk busy to the outgoing selector. Ground through the lower winding of relay 202 extends through both windings of relay 201 to battery. As hereinbefore set forth, both relays 201 and 202 have their windings connected differentially and do not operate if both of their windings are energized simultaneously. Under the condition just described, therefore, relay 202 operates but relay 201 does not. Relay 202, in operating, locks from ground over its upper inner front contact, through its lower winding and the two windings of relay 201 in series; operates relay 229 in a circuit from battery through the winding and over the back contact of that relay, lower back contact of relay 204, upper back contact of relay 230, to ground over the lower inner front contact of relay 202, and opens the circuit to the winding of relay 109 to prevent the possibility of mutilating a call in the event of a double connection. The operation of relay 202 also places the polarized supervisory relay 126 across the trunk toward the incoming selector. This circuit may be traced from conductor 118, over the upper back contact of relay 109, conductor 116, upper back contact of relay 208, upper outer front contact of relay 202, conductor 136, winding of relay 126, conductor 135, lower inner back contact of relay 208, conductor 117, lower inner back contact of relay 109, to conductor 119. The bridge of the winding of relay 126 placed across conductors 118 and 119 causes the incoming selector circuit IS to function in a manner well known to the art and return a ground on conductor 120. The function of this ground will be discussed subsequently.

Relay 229, in operating as set forth above, operates relay 223 in a local circuit, and also grounds conductor 250 over the lower outer back contact of relay 208. Relay 223, in operating, closes a circuit over its lower outer front contact for maintaining the bridge of relay 126 across conductors 118 and 119 upon the subsequent release of relay 202, operates relay 219 in an obvious local circuit, and also connects ground to conductor 250. Relay 219, operated, establishes a future holding circuit for relay 200 by connecting ground to the upper inner armature of that relay, closes a circuit from ground over its upper middle front contact, over the lower middle back contact of relay 205 and over conductor 134 to the armature of relay 126 for future supervisory purposes, and connects the incoming selector test conductor 120 to the windings of the differential test relay 201. As previously stated, the incoming selector upon being seized returns a ground over conductor 120 which is now connected to the windings of relay 201. Relay 202, which had been operated through its lower winding releases since this lower winding is now short-circuited. The differential test relay 201, which remained released since both of its differentially wound windings were energized, now operates through its upper winding alone, its lower winding being short-circuited together with the lower winding of relay 202.

At the time that conductor 250 is grounded by the operation of relay 229 the polarized relay 233 operates through its upper winding in a circuit to battery through resistance 234. Relay 206 thereupon operates from battery through its lower winding, back contact of relay 238, and front contact of relay 233, to ground previously traced to conductor 250. Relay 206, in operating, short-circuits resistance 220 and places transmission condenser 221 between the left windings of repeating coil 218, and opens the circuit from ground over the front contact of relay 229 to conductor 250, this conductor remaining grounded however from the lower inner front contact of relay 223.

At the termination of the alternating current seizure pulse from the manual end of the trunk relay 207 releases and operates relay 200 in a circuit traceable from ground over the back contact of relay 207, contact 251 of relay 201, conductor 137, lower outer back contact of relay 109, conductor 138, normally closed contacts of the make-before-break contact set of relay 200, and through the winding of relay 200 to battery. Relay 200, in operating, locks under control of relay 219; further opens the operating circuit for relay 109 to prevent the operation of this latter relay in the event of a double connection; and connects ground over its upper middle front contact, conductor 128, back contact of relay 111, to the outgoing selector test terminal conductor 105 as a busy ground to replace the ground which has been connected to conductor 105 through the low resistance upper winding of relay 202 from the front contact of relay 207. The operation of relay 200 also completes a circuit from the front contact of the now un-operated relay 207, over the outer front contact of relay 200, to the winding of relay 204 preparatory to pulsing. The dial exchange end of the trunk is now ready to receive pulses from the manual end, said pulses being transmitted in the manner set forth in the subsequent paragraphs.

Referring again to the manual end of the trunk as shown in Fig. 3, the operator after having inserted plug 328 of cord OC into jack TJ, inserts plug 338 of the dialing cord DC into the dialing jack DJ. Relay 340 of the dialing cord operates from ground over the operated springs of jack DJ and closes a circuit from battery over its front contact, over the normally closed lower, pulsing contacts of dial 341, tip of the dialing cord and tip element and spring of plug 338 and jack DJ, through the winding of relay 334, to ground over the left outer front contact of relay 312. Relay 334 operates in this aforementioned circuit and opens the circuit between the alternating current source 335 and conductors 215 and 216.

