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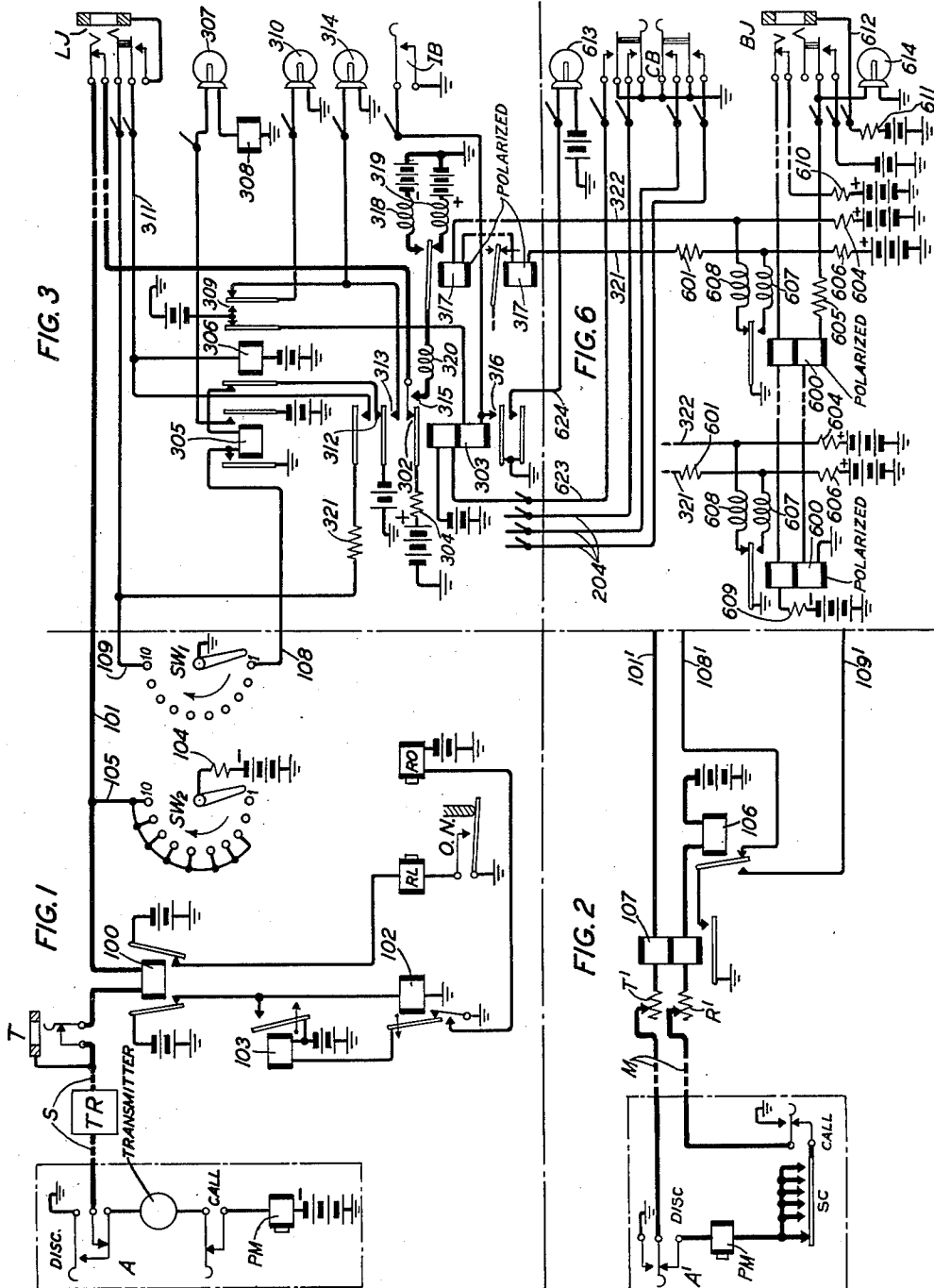
C. C. LANE ET AL

