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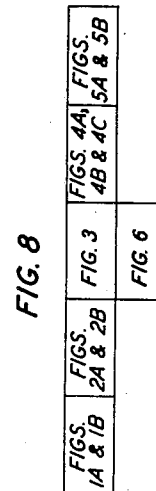
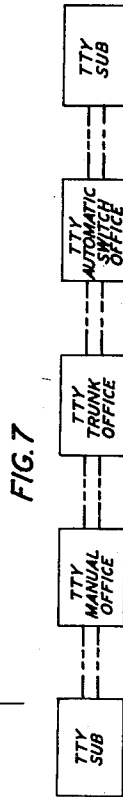
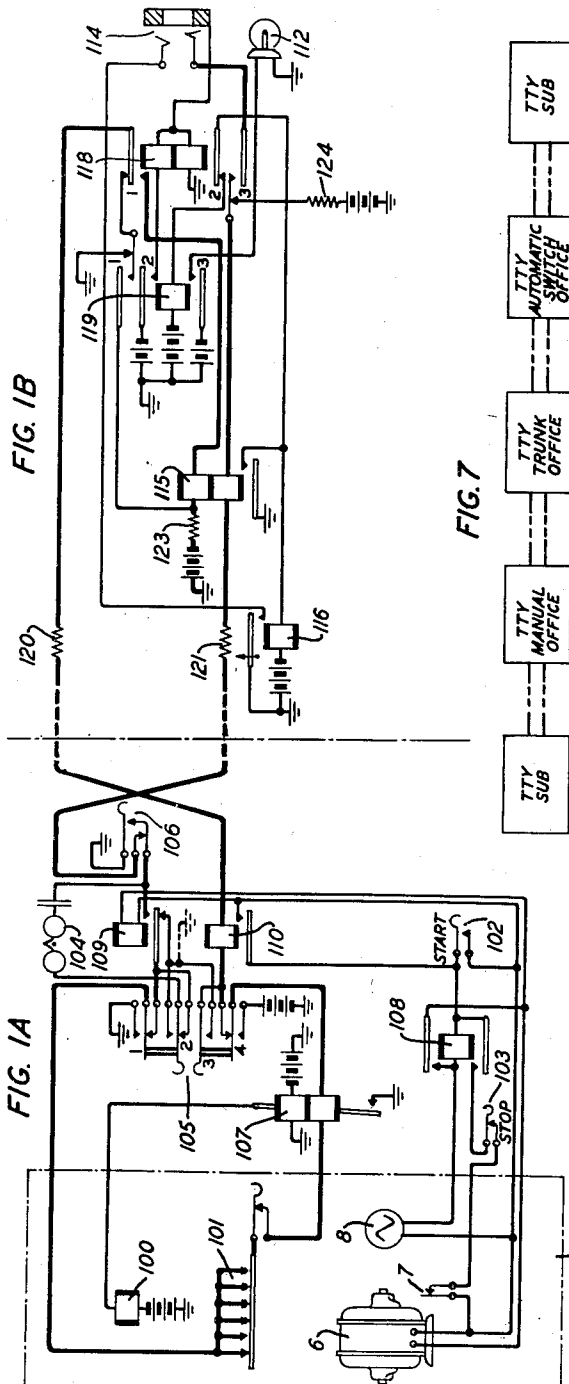
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2,158,113

TELETYPEWRITER TRUNKING SYSTEM

Filed Aug. 1, 1936

6 Sheets-Sheet 1



STATION A

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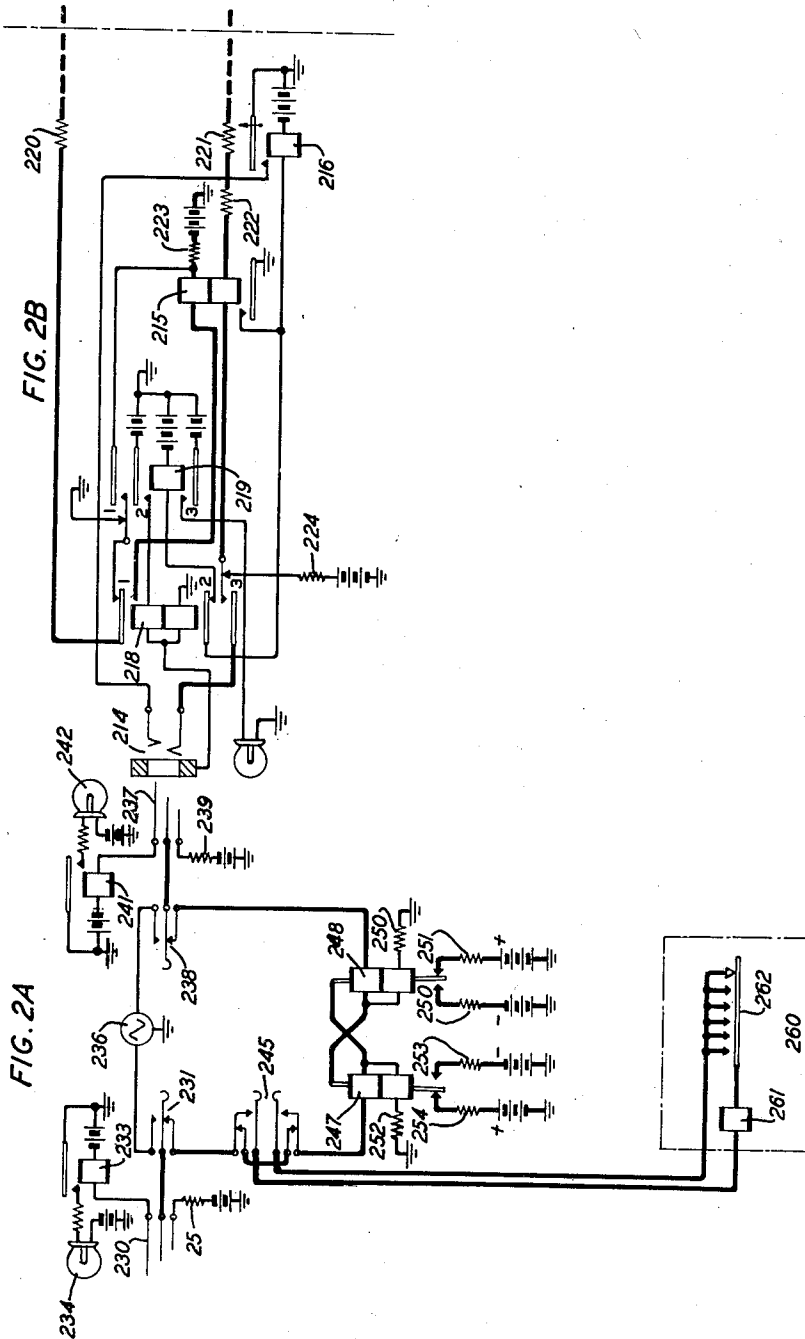
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TELETYPEWRITER TRUNKING SYSTEM