When the operator pulls dial 341 in preparation of the dialing of a digit, the upper or off-normal springs of the dial operate and connect ground to the sleeve of plug 338 and jack DJ thereby operating relay 339. Relay 301 now operates in a circuit from battery through its upper winding, over the back contact of relay 317, contacts of relay 339, to ground over the left outer front contact of relay 312. Relay 301, in operating, transfers the trunk conductors 215 and 216 from the left windings of repeating coil 307 to the

windings of retard coils 333 and 344, thereby preparing for the transmission of pulses under control of the back contacts of relay 334. As the dial returns to normal its lower or pulsing contacts open and close for the number of times corresponding to the particular digit dialed. The pulsing relay 334 releases and reoperates for each open pulse of the dial pulsing springs and, since its back contacts close the alternating current circuit, transmits alternating current pulses to the distant dial end of the trunk. At the end of each digit dialed relays 339 and 301 release as the dial off-normal contacts open, but again reoperate for each subsequent digit dialed. The alternating current dial pulses transmitted over conductors 215 and 216 cause the dial end of the trunk to function in the manner set forth below.

Referring again to Figs. 1 and 2, the alternating current dial pulses transmitted from the manual end of the trunk are rectified in the manner hereinbefore described and cause relay 207 to operate and release in response to the pulses. Relay 204 also follows the pulses under control of ground over the front contact of relay 207 and over the outer front contact of relay 200. The first operation of relay 204 opens the short circuit around the winding of relay 230, relay 230 operating in a circuit from the previously traced ground on conductor 250, over parallel circuits one of which extends over the back contact of relay 232, winding of relay 230, upper front contact of relay 229, resistance 231, to battery through the winding of relay 229 which holds. The other branch of the parallel operating circuit for relay 230 extends from the ground on conductor 250, over the lower back contact of relay 237, resistances 235 and 231, to battery through the winding of relay 229. Relay 230, in operating, removes ground from the lower armature of relay 204 and energizes the lower or releasing winding of relay 233 in a circuit from ground over the inner front contact of relay 201 and the upper inner front contact of relay 230 thereby causing relay 233 to release. The operation of relay 230 also provides an additional closure of the loop to the incoming selector since its upper outer front contacts parallel the lower back contacts of relay 236; operates relay 237 in a circuit traceable from battery through resistance 244, winding of relay 237 in parallel with resistance 243, lower front contact of relay 230 to ground on conductor 250; and, in addition, opens the circuit through the upper or non-operate winding of polarized relay 232 and removes the short circuit on condenser 241. Condenser 241 charges through the upper winding of relay 232 and momentarily maintains a flow of current through that non-operate winding. After condenser 241 has partially charged the current through the upper winding of relay 232 decreases to a point where that relay operates on its lower winding which is energized in a circuit from ground over conductor 250, through its lower winding, and through resistance 246 to battery. Relay 237, in operating, performs no useful function at this time. The release of relay 233 operates relay 236 in a circuit from battery through the winding of that relay, over the upper outer front contact of relay 223, back contact of relay 233, to ground over conductor 250. The release of relay 233 also removes the ground from resistance 245 and from the winding of relay 238, relay 238 now operating in a circuit from battery through resistance 245, winding of relay 238, to ground over conductor 250. Relay 236 performs no useful function at this time. Relay 238, in operating, opens the circuit through the lower winding of relay 208. Relay 208 thereupon releases, short-circuiting the left windings of repeating coil 218, and connecting condenser 221, in series with resistance 220, across conductors 116 and 117 to aid in the transmission of pulses to the incoming selector.