1,979,273

TELEGRAPH EXCHANGE SYSTEM

Filed Aug. 30, 1932

2 Sheets-Sheet 1



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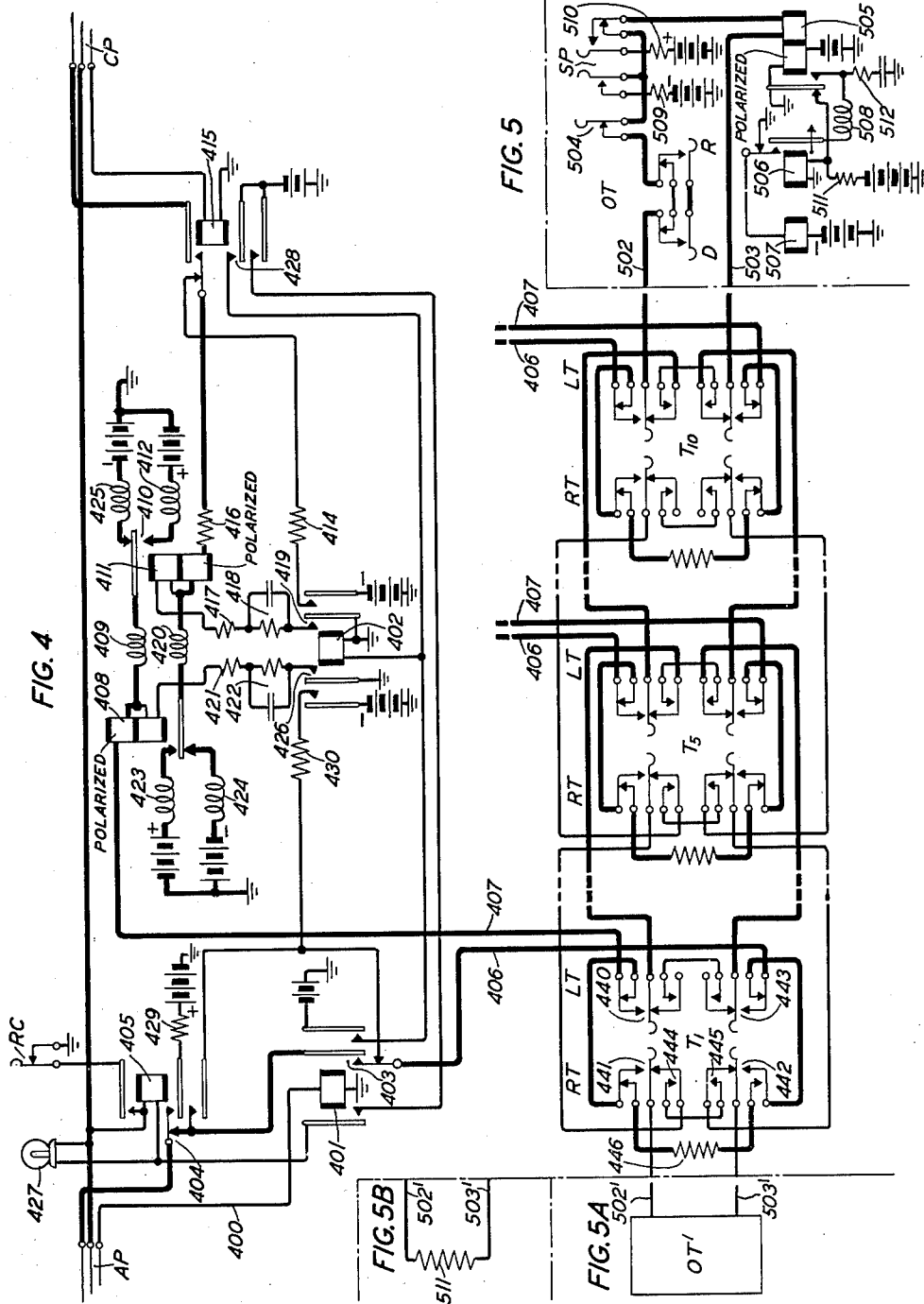
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1,979,273

TELEGRAPH EXCHANGE SYSTEM

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Application August 30, 1932, Serial No. 631,016

22 Claims. (Cl. 178—2)

This invention relates to teletypewriter switching circuits of the manually operated type employing link circuits preferably in the form of cord circuits for interchangeably connecting subscribers' lines and supervising inter-subscriber connections set up over them.

Features of the invention are:—

The use of a novel arrangement for preventing false calls at the central office by making it necessary that the subscriber open the line for a predetermined time before a signal is given the operator.

The use of separate busy indications on simple connections and broadcasting connection.

Arrangements for preventing false disconnect signals by preventing a disconnect signal being given until the line has been opened a predetermined time.

A cord circuit arrangement which will function with both grounded and metallic lines.

The use of a single cord circuit in combination with other devices for repeating into a plurality of lines for broadcast purposes.

The use of a cord circuit with a telegraph repeater comprising two relays.

An arrangement whereby after one station gives a disconnect signal the operator may continue to communicate with other subscribers or other subscribers on the circuit with each other.

Devices for preventing the operator's printer set motor running idle when not connected to a busy cord.

Acknowledgment is made that the system disclosed in Locke-Kinhead application Serial No. 459,684, filed June 7, 1930 was invented prior to the invention of the system herein described.

One object of the invention is to provide a simplified arrangement more effective, especially in the case of small installations, than that of the said Locke-Kinhead application.

This system is designed primarily to provide exchange service for connections between teletypewriter stations in police signal systems and in industrial plants where the stations are located at nearby points, or for connecting the stations with others at great distances, as branch offices in other parts of the country. In the case of connections at a distance connecting lines or cables are assigned permanently as interconnecting toll lines.

General description

In a typical case a teletypewriter switchboard in accordance with the invention has a capacity of about forty lines and is operated in a manner

analogous to a manual private branch exchange telephone switchboard. Jacks and call and busy lamps for all lines appear in the board before an operator. Cord and disconnect lamps are mounted in the keyshelf. Either one-way or two-way communication may be carried on by the subscriber and operator depending on whether the outlying station is equipped with a sending or with a receiving only typewriter. Two operators' teletypewriters are provided, one on either side of the switchboard arranged to be connected to any one of the cord circuits by means of a two position "typing" key thus permitting either operator to complete a connection.

Broadcasting jacks, common broadcast keys and acknowledgment lamps are located adjacent the line jacks on the face of the board for enabling the operators to send or broadcast messages to all stations simultaneously, or for enabling one station through one of the cord circuits to broadcast to all other stations. The broadcast may also be confined to any number of desired stations by operating a broadcast key individual to the line desired instead of the key common to all lines as above. This key together with call, busy and broadcast busy lamps is associated with the line jacks in the face of the switchboard. An audible signal is provided when the board is unattended and may be cut into use by operating a key located at the right of the jacks in the face of the board.

When more lines are required, two switchboards may be provided with the lines divided between them. This results in two separate installations with one operator's teletypewriter located between the two switchboards and arranged to connect to the cords of either board in a known manner. The station line and broadcast circuits in such case are multiplied to the second switchboard without additional equipment other than the second appearance of the lamps and keys.

In the accompanying drawings:—

Fig. 1 represents a teletypewriter station indicated at A connected over a toll line and telegraph repeater equipment to certain line equipment at the central office. The telegraph repeater, shown diagrammatically, may be of the type disclosed in the patent to J. M. Fell No. 1,479,430, issued January 1, 1924. For the purpose of this invention, however, the station equipment at A might equally well be replaced by toll line equipment of any well known variety located at the position of some other exchange operator.

Fig. 2 represents a metallic line circuit of a type commonly used for local or short line station working.

Fig. 3 represents additional individual line equipment to which the circuits of Figs. 1 and 2 may be connected, the jacks, lamps and keys of which appear before the operator. Relays 303 and 317 in this circuit function only on messages that are broadcast to the branch stations and do not enter into the operation when the station makes a call to another station.