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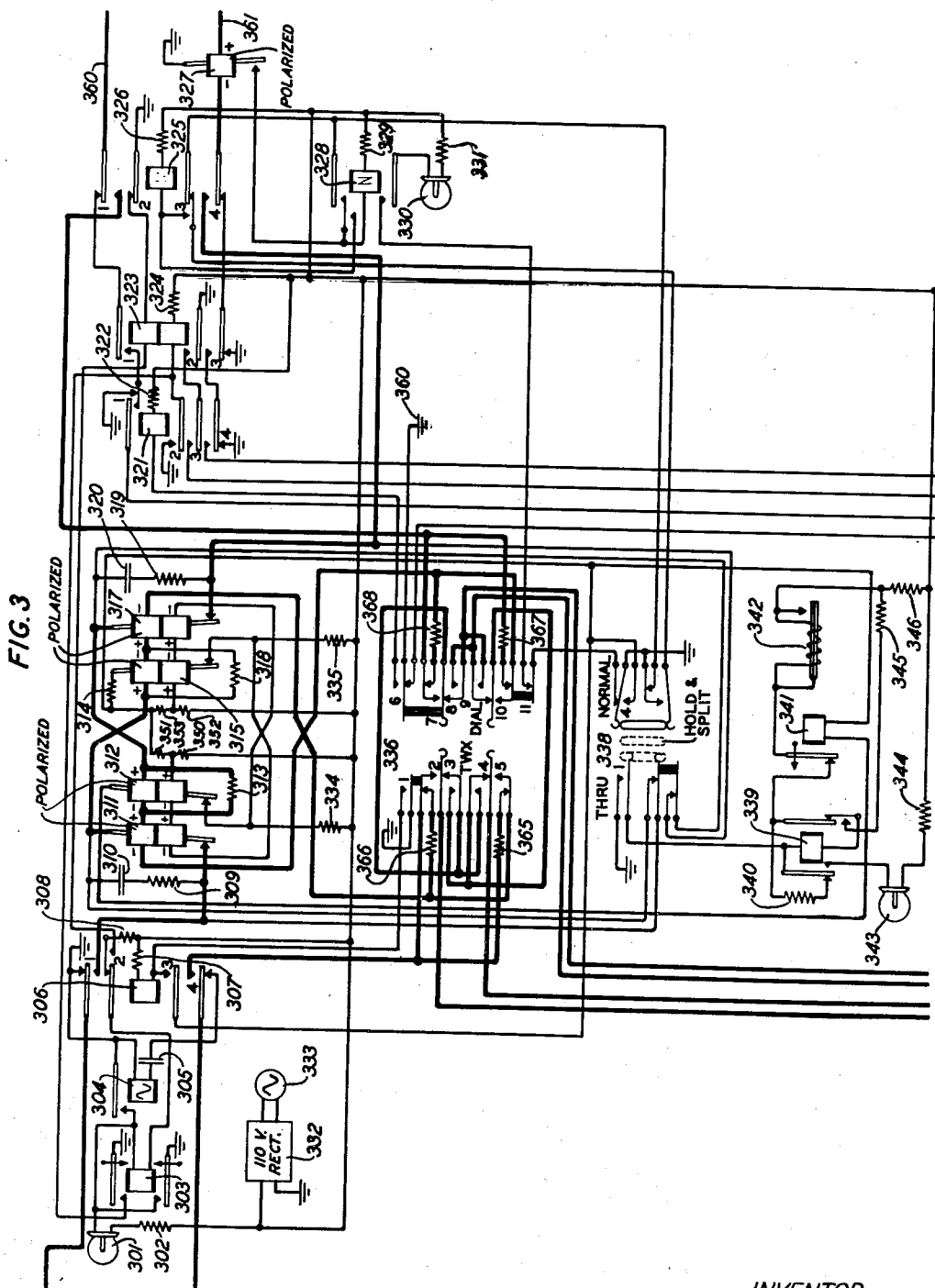
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TELETYPEWRITER TRUNKING SYSTEM

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6 Sheets-Sheet 3



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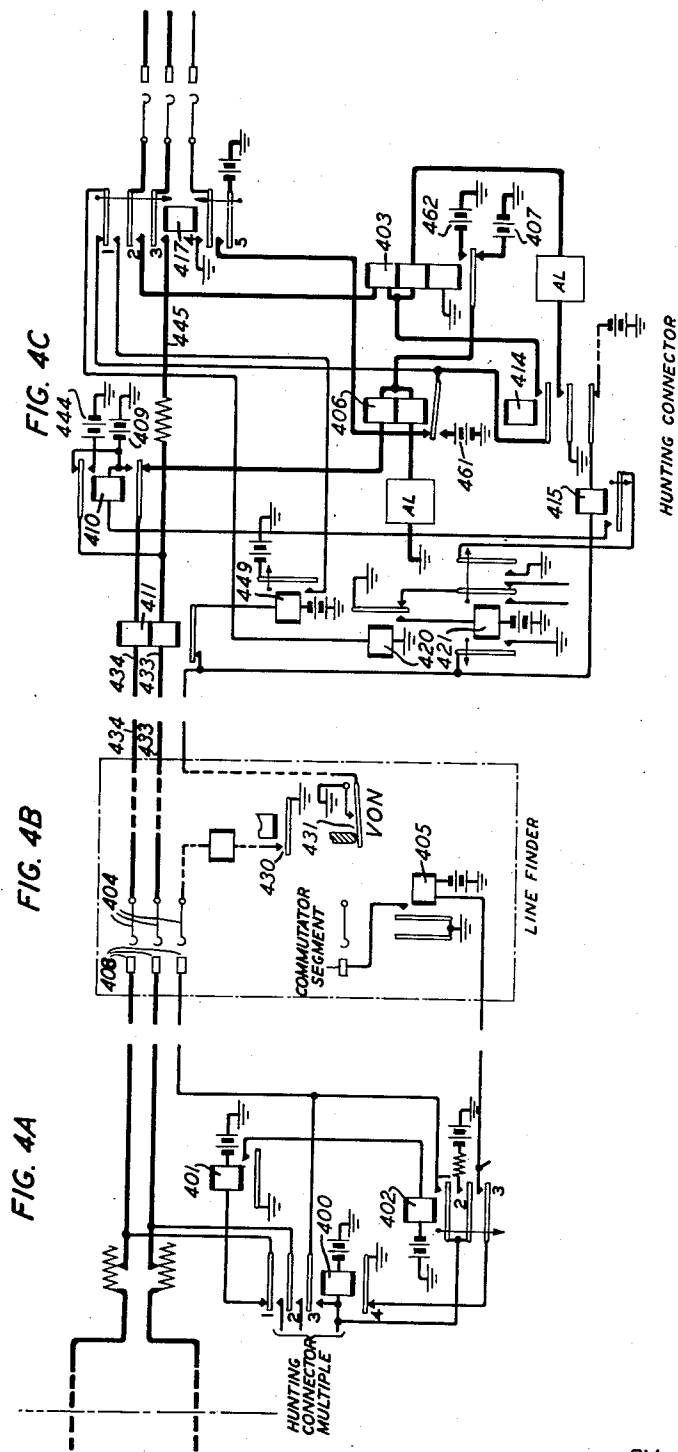
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TELETYPEWRITER TRUNKING SYSTEM