When relay 232 operates after condenser 241 is partially charged as set forth above, it opens the circuit through the windings of relay 229 and 230 both of which release. Relay 230, in releasing, opens the circuit through the winding of relay 126 from across conductors 116 and 117 thereby causing a pulse to be transmitted to the incoming selector IS. The release of relay 230 also prepares a circuit for operating relay 229 on the next dial pulse closure, releases relay 237, and opens the circuit through the lower or non-operate winding of relay 233. The release of relay 237 again closes the circuit through the upper or biasing winding of relay 232 thereby causing relay 232 to release. Relay 237, in releasing, also completes a circuit for partly energizing relay 229 so that this relay will operate quickly upon the release of relay 204 in response to incoming pulses. This partial energizing circuit for relay 229 is traceable from battery through the winding of that relay, through resistance 235, and over the lower back contact of relay 237 to ground on conductor 250.

Where the adjustment of the manual operator's dial, such as dial 341, is near or at the lower dial speed limit, i. e., that dial transmits pulses at a slow rate, the period of the opening interval of the pulse transmitted to the incoming selector is timed by the operation of relay 233 which, as set forth above, causes the release of relay 236 which latter relay closes the winding of relay 126 across conductors 116 and 117 to terminate the pulse.

Where the adjustment of the manual operator's dial 341 is at the upper limits of the dial speed, i. e. the pulses are transmitted at a higher rate of speed, relay 233 does not reoperate when once released by the operation of relay 230 on the first pulse and the open interval of the output pulse to the incoming selector is terminated in the following manner: The release of relay 204 reoperates relay 229 and when relay 204 reoperates on the succeeding pulse relay 230 reoperates and closes the circuit through the lower or non-operating winding of relay 233 before relay 233 can operate. The upper outer front contacts of relay 230 close the circuit of the winding of relay 126 across conductors 116 and 117 and thereby terminate the open period of the pulse.

The function of condenser 239 in series with resistance 240 to ground is to slow up the operation of relay 233 in the following manner: When the circuit through the lower or biasing winding of relay 233 is opened the relay would normally operate immediately since its upper or operating winding is energized by the ground on conductor 250. However, condenser 239, which was discharged as long as ground was connected to the lower winding of relay 233, now charges from battery through that lower winding and thereby momentarily maintains a non-operating flow of current through that biasing winding. After condenser 239 has charged to a certain point the current through the lower winding of relay 233 falls below a value at which that winding is effective and relay 233 thereupon operates. Similarly, condenser 241 in series with resistance 242

to ground, performs an identical function in connection with relay 232, maintaining a momentary flow of current through the upper or biasing winding of that relay after the energizing circuit through that winding has been opened and thereby slowing up the operating time for relay 232. The values of condensers 239 and 241, as well as the values of resistances 234, 240, 242 and 246, are so chosen as to provide for the proper operating times for relays 232 and 233 and thereby supply corrected output pulses having the proper percentage open and closed periods per pulse.

When relay 207 releases following the last closed incoming dial pulse, relay 204 also releases. Relay 229 thereupon reoperates from battery through its winding, over its back contacts, over the lower back contact of relay 204, upper back contact of relay 230, to ground over the lower inner front contact of relay 201. Relay 229, operated, again closes the local circuit through the winding of relay 223 to hold this latter relay upon the operation of relay 208 which takes place when the operation of relay 233, following the last incoming dial pulse, shunts down relay 238 which in turn completes the circuit from ground on conductor 250, over the front contact of relay 233, back contact of relay 238, to battery through the lower winding of relay 208.

The incoming selector IS and the connector C function in response to the outgoing pulses transmitted over conductors 118 and 119 and establish connections to the called station B, and cause the bell at that station to ring, in a manner well-known to the art. When the subscriber at station B removes the receiver from the switch-hook the connector circuit C functions and reverses the polarity of the battery and ground which it supplies to conductors 118 and 119 of the trunk circuit. The connector circuit relay supplying this battery and ground and the relay controlling the reversal are not shown since the equipment and operation of a connector circuit are well-known.

Supervisory relay 126 at this time is bridged across the incoming selector in a circuit traceable from the incoming tip conductor 118, upper back contact of relay 109, conductor 116, left upper winding of repeating coil 218, back contact of relay 236, lower outer front contact of relay 223, conductor 136, winding of polarized supervisory relay 126, conductor 135, left lower winding of repeating coil 218, conductor 117, lower inner back contact of relay 109, to the incoming selector ring conductor 119. Relay 126 now operates on this aforementioned reversal of potential from the connector circuit and closes a circuit from battery over the upper back contact of relay 204, winding of relay 203, upper back contact of relay 205, conductor 206, lower back contact of relay 115, front contact of relay 126, conductor 134, lower middle back contact of relay 205, to ground over the upper middle front contact of relay 219.