Fig. 4 represents the operator's cord circuit shown, consisting of supervisory relays 401, 405 and 415 and telegraph repeater relays 402, 408 and 411, used by the operator in completing a connection from one branch line to another, or for sending a broadcast message to a number of lines from the operator's printer OT of Fig. 5 or OT' of Fig. 5A.

Fig. 5 shows the operator's teletypewriter circuit arrangement, designated as OT, connected through various individual cord circuit typing keys T1, T5 and T10. The wiring of the keys is so arranged that operating any key to the LT position connects the main telegraph channel of the associated cord to the operator's set OT, whereas if the key is thrown to the RT position, it is connected to a similar operator's set OT' of Fig. 5A. When set OT only is provided, the maintaining circuit of Fig. 5B is used in place of the set OT'.

Fig. 6 shows a circuit organization common to all line circuits, which, when controlled by the operator's cord circuit, makes it possible to transmit or broadcast a message to selected stations, or to all stations simultaneously. In this figure a number of polarized relays are placed in series and respond to spacing and marking signals of the broadcast from the cord circuit. Each relay in turn reproduces these signals in a number of line relays in Fig. 3 also connected in series, each of which controls the impulses in the individual line. The broadcast message from the cord circuit is in this way transmitted to each line individually. As indicated on the drawings, the jack, key and lamp may be multiplied to more than one operator, when required.

The teletypewriter machines of the subscribers are of a known type in commercial use provided with mechanism by which the reception of a code combination causes the driving motor to start and remain in operation until stopped locally or by the reception of a special "upper case" code combination when it is stopped and remains stopped. Alternatively the motor of the subscriber's machine may be started and locked in operating position by any short line interruption.

Originating a call

Assuming now that station A desires to communicate telegraphically with a similar station at some remote point. The station "call" key would momentarily be depressed which opens the normally closed main circuit traced from negative battery through the station, line S and repeater TR, test jack T, relay 100 and lead 101 of Fig. 1, through contact of jack LJ of Fig. 3, contact 302 of relay 303 and compensating resistance 304 to positive battery. This causes relay 100 to release, opening the circuit of slow-release relay 102 which upon release, closes a ground circuit for the stepper magnet RO. Operation of this magnet causes the brush arms to move forward one step, arm SW₂ having no

function at this time and arm SW₁ connecting ground to switch terminal 1 and lead 108 for operating relay 305 of Fig. 3 over a path traced through the left break contact of relay 306 and contact 312 of relay 303 to battery. Relay 305 operates and provides a locking ground for itself at its left make contact, while at its right contact it connects battery to the calling lamp signal 307 in series with an auxiliary audible signal 308. Signal 308, not shown in detail, as is well known, is an auxiliary signal and may be disconnected by a key whenever the audible feature is not desired. Referring again to the release of relay 102 and the operation of the stepper magnet, it will be observed that the circuit for slow-release relay 103 is also opened by the release of relay 102 causing it to release and in turn operate relay 102 to release rotary magnet RO and reoperate relay 103, again releasing relay 102, causing the stepper switch to take another step. This sequence of operation continues until the relay 100 again operates at which time battery at its right contact is connected through release magnet RL and switch off-normal contact ON which is operated at this time, thus restoring the switch to normal. This action of stepping the switch beyond terminal 1 has to do with giving a disconnect signal which will be described later and has no function in calling. The switch may reach terminal 10 before relay 100 again operates but no further circuit change results.

The operator upon observing the calling lamp signal 307 answers with the cord circuit shown in Fig. 4, by inserting the answering plug AP in line jack LJ with which the lamp signal is associated. A circuit is thus closed in Fig. 3, from main battery through relay 306, sleeve lead 311, jack contact and plug sleeve to lead 400 of Fig. 4 and thence through sleeve relay 401 to ground. Relays 306 and 401 both operate. Relay 306 at its left contact opens the circuit for relay 305 causing it to release and put out lamp 307 and at contact 309 it applies main battery to light line busy lamp 310. Relay 401 of Fig. 4 upon operating closes at contact 403 the main circuit traced from tip of plug AP through normal contact 404 of relay 405, contact 403 of relay 401, and lead 406 to the associated cord typing key T1. If the key is normal the circuit is traced through its normally made contacts and back on lead 407 through top winding of polarized relay 408 thence through choke coil 409, contact 410 of polarized relay 411, choke coil 412 to positive battery (relay 411 having operated upon operation of relay 402 as described in next paragraph). It should be noted here that the circuit just traced replaces the positive battery supply normally provided in the line circuit of Fig. 3 through resistance 304, contact 302 of relay 303, due to the opening of the break contact on the line jack LJ when the plug was inserted.

Referring again to the operation of relay 401, a circuit is also closed at its right contact for operating relay 402 which places the repeater element of the cord consisting of relays 408 and 411 in a position to repeat the marking and spacing signals to the called line. This will now be described. The right contact of relay 402 closes negative battery for operating relay 411 traced through resistance 414, normal break contact of relay 415, regulating resistance 416, lower and upper windings of relay 411, in series, 150

artificial line resistances 417 and 418 and contact 419 of relay 402 to ground. The current through resistance 417 opposes but is only one-half the value of current through the resistance 416 in consequence of which the relay 411 will operate to marking position. At the front contact 410 of relay 411, positive battery through choke coil 412 will thus be connected through choke coil 409 to the midpoint of the windings of relay 408 causing it to operate on its top winding over the main teletype channel connected to negative battery at the subscriber's station. The path through the bottom winding of relay 408, artificial line resistances 421 and 422 and contact 426 of relay 402 to ground sets up a biasing current opposite in effect to the line current in the top winding but does not prevent relay 408 from operating since the artificial line resistances are designed to make the current flow in this path one-half the line current. Relays 408 and 411 thus remain operated for the repeating of telegraph signals as will be later described.