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6 Sheets-Sheet 4



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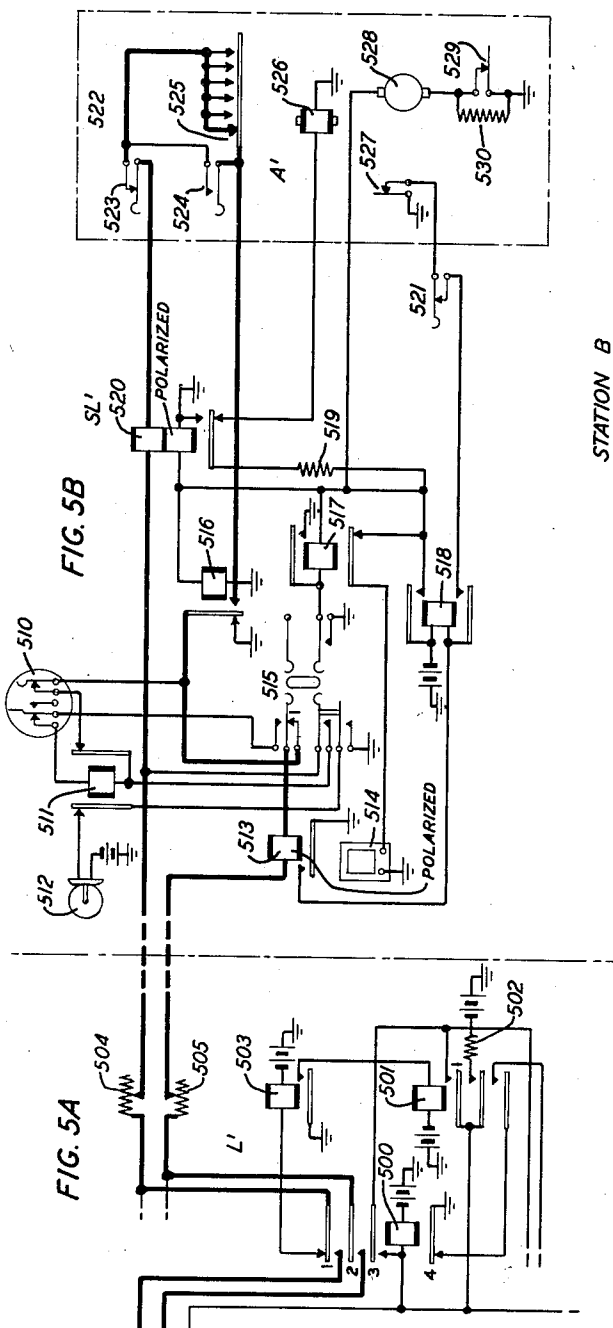
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TELETYPEWRITER TRUNKING SYSTEM

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6 Sheets-Sheet 5



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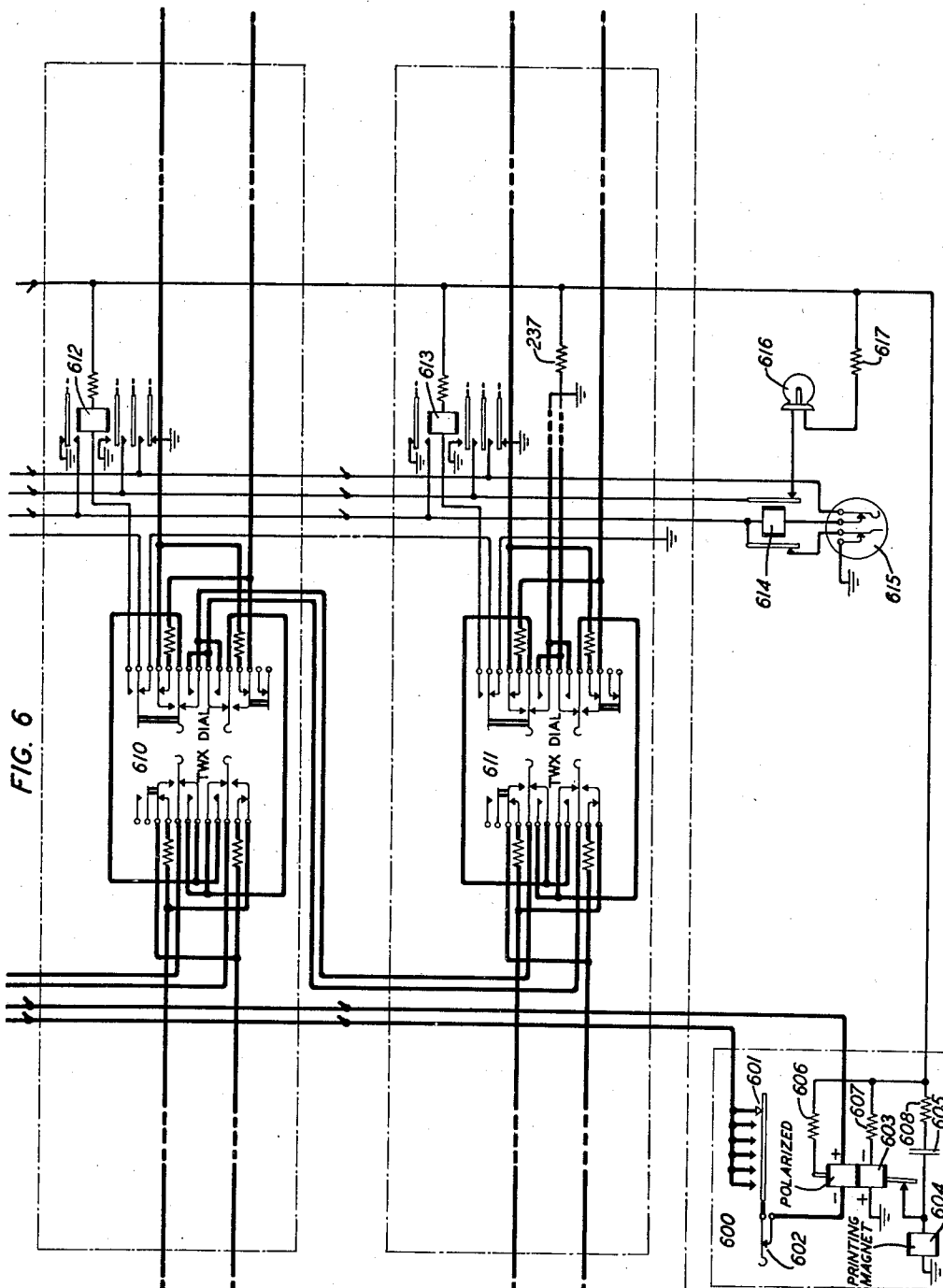
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6 Sheets-Sheet 6



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2,158,113

TELETYPEWRITER TRUNKING SYSTEM

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Application August 1, 1936, Serial No. 93,806

6 Claims. (Cl. 178—2)

This invention relates to printing telegraph systems, and more particularly to such systems requiring switching arrangements at central offices.

5 The object of the invention resides in a trunking system for completing telegraphic typewriter connections between the telegraphic subscribers associated with a manually operated central office and telegraphic subscribers associated with an automatic switching central office or private branch exchange, said trunking system including a central trunking station or central office adapted for regulation as a through-repeater station and having means for originating connections to either type of subscriber's station.

10 According to one embodiment of the present invention, there is provided a printing telegraph trunking system arranged to selectively interconnect lines from manually operated teletypewriter offices with lines from automatic switching telegraph offices. The trunk circuits of this trunking system are divided into groups, each group having a sending and receiving printer and a dialing system selectable by any of the trunks in the group. Each trunk circuit in a group comprises a repeater, a two-position key and a three-position key, which may be manipulated in various manners for answering and originating connections and signaling apparatus for supervising such connections. The two-position key is provided for the purpose of connecting the local or trunk operator's printer set in series with a printer set at either the central office or an automatic office and for associating the dial with the automatic switching system. The two-position, and the three-position keys may be used in various combinations for adjusting the trunking system as required for completing and originating calls and for functioning as a through-repeater trunk.