Relay 203 operates, transfers conductors 215 and 216 from the right windings of repeating coil 218 to the alternating current source 210 through the windings 211 and 212 of a retardation coil, and operates relay 209 which grounds condensers 213 and 214 to reduce the amount of induction to other trunks. The slow-to-operate relay 205, which is energized simultaneously with relay 203, operates after an interval, opens the operating circuit for relay 203 which releases, and operates relay 115 in a circuit from ground over the upper middle front contact of relay 219, lower outer front contact of relay 205, conductor 127, upper normally closed contact and winding of relay 115, to battery through resistance 125. Relay 115, in operating, locks over conductor 132 to ground over the lower outer front contact of relay 219 and opens the operating circuit for relay 205 which releases. Relay 203, in releasing, releases relay 209 and terminates the alternating current pulse transmitted to the manual end of the trunk by transferring conductors 215 and 216 from coil windings 211 and 212 to the right windings of repeating coil 218, thereby also completing the talking connection at the dial end of the trunk. Upon the release of relay 205 its removal of ground from conductor 127 removes the short circuit from the winding of relay 107 which thereupon operates from battery through resistance 124, winding of relay 107, upper front contact of relay 115, to the previously traced ground over conductor 132. Relay 107 performs no useful function at this time.

Referring again to the manual end of the trunk shown in Fig. 3, the pulse of alternating current transmitted from the dial end of the trunk upon the answer of the subscriber at station B as set forth above, operates relay 300 in the manner hereinbefore described. Relay 317 operates in a circuit from battery through resistance 319 and the winding and left inner back contact of relay 317, and over the right front contact of relay 312 and the front contact of relay 300, to ground. The right front contacts of relay 317 short-circuit the lower, high resistance winding of relay 315, thereby allowing sufficient current to flow through the windings of relay 325 of the operator's cord OC to cause relay 325 to operate and extinguish the cord supervisory lamp 326 as an indication to the operator that the called station has answered. At the termination of the alternating current pulse from the dial end of the trunk relay 300 releases and removes the short circuit from the winding of relay 316, relay 316 now operating from battery through resistance 318 and its winding, left front contact of relay 317, to ground over the left inner front contact of relay 312, this same ground also locking relay 317.

The subscribers at stations S and B are now in communication over a transmission circuit identical with that previously traced in connection with the call from station A to station S except that in this instance, since relay 109 is released, the circuit from the left windings of repeating coil 218 extends over conductors 116 and 117, over back contacts of relay 109, conductors 118 and 119, and over the incoming selector IS, connector C and line 123 to the called station B.

When the subscriber at station B replaces his receiver on the switch-hook at the termination of the conversation the connector circuit C functions and reverses the polarity of the potential supplied to conductors 118 and 119, thereby causing polarized relay 126 to release. Relay 203 thereupon operates in a circuit from battery over the upper back contact of relay 204, winding of relay 203, upper back contact of relay 205, conductor 206, lower front contact of relay 115, back contact of relay 126, conductor 134, lower middle back contact of relay 205, to ground over the upper middle front contact of relay 219. Relay 205 is also energized in this circuit but does not operate immediately due to its slow-operating characteristics. Relay 203, operated, operates relay 209 and connects alternating current to con-

ductors 215 and 216 in the manner previously described. When relay 205 operates after an interval, it releases relays 203 and 115, relay 107 remaining locked over the upper back contact of relay 115 to the previously traced ground over conductor 127. Relay 203, released, releases relay 209 and also terminates the alternating current pulse transmitted to the manual end of the trunk. Relay 115, released, releases relay 205 which in turn releases relay 107.

The alternating current pulse from the dial end of the trunk, as described above, operates relay 300 at the manual end of the trunk. Relay 300, operated, short-circuits the winding of relay 317 by ground over its front contact and over the right front contacts of relays 312 and 316. Relay 316 holds to this same ground over the inner back contact of relay 317 as this latter relay releases. Relay 317, released, opens the short circuit on the lower, high resistance winding of relay 315 thereby releasing the cord circuit relay 325. Relay 325, released, relights the cord circuit lamp 326 as a disconnect signal. At the termination of the alternating current pulse relay 300 releases, in turn releasing relay 316.