Plug AP having been inserted in jack LJ, the operator now throws typing key T1 to the LT position which connects the operator's teletypewriter OT over leads 502 and 503 to the associated cord through the normal contacts on all other cord circuit keys T5 and T10 in series, contacts 440 and 443 of key T1 to leads 407 and 406, respectively, of the cord circuit, shown in Fig. 4. The loop through leads 502 and 503 in the operator's set OT of Fig. 5 includes the break contacts on disconnect key "D" and recall key "R", sending contact 504, break contact on splitting key S and right winding of polarized relay 505. Current over the main teletypewriter channel between the subscriber's and cord circuit repeater relays, thus flowing through relay 505 causes it to operate and remove the short circuit from relay 506 allowing it to operate. Relay 506 through its operated contact then closes a path from negative battery on printer magnet 507 through choke coil 508 and make contact of relay 505 to ground. Relay 506 being slow to release continues to maintain the circuit for the printer magnet just described leaving the polarized relay 505 free to follow the telegraph signals and register the message on the operator's printer. The operator at sending contact 504 now transmits any code combination or short line interruption to start the calling station teletypewriter and requests the number of the line to which the station desires to be connected. The above description assumes a switchboard equipped with a single operator's set OT in which case the resistance 511 of Fig. 5B is also used to complete the loop between leads 502' and 503' to prevent the telegraph channel being opened in case a typing key should be thrown falsely to the RT position. The above description, however, applies equally well to switchboards equipped with two operators' sets OT and OT' of Fig. 5A. In this case the Fig. 5A is used in place of Fig. 5B and thus permits the cord circuit typing keys to be thrown either to the LT or RT position and enable either operator OT or OT' to take the call as would be required for teamwork or light load conditions at the switchboard.

Completing a call to another subscriber

For the purposes of this description it may be assumed that all lines in the exchange have

the same line circuit as shown in Fig. 3 so that the operator upon receiving the number of the called line from the calling subscriber, inserts the calling plug CP into the jack LJ of the called line, unless the line is busy as indicated by the associated busy lamp 310. This action on the part of the operator closes a circuit at the local make contact on the jack LJ through the windings of relays 306, Fig. 3, and relay 415 of Fig. 4, causing both to operate. The operation of relay 306 at contact 309 lights the associated busy lamp 310, while relay 415 at contact 428 maintains the main battery supply circuit for holding relay 402 operated and at its top make contact closes the main teletype channel to the called subscriber over a path traced as follows: starting from positive battery through choke coil 423, operated contact and armature of relay 408, thence through choke coil 420, lower winding of relay 411, resistance 416, top make contact of relay 415 and through the tip of the plug and jack over lead 101, through relay 100, contact of test jack T, and line S to negative battery at the called station. It will be noted that negative battery from the subscriber's station is thus connected to the lower winding of relay 411 in place of the negative battery through resistance 414, thereby continuing to hold relay 411 operated. A complete circuit from station A is thus established to a similar station A through the repeater relays in the operator's cord circuit. The operator upon inserting the plug in the jack of the called line sends a character signal or a short line interruption by means of break key 504 for starting the called station teletypewriter, and if desired, a special code combination for operating a signal bell at the station. When the operator is satisfied the calling and called parties are in communication, as indicated by the message recorded on his own printer, the typing key T1 is restored to normal thus leaving the subscribers connected through the repeater relays of the cord circuit. The release of the typing key renders the operator's teletypewriter inoperative due to breaking the circuit through relay 505 which upon release opens the circuit for relay 506, causing ground to be connected to the printer magnet 507 which stops it from running free.

Communication between subscribers

The way in which telegraph signals are transmitted from one subscriber to another will now be described. In sending signals from calling station A, the operator intermittently opens the normally closed main teletype channel. On the first spacing signal relay 408 releases due to the reverse flux in the lower winding with the upper winding open. Positive battery through choke coil 423 is therefore removed from the teletype channel leading to the called subscriber's station and in its stead negative battery through choke coil 424 is connected. This produces the effect of an open circuit because negative battery meets negative battery in the called subscriber's station. Under this condition repeater relay 411 remains operated due to negative battery through choke coil 424 being connected to the junction of the windings on relay 411 which reverses the current flow in the upper winding through artificial line resistances 417 and 418 and contact 419 of relay 402 to ground. The flux in upper winding is

thus in the same direction as the previous flux in the lower winding and prevents relay 411 from releasing. When the marking signal is sent, current through the upper winding again operates relay 408 by overcoming the flux in the lower winding. A similar action occurs when the called station is sending. The opening of the line in this case causes relay 411 to release due to the open circuit through the lower winding and the biasing circuit through the upper winding. Relay 411 at its back contact therefore connects negative battery through upper winding of relay 408 to the calling station negative battery which gives the effect of an open circuit. Relay 408 remains energized at this time due to negative battery through choke coils 425 and 409 being connected to the junction of the two windings of relay 408 to ground which reverses the current flow in the lower winding through artificial line resistances 421 and 422 and contact 426 of relay 402 to ground. When a marking signal is sent by the called station, relay 411 reoperates to restore positive battery to the calling station. During the transmission of these signals, relay 100 in the line circuits may or may not operate, but if it does, relay 102 being slow to release, remains energized and the selector switch remains normal.

In connection with a repeater of this kind, the radiation of energy from the intermittently operating contacts may severely interfere with the operation of the radio broadcast receivers or short wave receiving equipment located nearby. Choke coils 409, 412, 420, 423, 424 and 425 are accordingly shown as devices for suppressing radiation and are used in conjunction with contact protecting condensers and resistances located across the front and back contacts of relays 408 and 411, not shown, for suppressing the radiation.