40 Fig. 1—A illustrates a teletypewriter subscriber's station of the type connected with a manual switchboard;

45 Figs. 1—B, 2—A and 2—B illustrate a line circuit, repeater cord circuit, and a second line circuit, respectively, of a manually operable central office of the type for interconnecting teletypewriter stations;

50 Figs. 3 and 6 illustrate a teletypewriter trunking switchboard with trunks extending in two directions;

55 Figs. 4—A, 4—B, 4—C, and 5—A illustrate a line circuit, line finder, connector, and second line circuit, respectively, for an automatically operated central office;

Fig. 5—B illustrates a teletypewriter subscriber's station of the type which is connected with an automatically operated central office;

60 Fig. 7 illustrates the diagrammatic arrangement of the stations and several offices; and

Fig. 8 illustrates the arrangement of the drawings for the correct association of the circuit diagrams.

In general, the operation of this system is as follows:

5 Let it be assumed that an outlying teletypewriter subscriber in a manual exchange district desires a connection to a distant subscriber who is connected to an automatic telephone exchange. The subscriber represented by the apparatus in Fig. 1—A initiates a call by operating the start key 102. In response to this operation, electrical circuits are established for starting the teletypewriter motor 6, establishing a signaling circuit and operating the printer magnet. The signaling circuit is established to a manual exchange represented by the line circuit Fig. 1—B, repeater cord circuit Fig. 2—A, and the line circuit Fig. 2—B. The establishment of this circuit operates electrical apparatus and lights lamp 112 associated with the subscriber's line jack 114 for indicating an incoming call to an operator at the manual exchange. Upon observing the light an operator inserts plug 230 into jack 114 and actuates key 245 for associating the cord circuit printer 260 with the subscriber's station and establishing a signaling loop. A signal is printed by the manual operator and transmitted over the established loop to advise the subscriber that signals may now be transmitted by said subscriber indicating the connection desired. When the signals transmitted by the subscriber are received on the cord circuit printer the manual operator inserts plug 237 into jack 214 of a line connected to a distant trunking office associated with the desired automatic exchange. The insertion of the plug into the trunk jack 214 establishes a loop to a trunk such as shown in Fig. 3. The manual operator first actuates the ringing key 238 for operating trunk circuit relays and lighting lamp 301 in the selected trunk. The trunk operator responds to the signal by actuating key 366 to the TWX position for associating printer 600 with the signaling loop connected to printer 260. A signal is transmitted from printer 600 advising the manual operator to proceed and in response, signals are transmitted by the manual operator by manipulation of her sending keys 262 for operating the trunk position printer 600 giving the station to be called. When these signals have been transmitted, the manual operator has completed her duties and the cord circuit of Fig. 2—A remains as a through signaling path. As soon as the trunk circuit is selected by the manual operator, circuits are established for operating the trunk finder Fig. 4—A and 4—B in order that no time be lost in completing the connection. The operator at the trunking switchboard uses the apparatus shown in Fig. 3 for operating the switches of an automatic telephone 60

exchange. The two-position key 336 is moved to the dial position which associates the dial and dial signal with the automatic switches. When the connector switch is associated with the trunk circuit the dialing signal is operated. The signals dialed by the trunk operator set the connector switch Fig. 4—C for connecting the trunk circuit to a particular teletypewriter subscriber. When the line switch Fig. 5—A is connected to the proper line, an audible signal is sounded at the teletypewriter subscriber's station indicating a call for said station. The called subscriber responds by actuating the teletypewriter apparatus for transmitting a code signal to the calling subscriber indicating that the connection has been completed. As soon as this signal is received, the calling subscriber Fig. 1—A transmits his code message to the selected subscriber Fig. 5—B. After the message has been transmitted, the proper disconnect signals are transmitted, which furnish information to the subscriber stations and indicate by supervisory signals in the trunk switchboard Fig. 3, and manual switchboard Fig. 2—A, that the apparatus used for completing this connection may be restored to normal.

Having briefly discussed the general operation of the system involved in establishing a connection between two distant subscribers, the manner in which this connection is established will now be described in detail. When a subscriber desires to initiate a call the station mechanism is actuated and a sending loop is established by the operation of the start key 102. The operation of the start key associates the alternating current source 8 with relays 108 and 109, both of which operate. Relay 108 in operating establishes a locking circuit for itself from one side of the alternating current source through its winding and lower contact, contact of manually operable stop key 103, contact of automatically operable motor stop key 7 to the opposite side of the alternating current source. The operation of relay 108 further establishes a circuit for the motor 6 from one side of the alternating current source through its top contact, motor winding and armature, to the opposite side of the alternating current source. The operation of relay 109 establishes a circuit loop which may be traced from ground through contact 1 of relay 119, contact 1 of relay 118, line resistance 120, winding of relay 110, contact 4 of key 105, lower winding of relay 107, transmitting contacts of keys 101, contact 1 of key 105, contact of relay 109, normal contact of key 106, line resistance 121, lower winding of relay 115, contact 3 of relay 118, resistance 124, to positive battery. Resistances 120 and 121 represent a line loop of several miles. The circuit as above traced establishes the operation of relays 107, 110, 115. The operation of relay 107 establishes a circuit for operating the printer magnet 100. The operation of relay 110 establishes a contact for replacing the contacts of start key 102 when this key is released. The operation of relay 115 establishes a circuit for relay 119 traced from ground, through the contact of relay 115, contact 2 of relay 118, winding of relay 119, to battery. The operation of relay 115 also establishes an obvious circuit for operating relay 116. Relay 116 connects ground to the tip of jack 114. The operation of relay 119 establishes an obvious circuit for lighting lamp 112 through its contact 3 and a busy circuit through its contact 2, from battery to the upper winding of relay 118 to the

multiplied sleeve of jack 114. The upper contact 1 of relay 119 connects negative battery to the loop and disconnects ground.

Upon observing the illumination of the signaling lamp 112, the manual operator inserts a plug such as 230 into the line jack 114. The insertion of this plug in the jack establishes an operating circuit for relays 118 from ground, through its lower winding, sleeve of jack 114, sleeve of plug 230, resistance 232, to battery. The operation of relay 118 releases relay 119 and closes the path of the signaling loop. This signaling loop is now extended to the cord circuit repeater through contact 3 of relay 118. As soon as plug 230 is inserted in jack 114 the manual operator actuates key 245 for associating the printer 260 with the subscriber's station printer 10. The signaling circuit may now be traced from positive 48-volt battery, through the normal contact of repeater relay 248, upper winding of repeater relay 247, lower contact of key 245, contacts 262 and magnet 261 of printer 260, upper contact of key 245, normal contact of ringing key 231, ring of plug 230 and jack 114, contact 3 of relay 118, lower winding of relay 115, loop resistance 121, normal contact of key 106, contact of relay 109, contact 1 of key 105, sending keys 101, lower winding of relay 107, contact 4 of key 105, winding of relay 110, loop resistance 120, contact 1 of relay 118, upper winding of relay 115, resistance 123, to negative battery. Relay 115 is differentially connected in the loop circuit and therefore current through both windings as traced causes its release. The release of relay 115 opens the operating circuit for slow operating and releasing relay 116. The manual operator sends a code signal to the calling subscriber by manipulating the keys of printer 260. These signals are sent directly from the printer 260. It will be noted that during the transmission of signals to station "A" the repeater relay 247 is operated but since no connection has as yet been made over plug 237 the action of repeater relay 247 is not effective. In response to this signal the calling subscriber manipulates the keys 101 of printer 10 to transmit a code message to the manual operator. This message is recorded on the printer 260 and provides the manual operator with the station and subscriber's line to which the calling subscriber wishes a connection. A record is made on each printer upon the transmission of each message. The manual operator now selects a line extending to a trunk connected to the particular automatic exchange to which the calling subscriber desires a connection. Let it be assumed that the line circuit Fig. 2—B connects to a trunk circuit extending to the desired line. Plug 237 is, therefore, inserted in jack 214. A circuit is thus established for the operation of relay 218 from ground through its lower winding, sleeve of jack 214 and plug 237, resistance 239 to battery. The operation of relay 218 establishes a circuit for the operation of relay 215 traced from negative battery, through resistance 223, upper winding of relay 215, contact 1 of relay 218, to ground through contact 1 of relay 306. The operation of relay 215 establishes an obvious circuit for operating relay 216 which in turn establishes a circuit for relay 241 from ground through the contact of relay 216, tip of plug 214 and jack 237, winding of relay 241 to battery. The operation of relay 241 establishes an obvious circuit for lighting lamp 242. Returning again to relay 218 the operation of this relay further establishes a signaling path from the cord