Plug 338 of the dialing cord DC was withdrawn from jack DJ by the manual operator at the conclusion of the dialing of the wanted number. This resulted in the release of relay 340 of the dial cord and relays 334 and 339 of the trunk. When the manual operator now withdraws plug 328 of her operator's cord circuit from jack TJ in response to the lighted disconnect lamp 326, relays 315, 323 and 324 release. Relay 323, released, releases relay 312 and also completes a circuit from ground over the lower front contact of relay 330, back contact of relay 323, to battery through the lower winding of relay 301, and also over the back contact of relay 337 to battery through the winding of relay 336, thereby operating both relays 301 and 336. Relay 301, operated, connects alternating current to conductors 215 and 216 over a previously traced circuit thereby transmitting a disconnect signal to the dial end of the trunk. This disconnect signal is a long pulse and its length is controlled as follows: Relay 336 operates simultaneously with relay 301 and operates relay 339 to ground over the lower back contact of relay 310. Relay 339 operates relay 338 in a local circuit. The slow-to-operate relay 337 is thereupon energized in a circuit from battery through its winding, over the front contact of relay 338, back contact of relay 323, to ground over the lower front contact of relay 330. Relay 337 operates after an interval, partially closes an operating circuit for relay 343 and locks over its lower front contact and the back contact of relay 323 to ground under control of the lower front contact of relay 330. Relay 337, operated, also opens the operating circuit for the slow-to-release relay 336 which releases after an interval and opens the operating circuit for relay 339. Relay 339 is slow to release and releases after an interval and opens the operating circuit for relay 338. Relay 338, which also has slow-releasing characteristics, releases after an interval and completes the operating circuit for relay 343. This circuit may be traced from battery through the winding of relay 343, over the upper front contact of relay 337, back contact of relay 338, and over the back contact of relay 323, to ground over the lower front contact of relay 330. Relay 335, operated, opens the locking circuit for relay 330. Relay 330 releases, releasing relays 301, 343 and 337. The release of relay 301 disconnects the alternating current from conductors 215 and 216 and thereby terminates the long disconnect pulse transmitted to the dial end of the trunk. All relays at the manual end of the trunk are now released and this end of the trunk is thereby restored to its normal condition. The dial end of the trunk restores, in response to the long disconnect signal pulse just described, in the manner set forth in subsequent paragraphs.

Relay 207 at the dial end of the trunk operates in response to the long disconnect signal pulse and in turn operates relay 204 over a previously traced circuit. Relay 204, operated, removes the ground supplied over the inner front contact of relay 201, the upper back contact of relay 230 and the lower back contact of relay 204, from resistance 231, whereupon relay 230 operates in series with the operated relay 229 and resistance 231, over the back contact of relay 232, to the previously traced ground on conductor 250. Relay 230, operated, operates relays 232 and 237 and releases relay 233 over previously traced circuits. Relay 233, released, operates relays 236 and 238 in the manner hereinbefore set forth. The loop to the incoming selector is maintained over the upper outer front contacts of relay 230. Following the operation of relay 237 relay 232 operates, after an interval controlled by the timing condenser 241 and resistance 242 as previously described, and releases relays 229 and 230. Relay 230, releasing, releases relay 237. Relay 238, operated, releases relay 208. Relay 230, released, opens the loop to the incoming selector. Relay 237, released, again establishes a flow of current through the upper or biasing winding of relay 232 and causes that relay to release. Relay 233 reoperates since the release of relay 230 opens the circuit through the lower or biasing winding of relay 233.

Should relay 126 be operated at the time that the manual end of the trunk disconnects, it will release upon the opening of the loop to the incoming selector by the release of relay 230. The release of relay 126 cannot falsely operate relay 203 at this time, however, since the operating battery for relay 203 is opened by the operated relay 204. The function of resistance 243, which is connected in parallel with the winding of relay 237, is to make relay 237 somewhat slow in releasing to insure the release of relay 229 before the release of relay 232.

Relay 233, reoperating as set forth above, short-circuits the winding of relay 238 which releases and reoperates relay 208 through the lower winding of that relay over a previously traced circuit. Relay 208, operated, opens the locking circuit for relay 223 which thereupon releases, in turn releasing relays 219 and 233. The release of relay 233 opens the circuit through the lower winding of relay 208 which thereupon releases.