Station disconnect

When the communication between two stations is ended, either the calling station or called station causes disconnect lamp 427 associated with the cord circuit of Fig. 4 to light indicating to the operator that the connection is to be taken down. The calling station does this by operating key "Disc.", which mechanically holds the line open for an interval of five seconds. The release of the line relay 100 of Fig. 1 releases relay 102 causing ground to be connected to the rotary magnet RO thereby advancing the stepper switch one step. As described in connection with originating a call, alternate release and operation of the relays 102 and 103 continue to step the switch around until terminal 10 is reached. Ground then placed on terminal 10 by the arm SW₁ energizes relay 405 and lights lamp 427 in the cord circuit of Fig. 4 over a path extending from terminal 10, lead 109, ring side of jack LJ and plug AP to relay 405 and lamp 427, battery for operating this circuit having previously been connected over a path traced from bottom contact of sleeve relay 415, left contact of answering sleeve relay 401 to the other side of relay 405 and lamp 427. The relay 405 provides a locking ground for itself at its upper make contact at release key RC which prevents its release when the disconnect key at the calling station closes again causing relay 100 to reoperate and energize the stepper magnet RL for restoring the selector switch to normal. Referring again to the operation of the stepper switch, it should be noted

that during its rotation, the circuit is closed by switch arm SW₂ beginning at the third terminal from negative battery through resistance 104 to lead 105, main channel lead 101, thence through jack LJ and plug AP and cord circuit repeater relays 408 and 411 to positive battery. This circuit on a disconnect between two local stations performs no useful function but on a disconnect between a local station and a toll line, it acts as a substitute for the negative battery supply of the calling station to close the repeater and toll line circuit to which the called end of the cord may be connected and prevent the local disconnect signal from being retransmitted. The operation of relay 405 previously described also opens contact 404 to connect positive battery through resistance 429 to the calling station channel and at its bottom contact maintains a closed circuit for the main teletype channel toward the repeater relays 408 and 411 traced from negative battery through left make contact of relay 402, resistance 430 and lower make contact on relay 405 to positive battery through the repeater relays 408 and 411.

The operator upon noting the disconnect signal again operates the typing key to associate the operator's teletypewriter OT with the cord circuit to send a stop signal code combination from the keyboard to the called station. The impulses of this signal are repeated over the repeater elements in the cord circuit and are sent out over the called line to stop the teletypewriter motor at the called station, but do not affect the calling station due to the channel being cut at relay 405 as described above. The operator now withdraws plug CP from the jack of the called line which releases relay 415 opening at contact 428 the locking circuit of relay 405 and extinguishing disconnect lamp 427. Relay 405 in releasing re-connects at contact 404 the calling station to the main channel through the operator's set OT and repeater relays 408 and 411. It will be further noted that the main channel from the repeater relays to the calling plug CP at this time is closed by the top make contact on relay 415 which was released on withdrawal of the calling plug CP. The operator now sends a stop signal to stop the teletypewriter at the calling station, withdraws plug AP from the line jack and restores the typing key thus returning all equipment to normal.

Trunk circuit connection

The establishment of a trunk circuit connection is essentially the same as described above for a local connection except for a difference in the supervisory features at the operator's set OT which will now be described. Referring to Figs. 1 and 3, the calling subscriber operates the "Call" key to signal the central office. The operator at the central office responds by plugging the cord of Fig. 4, to which the operator's set OT is connected through key T1, into the LJ jack of the calling line and obtains the necessary information in regard to the connection wanted. The operator then proceeds to set up the desired connection by plugging the calling end of the cord into the jack of a toll line and after operating the splitting key SP in Fig. 5 operates the break key 504, thereby opening the line for a short interval of about two seconds and causing a line signal to light at the distant office. The toll line in this case may be assumed to terminate at the local end in equipment similar to that of

Figs. 1 and 3 and may be assumed to terminate at the far end in apparatus which, among other functions, responds to such a short break signal in a manner similar to that of Figs. 1 and 3.

5 The operation of the splitting key SP just referred to connects the first operator's teletypewriter OT to the toll line over a path extending from negative battery through resistance 509, left operated contact of key SP, sending contact 504, normal contacts of keys R and D and
10 lead 502 to contact 440 of typing key T1 associated with the cord circuit of Fig. 4, thence over lead 407 and upper winding of relay 408, choke coil 409, to positive battery at the front contacts of relay 411. Signal impulses in this
15 circuit are repeated to the toll line channel over a path extending from positive battery through choke coil 423 and front contact of relay 408, choke coil 420 and lower winding of relay 411, resistance 416, top operated make contact of relay 415 and tip lead of the plug and jack circuit to lead 101 of the toll line. At the right
20 operated contact of splitting key SP, Fig. 5, positive battery through resistance 510 and polarized relay 505 is connected to the calling subscriber's teletypewriter channel over lead 503, contact 443 on typing key T1, lead 406, contact 403 of relay 401 and contact 404 of relay 405, thence to the calling station. The operation
30 of the break key of the teletypewriter momentarily opens the toll line causing a calling signal to light at the distant office. This break in the circuit, however, is not transmitted to the calling subscriber due to the splitting key SP being
35 operated.

When the distant operator answers by connecting his teletypewriter to the line, the first operator passes the necessary information for enabling the distant operator to complete the
40 call to the station wanted and then restores the splitting key SP to normal. With the splitting key normal, the calling subscriber's line will be connected to the toll line in series with the first operator's printer and the communication received on the operator's printer will indicate
45 when the connection has been properly established. The operator then restores the typing key T1 which disconnects the operator's printer from the circuit and leaves the cord circuit repeater relays of Fig. 4 connected between the
50 calling subscriber and the distant subscriber.

Recall on toll lines

55 The calling subscriber may wish to request a change in the toll line connection in which case the "Disc." key is operated causing relay 405 to operate and light the disconnect lamp of the cord circuit 427 in front of the operator as previously described for disconnecting after the
60 completion of a local call. It should be noted here that the five-second open interval caused by the subscriber's "Disc." key is not transmitted to the toll line due to the path in Fig. 1 from negative battery through resistance 104 and
65 switch arm SW₂ being connected over lead 105 to the main teletype channel. The operator now associates his printer OT with the cord circuit by operating typing key T1 and reconnects the calling station channel by operating
70 recall release key RC of the cord circuit which releases relay 405 and puts out lamp 427. The operator challenges and upon learning that another station is wanted at the distant exchange, for example, operates the splitting key and sends
75 a recall signal to the distant operator by operat-

ing recall key R. The key R is arranged so that the line is held open for a period of seven seconds causing a recall signal to light before the distant operator who then answers and changes
80 the connection to the desired station. The first operator again restores the splitting key and after noting from his own printer that the connection is completed, restores the key T1 to normal leaving the two subscribers connected
85 through the repeater of the cord circuit.