circuit to the trunk circuit Fig. 3. In order to establish connection with the trunk circuit the manual operator actuates the ringing key 238 to associate alternating current from source 236 for operating relay 304 of the trunk circuit. This circuit may be traced from the alternating current source 236, through the contact of key 238, ring of plug 237 and jack 214, contact 3 of relay 218, lower winding of relay 215, resistance 222, resistance 221, contact 4 of relay 306, condenser 305, winding of relay 304, to ground through contact 1 of relay 306, relay 304 operates in the circuit traced and establishes a circuit for the operation of relay 303 from ground, through contact 1 of relay 306, contact of relay 304, winding of relay 303, contact 2 of relay 306, resistance 308, to battery. The current source shown in this trunk circuit is a rectifier which supplies rectified current from the alternating current source 333, as shown, carried through any conventional rectifier diagrammatically shown as 332. The operation of relay 303 establishes an obvious circuit for lamp 301 to indicate that the trunk has been selected. A second circuit is established from ground, through the upper contact of relay 303, winding of relay 323, resistance 324, to battery source 332. Relay 323 operates in the circuit traced for starting the operation of the trunk finder switch as hereinafter described and for associating a dial circuit with the outgoing line. The dial 615 is common to a group of trunks and, therefore, the circuit paths between the dial and the outgoing line are not completed until the trunk operator has performed other functions. Upon observing the illumination of lamp 301 the trunk operator actuates key 336 to the TWX position for completing the signaling loop between the cord circuit and trunk circuit operators' positions. The operation of key 336 establishes a circuit to operate relay 306 from ground, through contact 1 of the TWX key combination, winding of relay 306, resistance 307 to rectified battery current. The operation of relay 306 releases relays 303 and 304 establishes a holding circuit for relay 323 and establishes a signaling path between the trunk circuit printer 600 and the cord circuit printer 260. The holding circuit for relay 323 may be traced from ground through contact 2 of relay 325, upper winding of relay 323, contact 2 of relay 306, resistance 308 to battery. The signaling path may be traced from positive 48-volt battery Fig. 2—A, through the contact of relay 247, upper winding of relay 248, normal contact of key 238, ring of plug 237 and jack 214, contact 3 of relay 218, lower winding of relay 215, resistance 222, resistance 221, contact 4 of relay 306, contact 2—3 of key 336, key 601 of printer 600, key 602, upper winding of relay 603, contact 4—5 of key 336, upper winding of relay 317, upper winding of relay 315 in multiple with resistance 318, armature and contact of relay 311, contact 1 of relay 306, resistance 220, contact 1 of relay 218, upper winding of relay 215, resistance 223, to negative battery. Relay 215 is differentially connected in this loop circuit and therefore current through both windings as traced causes its release. The release of relay 215 releases relay 216 which in turn releases relay 241 and extinguishes lamp 242. The printer 600 is common to all trunk circuits of a position and may be associated with other trunks by the operation of the associated trunk keys such as 610 or 611. For this purpose a series circuit is extended through the key contacts as shown.

As soon as the foregoing signaling path is established the trunk operator manipulates the keys of the printer 600 to advise the manual operator Fig. 2—A that code signal impulses may be transmitted to the trunk circuit printer indicating the subscriber's station to be called.

These signal impulses are transmitted by the cord circuit printer 260 over a circuit which may be traced from positive 48-volt battery, through contacts of repeater relay 248, upper winding of repeater relay 247, lower contact of key 245 which is operated, contacts 262 of printer 260, printer magnet 261, upper contact of key 245, the contact of key 231, ring of plug 230 and jack 114, contact 3 of relay 118, lower winding of relay 115, line resistance 121, contact of key 106, contact of relay 109, contact 1 of key 105, printer keys 101, lower winding of relay 107, contact 4 of key 105, winding of relay 110, line resistance 120, contact 1 of relay 118, upper winding of relay 115, resistance 123 to negative battery. As the signal impulses are transmitted the repeater relay 247 is operated and spacing and marking signal impulses are transmitted to the trunk operator's printer 600. The cord circuit repeater relays 247 and 248 are maintained in the position shown when the loop circuit is closed. The current flowing through the upper winding is approximately twice as great as that flowing through the lower winding and of the opposite polarity. When the loop is opened by the transmission of signals, the current through the lower winding becomes effective and causes the armature of the relays to be attracted toward the inner or upper contact. This causes a spacing signal to be transmitted since in this case negative battery is connected from the repeater relay to negative battery in the line circuit. The normal loop circuit and the spacing signal circuit may be traced at the same time, the normal loop circuit extending from positive 48-volt battery through resistance 254 and the spacing signal extended at 48-volt negative battery through resistance 253. This extends over the armature of relay 247, upper winding of relay 248, contact of key 238, ring of plug 237 and jack 214, contact 3 of relay 218, lower winding of relay 215, line resistances 222 and 221, contact 4 of relay 306, which relay is operated at this time, contact 2—3 of key 336, which is actuated at this time, contacts 601 and 602, upper winding of relay 603, contact 4—5 of key 336, upper windings of relays 317 and 315, contact of relay 311 in multiple on the contact 2 of key 336, contact 1 of relay 306, line resistance 220, contact 1 of relay 218, upper winding of relay 215, resistance 223 to negative battery. It is apparent that as the signal impulses are transmitted by the operator, the open periods will cause the armature of relay 247 to be attracted toward the contact connected to the negative 48-volt battery. This causes the spacing signal to be transmitted to the trunk operator from negative to negative battery and transmits the same signal to the subscriber's station A by opening the loop at the sending keys 262. Consequently, a record is made in each of the printer stations involved in the connection. Under this condition of sending relay 248 holds its armature against the positive contact since current is reversed in the lower winding. This completes the duties required of the manual operator and key 245 is, therefore, restored to normal and the cord circuit remains as a through signaling path with the two-way cord circuit repeater included in the signaling circuits. This signaling path will be

traced upon the completion of the connection to the called subscriber.