The loop across the incoming selector IS having been opened by the release of relay 230, that selector releases and removes the ground from the sleeve conductor 120 thereby releasing relay 201. Following the release of relay 219, relay 200 remains locked over the back contact of relay 219 to ground over the front contact of relay 207. Relay 204 also remains operated but is ineffective since the release of relay 201 has removed the ground from the lower armature of relay 204. Relay 200, remaining operated, maintains the busy ground on the outgoing selector test terminal associated with this trunk in a circuit traceable from ground over the upper middle front contact of relay 200, over conductor 128, and over the

back contact of relay 111, to test conductor 105 of the outgoing selector terminal bank. When relay 207 releases at the termination of the long disconnect signal pulse it releases relays 200 and 204 and thereby restores the dial end of the trunk to normal.

Should the outgoing selector OS seize this trunk after the trunk has been taken up for use by an operator at its manual end but before the busy ground has been connected to the outgoing selector test conductor 105 by the operation of relay 207, relay 106 will operate over the loop of station A. Relay 106, operated, operates relay 108 which in turn operates relay 111. Relay 113, however, does not operate under this condition since its operating circuit is open at the lower back contact of relay 223. The relay 223 is energized as above explained by the operation of relay 220, which in turn is operated over a circuit closed at the front contact of differential relay 202. Also as above explained the relay 202 is operated over a circuit closed at the front contact of relay 207 in response to the incoming seizure impulse. Since relay 113 remains deenergized at this time the impulse circuit from the impulse relay 106 is held open, and the calling subscriber is prevented from transmitting impulses of alternating current from the source 210 over the trunk circuit toward the distant end. Relay 202 in operating as the result of the incoming seizure impulse opens the operating circuit of relay 109. This prevents the extension of the subscriber's line 100 to the conductors 116 and 117 of the outgoing trunk which has been seized at the distant end. Relay 219 is also operated at this time from ground over the upper inner front contact of relay 223. With relays 111 and 219 operated a tone is connected to the outgoing selector and is transmitted back to the calling dial subscriber as a busy indication. The circuit for this tone may be traced from battery through the tone interrupter 247 to ground through the right winding of transformer 249 from which point it is induced in the left winding of that transformer and is extended in a circuit through condenser 248, upper outer front contact of relay 219, over conductor 130, lower outer front contact of relay 111, to the ring conductor 104 extending towards the subscriber at station A through the outgoing selector OS and line finder LF.

When the subscriber at station A, upon recognizing the busy signal as an indication to disconnect and initiate another call, replaces the receiver on the switch-hook, relay 106 releases. Relay 108 thereupon releases, in turn releasing relay 111. During the releasing time of relay 111, which is a slow-to-release relay, the ground is removed from conductor 105 to permit the release of the outgoing selector and line finder circuits. After relay 111 has released, the busy ground is again connected to conductor 105 in a circuit traceable from the conductor, over the back contact of relay 111, conductor 128, to ground over the upper middle front contact of relay 200 which has since operated at the termination of the seizure pulse transmitted from the manual end of the trunk in the manner hereinbefore described. From this point on the call originating at the manual end of the trunk is completed in the manner identical with that described for the connection established from station S to station B.

Conductor 217 extends to a traffic register circuit (not shown) which records the number of calls made over this trunk. The traffic register (not shown) is normally operated and the recording of a call is accomplished by the removal of ground from conductor 217 once per call, thereby causing the register to release and reoperate and thus record one call. It will be noted that conductor 217 is normally grounded over the lower outer back contact of relay 205 and the inner back contact of relay 201. On outgoing calls relay 201 does not operate but relay 205 operates once, during the transmission of the seizure signal to the manual end of the trunk, and thereby opens the circuit over conductor 217 and causes the call to be recorded. On incoming calls the opening of conductor 217 is under control of relay 201 which operates once per incoming call. Relay 205, which operates several times per incoming call, has no effect on traffic registration in this instance since relay 201 operates before the first operation of relay 205 and remains operated until after relay 205 has released for the last time, thereby insuring that the traffic register circuit is ungrounded only once per incoming call.