Toll line disconnect

At the end of the communication, the calling subscriber operates the "Disc." key to light the disconnect lamp 427, and the operator challenges
90 as described above in the case of a recall. The operator finding the connection is to be taken down first sends a character signal to the calling line to stop the subscriber's motor, then withdraws the plug AP from the calling line jack.
95 A disconnect signal is then sent to the distant operator by operating the disconnect key D which opens the main channel for ten seconds and lights a disconnect lamp before the second operator. The first operator now withdraws the
100 calling plug CP from the toll line and restores the typing key T1. It is sufficient for the purposes of the present invention to assume that a toll line terminates at a distant point in devices which will discriminate between the seven and
105 ten second interruptions of the line circuit for the purposes of giving to an operator recall and disconnect signals respectively. The operation of the devices which accomplish these results does not react back upon the devices herein described.
110 Such toll line terminating equipment is disclosed in a copending application of F. S. Kinkead and G. A. Locke, Serial No. 704,380, filed Dec. 29, 1933.

Metallic line connection

115 In the case of short subscriber loops, the station teletypewriter is connected to the metallic line circuit without going through toll circuit repeaters. This is shown in Figs. 2 and 3. The
120 main teletype channel in this arrangement includes a normally closed loop extending from negative battery through relay 106 of Fig. 2, lower winding of relay 107, and compensating resistance R', over one side of line M, through
125 the A' station "Call" key, sending contact SC, printer magnet PM and "Disc." key, back over the other side of line M, compensating resistance T' and upper winding of relay 107, lead 101', break contact of jack LJ of Fig. 3, contact 302
130 of relay 303, resistance 304 to positive battery. This circuit maintains relay 106 operated and relay 107 in a non-operated condition due to the differential action of its upper and lower windings. Now, when the station A' originates
135 a call by operating the "Call" key, relay 107 releases due to the circuit being open through the upper winding and to closure of ground from the "Call" key through the lower winding and relay 106 to negative battery. Relay 106
140 remains operated while relay 107 closes at its front contact a ground for the operation of relay 305 of Fig. 3 traced through the operated front contact of relay 107, lead 108', winding of relay 305, left back contact of relay 306, and contact 312 to main battery. Relay 305 closes a locking
145 circuit for itself at its left contact and at its right contact lights the calling lamp 307. When the station call key is released, the channel is again closed restoring relay 107 to normal and
150

leaving relay 106 operated. From this point on the operation is as described above for the single line circuits of Figs. 1 and 3. When the connection is ready to be taken down station A' sends a disconnect signal by operating the "Disc." key which momentarily opens the loop and connects ground to the upper side of the line M, causing relay 106 to release and relay 107 to operate over its upper winding to positive battery at the front contact of repeater relay 411 in the cord circuit of Fig. 4. With relay 106 released and relay 107 operated, ground contact of 107 is connected through the back contact of relay 106 over lead 109' to the ring of the jack LJ and associated plug AP of the cord in Fig. 4 to relay 405 and lamp 427. The operation of relay 405 and the lighting of lamp 427 occurs and the operator proceeds to stop the calling subscriber motor and pull down the cord plug, all as previously stated for the operation of a station disconnect. The resistances T' and R' shown in the sides of the line M of Fig. 2 are adjustable in order to maintain a specified line current for varying lengths of line and provide for more uniform operation of the telegraph apparatus.

Broadcasting.

As previously mentioned, the exchange system disclosed herein provides for sending broadcast messages to any number or all of the stations of the system simultaneously. Broadcast connections may be established wherein the operator makes the broadcast to any or all stations of the private branch exchange. Broadcast connections may be established in which one of the stations sends the broadcast to any or all other stations. Broadcast connections may be established in which the operator at one exchange sends a broadcast over a tie line to any or all of the stations in a second exchange. Finally, broadcast connections may be established in which one of the stations of one exchange may be broadcast over a tie line to any or all of the stations connected to a second exchange.

Broadcast connections of the first type in which the operator broadcasts the message to all stations of the private branch exchange are established by the operator inserting the answering plug AP of an idle cord, Fig. 4, into jack BJ of Fig. 6. The cord circuit in this case functions just as it would on a station to station call so that upon insertion of the plug closure of the sleeve circuit 400 causes relay 401 to operate from main battery through resistance 611, in turn operating relay 402. Relay 402 in operating causes repeater relays 408 and 411 to operate thus closing one side of the teletypewriter channel in local circuit traced from positive battery through resistance 423, make contact relay 408, choke coil 420 and lower winding of relay 411, resistances 417 and 418 to ground at contact 419 of relay 402. The other side of the teletypewriter channel is connected to the series circuit through the polarized relays 600 of Fig. 6 traced from positive battery through choke coil 412 in Fig. 4, front contact of relay 411, choke coil 409, upper winding of relay 408, thence over lead 407 through the normal contacts of the cord circuit typing key T₁, back over lead 406 of Fig. 4, contact 403 on relay 401, contact 404 on relay 405 and thence over the tip of the plug AP and jack BJ in Fig. 6 to the upper windings of relays 600 in series to resistance 609 and negative battery. It will