Referring again to relay 306, it will be remembered that a circuit is established through the contacts of this relay for holding the relay 323 operated. When the trunk operator has received the code signal from the manual operator, key 338 is operated to the hold and split position before the TWX key is restored to normal. In the hold and split position of key 338 a locking circuit is established for the aforesaid relay 306 which may be traced from ground, through contact 4 of key 338, contact 3 and winding of relay 306, resistance 307, to battery. Relay 323 is thus held in an operated position until key 338 is restored to its normal position. The trunk operator now operates key 336 to the dial position which energizes relay 321 for associating the dial with the outgoing trunk conductors. Similar relays 612 and 613 are shown connected with keys 610 and 611, respectively, for associating the common dial with other trunk circuits. A series circuit is carried from ground 360 through the contacts of the keys, as shown, for operating these relays as the individual trunk keys are operated. The circuit for operating relay 321 may be traced from ground 360 through contact 5 of key 336, winding of relay 321, resistance 322, to battery. The connections from the dial to the line, through the contacts of relay 321, may be traced as follows: The dial lamp is lighted from ground, through contact 2 of relay 323, contact 3 of relay 321, right contact of relay 614, lamp filament, resistance 617 to battery. The tip conductor of the line is associated with the dial through contact 1 of relay 325, contact 1 of relay 323, make-before-break contact 1 of relay 321, contact and armature of relay 614, left contact of dial, to ground. This circuit may also be traced through the winding of relay 614, right contact of dial, contact 4 of relay 321, contact 3 of relay 323, contact 4 of relay 325, winding of relay 327, to the ring conductor of the line. The dial contacts are thus extended to the finder switch Fig. 4—A.

At the trunk office the tip and ring line conductors 360 and 361 are connected to a terminal set in the trunk or line-finder switch bank herein termed a line finder. Other trunks in the system are respectively connected by means of conductor pairs to other terminal sets in the same line-finder switch. The line-finder switch is of the rotary step-by-step type, which is disclosed in U. S. Patent 815,176 granted to A. E. Heath et al. on March 13, 1906. The trunk lines may be arranged in one or more groups and subgroups, as fully covered in Patent 1,958,930 to F. J. Singer, May 15, 1934. For each subgroup of lines there is provided a subgroup relay such as relay 405, which operates when a call is initiated. As hereinbefore stated the ground on contact 1 of relay 321 initiated the operation of the finder switch when relay 323 operated. Upon the operation of relay 321 this ground was replaced by the dial ground. Obvious circuits are established for the operation of relay 401, 402 and 405, and as is apparent the finder switch operations hereinafter described are either completed or nearly completed by the time the key 336 is operated to the dial position. The operation of the subgroup relay 405 connects ground to a segment on a commutator which is mounted on a line-finder switch. The commutator is provided with ten segments to correspond to ten levels or subgroups of the switch, there being ten lines in each subgroup. When a call is initiated by the operator a line-finder switch is

automatically operated first in an upward movement to a particular level and then in a rotary movement to a set of terminals to which the calling line is connected. The upward movement of the brush set is regulated by a brush passing over the segment on the commutator and when the brush reaches a commutator segment to which the calling line has applied ground by means of its associated subgroup relay the upward movement of the line-finder brush set is checked at the level in which the calling line terminal set is located. In this way the level at which the calling line terminates is selected and the line-finder brush is then automatically rotated over the terminal set in a particular level until it finds grounded battery which is connected to the calling line. This prevents further rotary movement of the brush set and completes an operating circuit for cutting the conductors through to a connector switch.

The line and connector switches are shown in schematic form since their operation is well understood and since they operate in the system in the same manner as fully described in the aforementioned Patent 1,958,930 to F. J. Singer. As previously stated, the operation of the dial key establishes a circuit for the operation of relay 401 (Fig. 4—A). This circuit may be traced from battery to the winding of relay 401, normal contact 1 of relay 400, tip conductor of trunk, normal contact 1 of relay 325, contact 1 of relay 323, to ground on contact 1 of relay 321, before the dial key and relay 321 are operated. After the operation of this key and relay the circuit is extended through the left contact of relay 614, left contact of dial 615 to ground. The operation of relay 401 establishes an obvious circuit for the operation of relay 402. The operation of relay 402 connects ground to the switch sleeve terminal and establishes a circuit at this time for operating the line switch relay 405 from battery through the winding of relay 405, contact 3 of relay 402 to ground through contact 4 of relay 400. The operation of relay 405 connects ground to a particular segment on the switch commutator and also establishes a circuit for the switch start relay. It will be assumed that the ground disclosed is connected to the tenth level of the switch, and consequently the operation of relay 405 places a ground upon the tenth commutator segment. The operation of the switch start relay establishes circuits for the vertical magnet which elevates the switch in single steps to the tenth level, where it finds ground associated with the commutator. The vertical magnet is then energized to rotate the switch brushes for the selection of the trunk conductor shown. At the first vertical step the vertical off-normal springs 430 operate to connect ground to conductor 432. This circuit is maintained closed until the dialing of the code number has been completed. When the brushes 404 are associated with trunk terminals 403 a circuit is established for operating the cut-off relay 400. This circuit may be traced from ground through off-normal contact 430, sleeve conductor 432, sleeve brush and terminal of the switch, contact 1 of relay 402, winding of relay 400 to battery. The circuit traced includes a circuit through the winding of a cut-through relay which is not shown. The cut-through relay associates the trunk conductors with the connector switch (Fig. 4—C) and the sleeve conductor of the finder with the sleeve conductor of the connector Fig. 4—C. A busy condition for the con-

necter and a circuit for operating the connector relay 449 is thus established.

When the trunk has been found by the trunk finder and the cut-through relay operated, supervisory circuits are established to advise the trunk operator of the advancement of the connection. A circuit is first established for the operation of dial relay 614 over the tip and ring conductors which may be traced from negative battery 409 through the upper normal contact of relay 410, lower winding of relay 411, ring conductor 433, brush and terminal of the finder switch, winding of relay 327, contact 4 of relay 325, contact 3 of relay 323, contact 4 of relay 321, right contact of dial 615, winding of relay 614, contact 1 of relay 321, contact 1 of relay 323, contact 1 of relay 325, tip conductor 360, tip terminal and brush of the line-finder switch, conductor 434, upper winding of relay 411, lower contact of relay 410, upper winding of relay 406, contact of relay 403 to positive battery. The operation of relay 614 extinguishes the dial lamp 616 to indicate to the trunk operator that the circuit is cut through and ready to receive dialing impulses. The dial 615 is now actuated by the trunk operator for the selection of the wanted line by causing the connector (Fig. 4—C) to select said line. The connector Fig. 4—C is the same as disclosed and described in detail in Patent 1,958,930 to F. J. Singer, May 5, 1934 and therefore only the apparatus which is essential for completing the connection is shown herein. For the sake of simplicity the apparatus is numbered as in the patent. Impulses corresponding to the code number of the called station cause the operation and release of the pulsing relays in the connector (Fig. 4—C). The operation of the connector circuit (Fig. 4—C) in response to the dial interruptions is the same as described in detail in the aforementioned patent to F. J. Singer. It therefore appears that a general statement of the operation is sufficient. The first set of impulses transmitted, operates the vertical magnet and causes the connector shaft and associated brushes to be elevated to the desired level. Between the first and second series of dial pulses the pulsing circuit is transferred from the vertical magnet to the rotary magnet. Subsequent series of pulses therefore cause the brushes to rotate for selecting a particular set of terminals to which the desired line is connected. Assuming that the selected station is idle at the time of the completion of the dial interruptions, a circuit is closed for operating a cut-through relay 417 which connects the line and sleeve conductors to the called line apparatus. The operation of the cut-through relay places a ground on the sleeve of the brush shaft for operating the line cut-off relay 500. This same ground places a busy condition on the sleeve terminal of the connector multiple bank in order to prevent other connectors from seizing this line. The operation of the cut-through relay 417 also establishes a reversal of polarity through the trunk circuit by operating relay 410. Relay 449 is operated at this time and therefore the operation of relay 417 establishes obvious operating circuits for relays 420, 421 and 410. Relay 415 is also in an operated position at this time. This associates positive potential with the tip conductor and negative potential with the ring conductor over the circuit previously traced through the windings of relays 411, 327 and 614. The reversal of potential causes the operation of relay 327 in the trunk circuit to cause the disconnection of