What is claimed is:

1. In a telephone system, lines, a set of terminals including a test terminal, a two-way trunk terminating in said terminals, a test relay for said trunk, a test circuit including a winding of said relay and said test terminal, connecting means for extending a calling line into connection with said terminals on an outgoing call without operating said test relay, means under control of said relay for operatively connecting the extended line to said trunk, means controlled over said line for sending signals to the distant end of the trunk, means for sending a signal over the trunk in the opposite direction when seized at the distant end, and means responsive to said incoming signal for operating said relay to disable a connection that is in the act of seizing the trunk on an outgoing call.

2. In a telephone system, lines, a set of terminals including a test terminal, a two-way trunk terminating in said terminals, a test relay having differential windings thereon, a test circuit including the windings of said relay and said test terminal, automatic switches for extending a calling line into connection with said terminals on an outgoing call and for closing the test circuit through the windings of said relay, said relay remaining deenergized because of its differential character, circuit means controlled by said relay in its released condition for operatively connecting the extended line to said trunk, means controlled over said line for sending signals over the trunk to the distant end, means for sending a signal over the trunk in the opposite direction when the trunk is seized at the distant end, and means responsive to said signal incoming over the trunk from the distant end for operating said differential relay to prevent an outgoing call from being extended over the trunk line.

3. In a telephone system, an exchange, a two-way trunk line outgoing from said exchange to a distant point, means for seizing said trunk at either end for extending a connection thereover to the opposite end, means responsive to the seizure of said trunk at the distant end for sending a signal of alternating current to cause the trunk to be guarded at said exchange against seizure, and a differential relay at said exchange responsive to said incoming alternating current signal to prevent the extension of an outgoing call over said trunk in the event both ends of the trunk are seized at the same time.

4. In a telephone system, lines, a set of terminals including a test terminal, a two-way trunk terminating in said terminals, a test relay for said trunk, a test circuit including the winding of said relay and said test terminal, automatic means for extending a calling line into connection with said terminals on an outgoing call without operating said test relay, means dependent upon the released condition of said test relay for connecting the extended line to said trunk, means for seizing said trunk at the distant end, means responsive to the seizure of said trunk at the distant end for operating said test relay to prevent the connection of said extended line to said trunk on an outgoing call, and means controlled by said test relay for sending a tone current over said extended line.

5. In a telephone system, an operator's position, a trunk terminating at one end at the operator's position, a call lamp for said trunk, a cord circuit at said position for making connection with said trunk, a supervisory lamp for said cord, means for seizing the trunk at the distant end to extend a call to the operator, means responsive to such seizure for sending a signal over the trunk to cause the lighting of said call lamp, means controlled over the trunk to operate said supervisory lamp when the trunk is released at the distant end, means effective in the event of a reseizure of the trunk before the operator disconnects for receiving the signal sent as a result of such reseizure without affecting said supervisory lamp, and means including said signal receiving means for lighting said call lamp when the operator disconnects from the trunk.

6. In a telpehone system, a trunk terminating at one end at an operator's position, a call lamp for said trunk, a cord circuit at said position for making connection with said trunk, a supervisory lamp for said cord, automatic switches for seizing the trunk at the distant end to extend a call to the operator, means responsive to such seizure for sending a signal of alternating current over the trunk to cause the lighting of said call lamp, means controlled over the trunk to operate said supervisory lamp when the trunk is released at the distant end, means effective in case the trunk is reseized at the distant end before the operator disconnects for receiving the alternating current signal sent as a result of such reseizure, and means controlled by said signal receiving means for lighting said call lamp when the operator disconnects from the trunk.

7. In a telephone system, an operator's position, a trunk terminating at one end in a jack at the operator's position, a call lamp for said trunk, a cord circuit at said position for making connection with said trunk, a supervisory lamp for said cord, automatic switches for seizing the trunk at the distant end to extend a call to the operator, means for sending an alternating current signal from the distant end when said trunk is seized by said switches to cause the lighting of said call lamp, means for sending an alternating current signal over said trunk to the distant end when the operator inserts the plug of her cord circuit in the trunk jack, means for lighting said supervisory lamp as a disconnect signal, means effective in case the trunk is reseized at the distant end before the operator disconnects her cord circuit therefrom for receiving the alternating current signal without affecting the call lamp or the supervisory disconnect lamp, and means controlled by said signal receiving means for lighting the call lamp when the operator disconnects from the trunk.

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