be noted in tracing the above circuit that the operation of typing key T₁ of Fig. 5 will, when operated, connect the operator's sending contact 504 in series with this circuit and provide the operator with means for effecting a broadcast. Before proceeding further, attention is directed to the normal condition of the broadcast circuit of Fig. 6 prior to insertion of the cord plug in jack BJ. Relays 600 in this arrangement normally have their armatures held against their back contacts by a closed circuit traced from positive battery through resistance 610, inner contact of jack BJ and upper winding of relays 600 to negative battery through resistance 609. Furthermore, it will be observed that the contacts of each relay 600 control a group of polarized line relays 317 of Fig. 3 to maintain them in a normally operated condition over a path extending from ground through the back contact of relay 600, choke coil 608, lead 322, through the windings of relays 317 in series and back over lead 321 through resistances 601 and 606 to positive battery. The line relay 317 at its front contact will therefore present positive battery through choke coils 319 and 320 to the station teletypewriter whenever relay 303 of an idle line circuit is operated. Since relay 317 at its back contact will connect negative battery through choke coil 318 to the line, it follows that if the relay is made to follow the spacing and marking signals of the broadcast message, the message will therefore be registered on the individual station set. The operation and release of this relay is accomplished by making the relay 600 of Fig. 6 follow the signals of the broadcast message, which will now be described. As previously described, the insertion of the cord plug into the broadcasting jack BJ established a main channel circuit from the repeater relays of the cord circuit through the operator's teletypewriter to the upper windings of the relays 600 in series. This path replaces positive battery through resistance 610 at the inner break contact of the jack BJ which normally holds relays 600 on their back contacts. At the same time, main battery is connected at the auxiliary make contact on jack BJ for lighting the broadcast busy lamp 614 and for energizing the lower windings of relays 600 in series with resistance 605 to ground. The flux thus set up in each relay 600 tends to operate the relay but is prevented from doing so by the differential action of the upper windings. At the time the operator plugs the cord into jack BJ she also operates the common broadcast key CB which operates all line relays 303 of Fig. 3 for making the relays 317 effective in transmitting signals to the station sets as mentioned above.

If one of the lines is busy on another call at this time the operation of relay 303 has no effect and will release again upon the release of the common broadcast key CB. On all idle lines, however, the operation of the relay 303 at contact 316 closes a locking circuit to ground for itself through its lower winding and back contact of relay 306 to the main battery causing it to remain operated all during the broadcast. At contact 313 main battery is connected to the line busy lamp 310 and through the right back contact of relay 306 to the broadcast busy lamp 314, which lamps remain lighted during the broadcast. Relay 303 at contact 312 also opens battery to the relay 305 for preventing any possible false operation and lighting of the line

signal 307. At the bottom make contact of relay 303 ground is closed to the common acknowledgment signal 613 of Fig. 6 which remains lighted until the broadcast is completed and the stations have acknowledged the broadcast.

Having thus traced the operating paths of the circuit it will be obvious that the sending contact 504 of the operator's teletypewriter upon following the spacing and marking signals of the broadcast message will cause the circuit through the upper windings of relays 600 of Fig. 6 to be intermittently opened and closed. When the circuit is open the flux through the lower windings causes relays 600 to operate and at the front contact connect ground to the other side 321 of the series circuit through the relays 317. The latter relay therefore is restored to normal and negative battery at its back contact is connected over the line through the station set to negative battery thereby reproducing the spacing signal at the operator's set. Similarly, the marking signal is sent by closing of contact 504 in the operator's set which restores the relays 600 to normal and in turn causing relays 317 to reoperate to connect positive battery to the station set.

When the broadcast is completed each station may send an acknowledgment signal to the operator by operating the "Disc." key of the station. The operation of this key opens the line for a period of five seconds causing the stepper switch of Fig. 1 to rotate to the tenth terminal as previously described for local stations in station to station connection. Ground through switch arm SW—1 then closes a circuit over lead 109 and resistance 321 through the top make contact of relay 303 to battery through relay 306 causing it to operate and open the holding circuit for line relay 303 through its lower winding causing it to release. The common acknowledgment signal 613 will therefore continue to remain lighted until all line relays 303 have been released, indicating to the operator that all stations have received the broadcast. If, for some reason, one of the stations fails to send an acknowledgment signal the operator will, after withdrawing the cord from the jack BJ, proceed to plug into the jack LF of the line which has failed to send the acknowledgment signal as indicated by lamps 310 and 314 of that line remaining lighted.

If, instead of sending a broadcast to all stations, the operator has desired to send it to certain definite stations then the operator would have operated the individual broadcast key IB shown in Fig. 3 associated with the line jack LJ instead of operating the common broadcast CB of Fig. 6. The operation of key IB connects ground to the S winding of relay 303 over the back contacts of relay 306 to battery. Relay 303 locks up at its contact 316 as in the case of the common broadcast key arrangement and the further operation of the circuit is as described for a broadcast to all stations.

The description of the operating features for a broadcast by the operator may equally well be applied where it is desired to send the broadcast from some particular station as for example station A'. In this case the station A' originates a call to the operator in the usual way. The operator answers by inserting the AP plug of the cord circuit, Fig. 4, into the calling line jack LJ, learns that the station desired to broadcast and proceeds to place the CP plug of the cord into the broadcast jack BJ. The broadcast

message is thus repeated by the cord circuit to the series relays 600 of Fig. 6 and the circuits function as previously described. In a similar manner the operator or subscriber of a distant exchange may be likewise connected through the cord circuit to the broadcast jack BJ in which case the operating features previously described apply. The broadcast circuit as described herein is a one-way circuit, i. e., the teletypewriter originating the signals at any one time cannot receive from the teletypewriters connected to receive the signals unless the circuit is changed for this purpose.

What is claimed is:

1. A printing telegraph exchange system comprising a central exchange, telegraph lines terminating thereat, a call signal circuit including a signaling device for one of said lines to indicate a call thereover, a stepping switch connected to the said line and effective upon the establishment of a calling condition upon said line to step, and means controlled by the stepping of said switch to establish and maintain said signal device in a call indicating condition.

2. A system in accordance with claim 1 in which the stepping of said switch is under control of a slow acting relay which acts upon the establishment of a calling condition in said line to cause said stepping switch to step.