the trunk conductors from the dial circuit and associate them with the calling station. The current flowing in one winding of relay 411 neutralizes the magnetic effect of the current in the other winding and this relay does not operate. The operation of relay 327 energizes relay 328 from ground through its armature and contact, winding of relay 328 to battery. The operation of relay 328 establishes an energizing circuit for relay 325 from ground through the contact of relay 327, upper contact of relay 328, winding of relay 325 to battery. Relay 325 in operating establishes a locking circuit for itself from battery through its winding and contact 3, to ground through contact 5 of key 338. It will be remembered that the key 338 was placed in the hold-and-split position when the dial key was operated. At this time the dial key 336 is restored to normal which releases relay 321. The key 338 is now moved from the hold-and-split position to the through position to actuate the left-hand contacts. The operation of this key does not establish any circuits at this time but prepares a path for the disconnect signal and opens two shunt circuits across the repeater relay contacts. The shunt path through the contacts of key 338 is closed except when the key is in the through position to insure a loop path under all circumstances when the repeater relays are not required in the signal transmission loop. Relay 341 is maintained operated over a circuit previously traced from ground on contact 4 of key 338 through its winding to battery through the contact of relay 312 and resistance 334. The circuit path for the operation of the disconnect relay 339 is consequently held open as long as the loop circuits are permanently established. Relay 341 is a slow-release relay which prevents its release during the transmission of signals.

Returning now to the operation of the called line apparatus, it will be remembered that the cut-off relay 500 was operated when the line was seized. The operation of relay 500 extends the signaling conductors from the connector (Fig. 4—C) to the line circuit (Fig. 5—A) and the called subscriber's station (Fig. 5—B). The reversal of polarity on the called line is effective over a circuit traceable from grounded positive battery 444, front contact and upper armature of relay 410, ring conductor 445, contact 3 of relay 417, contact 2 of relay 500, winding of polarized relay 513, normal contact of key 515 to ground on the back contact of relay 516. Relay 513 operates and in so doing closes an obvious circuit for the operation of relay 518. The latter relay establishes a locking path for itself from ground through the contacts of keys 527 and 521, lower contact and winding of relay 518 to negative battery. The operation of relay 518 establishes a number of operating circuits as follows:

1. From negative battery through the upper contact of relay 518, lower contact of relay 517, buzzer 514 to ground.
2. From battery through upper contact of relay 518, printer motor 528, contact 529 to ground.
3. Battery is connected through the winding of relay 516 to ground and the lower winding of polarized relay 520 to ground.

The polarized relay 520 may momentarily operate, but as soon as relay 516 operates the relay 520 is released, since the circuit over the loop extending through the upper winding of relay 520 holds the armature against the back contact.

A circuit is therefore established for the printer magnet 526 from ground through its winding, lower contact of relay 520, resistance 519, upper contact of relay 518 to negative battery. The buzzer tone is an indication to the subscriber that the line has been called and the motor started and the subscriber upon hearing the buzzer tone operates key 515 momentarily, which establishes an obvious operating circuit for relay 517 from ground through contact 4 of the key. Relay 517 in operating opens the buzzer circuit and establishes a locking circuit for itself from ground to its upper contact, which is maintained until the station disconnects.

The reversal of polarity previously referred to is of short duration. A circuit as shown in Patent 1,958,930 is established for operating relay 414 which opens the circuit for relay 415 which after a short interval causes the release of relay 410. The normal transmitting polarities through the connector repeater relays is thus established. The release of relay 410 reverses the polarity over the tip conductor which causes the release of relay 513. It will be remembered that a locking circuit was established for relay 518 and therefore the foregoing operations in the station circuit Fig. 5—B, recited after the operation of relay 518, do not depend in so far as time is concerned upon the interval between reversals beyond the time for operating relay 513. As previously stated, the signaling loop to the called station is established by the operation of relay 515. This loop extends to the repeater in the connector circuit, which is made up of two differential polar duplex repeaters such as polar relays 406 and 403, arranged to repeat signals from one point to another in opposite directions, but only in one direction at a time. The repeater circuit loop connections for the called station are traceable from grounded negative battery 409, back contact and upper armature of relay 410, ring conductor 445, contact 3 of relay 417, brush and terminal of the connector switch contact 2 of relay 500, winding of relay 513, contact 1 of key 515, contact of relay 516, sending keys 525 and 523, upper winding of relay 520, contact 1 of relay 500, tip terminal and brush of the connector switch contact 2 of relay 417 through the uppermost winding of relay 403, contact of relay 414 which is operated, contact of relay 406 to grounded positive battery 461. The current from battery 461 is simultaneously flowing through the middle winding of relay 403 but in the opposite relation to that in the uppermost winding. The current in the uppermost winding has approximately double the strength and opposite polarity to the current in the middle winding and predominates to hold the armature of the relay in engagement with the back contact.

The signaling circuit extending between the repeater of the connector and the repeater of the trunk circuit may be traced as follows: Grounded negative battery 409, contact of relay 410, lower winding of relay 411, ring conductor 433, brush and terminal of line-finder winding of polarized relay 327, contact 4 of relay 225, contact and armature of repeater relay 317, upper windings of repeaters 312 and 311, contacts 7 and 10 of key 336, resistances 367 and 368 in multiple, contact 1 of relay 325, tip of line-finder terminal and brush, upper winding of relay 411, contact of relay 419, upper winding of relay 406, contact of relay 403 to grounded positive battery 407. The current from battery 407 is simultaneously flowing through the lower winding of relay 406 but in

opposite relation to that in the upper winding. The current in the upper winding has double the strength and opposite polarity of that in the lower winding and therefore predominates to hold the armature of the relay in engagement with its back contact.

The foregoing circuits traced supply a signaling loop between the called subscriber and the repeater in the connector, also a repeater signaling loop between the connector and the trunk circuit.

For convenience in describing the repeater of the trunk circuit, it may be assumed that the repeater key 338 is operated as previously stated and that the loop circuits are established as previously described. The resistances associated with the repeating relays are for the purpose of proportioning the current flow in the lower windings of relays 311, 312, 315 and 317 for causing the repeater action of the relay when signals are transmitted. Current flows through resistances 353, 352, 351 and 350 from ground on contact 4 of key 338 to battery. This places a negative potential on the terminals of the lower windings of relays 312 and 315 associated with these resistances. Negative potential connected through resistance 334, contact of relay 312, winding of relay 341, to ground on contact 4 of key 338. Negative potential is also connected through resistance 335, contact of relay 315, resistance 314 to ground on contact 4 of key 338. The foregoing circuits through the lower windings of the repeater relays create currents known as spacing currents which tend to move the armatures of the relays away from the contacts with which they are associated so that when the signaling circuit is opened in the sending direction, the armature and contacts of one pair of relays are separated. These resistances also establish a holding current for the alternate pair of repeater relays when signals are transmitted as will be hereinafter described. As previously described, loops are established in each direction and current is flowing through the upper windings of the repeater relays 311, 312, 315 and 317. It may be assumed that the current flowing through the upper windings of these relays is approximately twice as great as the current in the lower windings and has the opposite magnetic effect. This maintains the contacts closed as shown except when signals are transmitted.