3. A printing telegraph system provided with a central office and a plurality of lines terminating thereat, at least one of said lines being a grounded line and at least one being a complete metallic circuit line, line terminating apparatus for each line at said central office, a link circuit for interconnecting said lines for telegraphic intercommunication, busy and call signals included in the line terminating apparatus for each line and a disconnect signal associated with said link circuit and instrumentalities whereby said signals function identically regardless of the type of lines with which said link circuit is connected.

4. A printing telegraph exchange system having lines terminating at a central office, at least one line having its stepping switch connected thereto as a part of the line terminating equipment at said office, a device connected with said line at a point remote from said office for establishing a calling condition upon said line, said stepping switch operating upon the operation of said device to establish the calling indication at said office, and instrumentalities at said office effective upon further stepping of said switch to establish a disconnect indication at said office, means being provided upon said line whereby a subscriber remote from said office may cause said switch to step further as aforesaid at a time when said line is connected to another line for intercommunication.

5. In a cord circuit for interconnection of telegraph lines, a relay controlling the application of current to a telegraph repeater, and two other relays each separately connected to a sleeve contact upon a plug terminating said cord circuit, each of said other relays having contacts connected to control said first named relay.

6. In a communication circuit having a normally closed subscriber's circuit extending to a central office, a stepper switch, a disconnect signal, devices actuated by opening the line at the subscriber's station for a definite period dependent upon the number of steps such switch must take to cause said switch to step to a terminal representing a disconnect condition, and

connections to said terminal to cause said signal to be energized.

7. A system according to claim 6 in which said signal is a device in a cord circuit, said device
80 being normally unenergized during the connection of said cord circuit to a line for communication.

8. In a telegraph exchange system, a plurality of subscribers' lines terminating at a central office, telegraph instruments in each line, devices at said central office whereby telegraph signals from any one line may be repeated to a single interconnected line, devices whereby telegraph signals from a line may be repeated to a selected plurality of lines, a busy signal for said
90 single line and a separate busy signal indicating the connection of said line as one of said selected plurality.

9. A telegraph exchange system comprising
95 telegraph lines terminating at a central office, a central office operator's link circuit at said office, a circuit at said office for broadcast transmission, instrumentalities for connecting by said link circuit a line selected from any of said
100 lines with said circuit for broadcast transmission from said selected line and separate instruments, one being individual to each line, whereby any selected plurality of said telegraph lines may be receptively associated with said broadcast
105 circuit.

10. A system in accordance with claim 9 further provided with instrumentalities whereby all idle lines except said selected line may be connected receptively to said broadcast circuit.

11. A telegraph exchange system comprising
110 telegraph lines terminating at a central office, a central office operator's link circuit at said office, a circuit at said office for broadcast transmission, instrumentalities for connecting by said
115 link circuit a line selected from any of said lines with said circuit for broadcast transmission and an individual instrument whereby said operator may associate all lines except the selected line with said broadcast circuit.

12. A telegraph exchange system comprising
120 telegraph lines terminating at a central office, a central office operator's link circuit at said office, a circuit at said office for broadcast transmission, instrumentalities for linking a selected
125 line with said circuit for broadcast transmission and an individual instrument by the actuation of which said operator may associate all lines with said broadcast circuit, there being provided lock-out means whereby any busy line is not so associated upon the actuation of said instrument.

13. A telegraph exchange system comprising
130 telegraph lines terminating at a central office, a central office operator's link circuit at said office, a circuit at said office for broadcast transmission, instrumentalities for linking a selected
135 line with said circuit for broadcast transmission and an individual instrument upon the actuation of which the operator may associate all lines with said broadcast circuit, said instrument being effective to connect idle lines immediately
140 and other lines if and when they become idle to said broadcast circuit.

14. In a printing telegraph system, a plurality of lines extending from a central office, means
145 whereby an operator at said office may extend one of said lines to a plurality of other lines for broadcast transmission thereto, an indicator be-

fore said operator to indicate whether all of said plurality of lines have acknowledged the broadcast and an additional indication designating any particular line which has not so acknowledged said broadcast.

15. In a printing telegraph circuit, a line terminating at a central office in a jack having tip and ring connections, apparatus for giving a disconnect signal at the central office comprising at the remote terminal of said line a device for opening the tip of said line and instrumentalities at the central office controlled thereby for grounding the ring of said line.

16. A system in accordance with claim 15 in which the instrumentalities include a stepping
15 switch.

17. A system in accordance with claim 15 in which the instrumentalities include a stepping switch which provides a ground path for a disconnect lamp located in a cord circuit.

18. In a printing telegraph exchange system the method of giving a call signal to a central office operator over a subscriber's line having a connection to a jack having tip and ring contacts which comprises opening the ring and
25 grounding the tip side of said line.

19. A telegraph exchange system in which a cord circuit is adapted to work with metallic or grounded lines and in which said interchangeable functioning of said cord circuit is accomplished by the inclusion in each kind of the said line circuits of relay arrangements which distinguish between call and disconnect signals and apply the same polarities to the tip and ring terminations of the line jack and the call signal controlling relay of the line for any given signaling condition.

20. A cord circuit for printing telegraph switching systems including therein between its terminals a telegraph repeater characterized in this, that said repeater consists of no more than two repeating relays, each of which said relays has a winding in a circuit controlled by the contacts of the other and wherein said cord circuit is terminated at each end by a connector device, each said connector device having a terminal for controlling the application of current to both of said relays.

21. A telegraph exchange system comprising a plurality of lines, a central office having manually controlled link circuits for interconnecting said lines, an operator's instrument associable with said link circuits for communicating with subscribers over said lines, said system including call signals for indicating incoming calls, disconnect signals for indicating lines to be disconnected, and also associated with each line at its central office termination, a busy signal, said busy signal being controlled to give a continuous positive busy indication at all times when a link circuit is connected thereto.

22. An arrangement in accordance with claim 21, in which each line terminates in a jack having a sleeve, and each link circuit terminates in a plug and further including means operable by insertion of said plug into said jack to energize a circuit over a path through said sleeve to energize said busy signal.

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