When the loop circuit between station A, Fig. 1, and the cord circuit, Fig. 2—A, is opened, the repeater in the cord circuit operates to send a spacing signal between the cord circuit and the trunk circuit, Fig. 3. In this case the armatures of relays 315 and 317 are opened by the action of the spacing current in the lower windings and a spacing signal is transmitted to station B, Fig. 5—B. This signal is, of course, carried through the repeater of the connector which operates as previously described. The spacing signal of the trunk repeater is transmitted by the opening of the contact of repeater relay 317. At the same time the contact of repeater relay 315 is opened for the purpose of opening the circuit path through resistance 335 and 314, which causes a difference in potential in the lower windings of relays 311 and 312, with the result that a holding current flows through these windings to hold the armatures of relays 311 and 312 against their respective contacts when the loop extending to the connector, Fig. 4—C, is opened for the spacing signal. This same condition exists when a signal is transmitted

ted from station B, Fig. 5—B. The opening of the loop between the connector and the trunk circuit causes the opening of the contacts of relays 311 and 312. The spacing signal is transmitted by relay 311 and the opening of the contact of relay 212 establishes a holding circuit for relays 315 and 317.

Signals are transmitted between station A and station B over the circuits and in the manner described.

Disconnect

Upon the completion of the message the line finder and hunting connector switches are held in place due to the fact that relay 411 is not operated. In order to restore the switches and other apparatus to normal the subscriber at either station A, Fig. 1—A, or station B, Fig. 5—B, transmits a stop signal, usually the upper case H, whereby the motor control contacts 7 at station A and motor control contact 521 at station B are opened, causing the release of their respective associated motor start relays 108 and 518. The release of relay 108 causes the release of relays 109 and 110 and also causes the deenergization of the lower winding of the pulse relay 107 and the printer magnet 100. Likewise, the release of relay 518 causes the release of relays 516 and 517 and the deenergization of the upper winding of pulse relay 520 and the printer magnet 526. It will be apparent that the release of relays 109 and 516 opened their respective transmitting loops. Relay 516 in releasing, connects ground at its armature and back contact causing only one winding of relay 411 to be energized. The release of relay 516 allows relay 406 to be operated to the position shown in the drawings. Relay 411 now having only one of its windings energized, operates, thereby causing the release of relay 420, which in turn causes the release of relay 421. The release of relay 421 opens the operating circuit for relay 417 and the operating circuit for relay 414. The release of relay 417 causes the release of the cut-off relay 500 and the operation of relay 403 to the position shown. The release of relays 420, 421 and 417 establishes a circuit for the switch release magnet which allows the switch shaft of the hunting connector switch to return to its normal position. When the hunting connector switch is returned to its normal position, the operating circuit for the release magnet is opened at the contacts and upper spring of the vertical off-normal springs. Simultaneously with the release of the hunting connector switch the line-finder switch is released since the release of relay 421 removes ground from the sleeve conductor associated with the line finder. A circuit is now established for the release magnet of the line switch, which operates and allows the line-finder switch shaft to return to normal. When the line-finder switch shaft returns to its normal position a locking circuit for the cut-off relay 400 is opened and the relay releases, thereby reassociating relay 401 with the ring conductor of the trunk.

When the loop between the trunk circuit, Fig. 3, and the station B is opened, the repeater relays 311 and 312 are energized by the spacing current and the contacts opened. A circuit for relay 341 is thus opened to cause its release. As previously stated this relay is slow to release in order that its release does not take place during the transmission of signaling. The release of relay 341 establishes a circuit for the ultimate

operation of relay 339. This circuit may be traced from ground, through contact 1 of key 338, winding of relay 339 and resistance 349 in parallel, contact of relay 341, thermostat 342, resistance 346, to battery. Relay 339 does not get sufficient current to operate in series with the winding of the thermostat 342. The current flow through the thermostatic relay 342 generates heat therein, which closes its contact after an interval of time. As soon as the contact of the thermostat 342 is closed, the thermostat winding is shunted, which furnishes sufficient current in the circuit traced for the operation of relay 339. In operating relay 339 alters its holding circuit, which is now carried through its right contact, resistance 345, resistance 346, to battery. The thermostat 342 is thus eliminated from the circuit. The operation of relay 339 establishes a circuit for the disconnect lamp 343, which may be traced from ground through contact 1 of key 338, left contact of relay 339, filament of lamp 343, resistance 344, to battery. The lighting of lamp 343 is a signal to the trunk operator to restore all keys to normal and in consequence of the restoration of the keys, all of the apparatus of the trunk circuit is restored to normal. Upon the release of trunk relay 306 a circuit is established for the operation of line relay 215 from ground on contact 1 of relay 306 through resistance 220, contact 1 of relay 218, upper winding of relay 215, resistance 223 to battery. Relay 215 establishes an obvious operating path for relay 216 and the operation of relay 216 establishes a circuit for relay 241 as previously traced. The operation of relay 241 establishes a circuit for lighting the supervisory lamp 242 as a disconnect signal to the manual operator. The same supervisory signal is received upon the restoring of the apparatus on the line circuit, Fig. 1—B. The manual operator removes plugs 239 and 237 from jacks 114 and 214, respectively, which releases relays 118 and 218 which completes the restoring of the apparatus of the system to normal.

Miscellaneous trunking operations

Referring again to the trunk position circuit, it will be apparent from the arrangement of the wiring of the key 336 that the printer 600 can be associated with the trunk conductors in either direction by operating the key to the position marked DIAL for one connection and the position marked TWX for the other. In a manner which will be obvious to those skilled in the art from the description herein calls may be made from station B to the trunk operator and extended to the operator at the cord circuit 2—A and thence to a subscriber at station A. If two incoming calls are simultaneously received on the same trunk, one from a station such as A and one from a station such as B, the operator may actuate key 338 to the hold-and-split position and by operating key 336 to the desired position, hold communication by the transmission of signals, with one station independently of the second connection. During the communication with either station, the loop in the opposite direction is held over an obvious circuit through resistances 365—366 or 367—368.

The trunk operator may originate calls in either direction by the use of key 336, with key 338 in the hold-and-split position. In originating a call to station A, key 336 is operated to the left for energizing relay 306 from ground on contact 1 of key 336, through the winding of relay 306,

resistance 307, to battery. This establishes a circuit for energizing relay 215 which may be traced from battery, through resistance 224, contact 3 of relay 218, lower winding of relay 215, line resistances 222 and 221, contact 4 of relay 306, contact 2—3 of key 336, printer 606, contact 4—5 of relay 336, upper windings of relays 317 and 315, armature and contact of relay 311, contact 1 of relay 306, resistance 220, contact 1 of relay 218, to ground on contact 1 of relay 219. The operation of relay 215 establishes a circuit for operating relay 219 from ground through the contact of relay 215, contact 2 of relay 218, to battery through winding of relay 219. The operation of relay 219 establishes an obvious circuit for lighting lamp 212. The manual operator inserts plug 237 in jack 214 for answering the call from the trunk operator and receives signals as previously described on printer 269. This operator then inserts plug 230 into a jack such as 114 associated with the desired subscriber's station. The insertion of the plug in the jack energizes relay 118 and associates the station apparatus with the cord circuit. Key 231 is actuated by the cord circuit operator for associating ringing potential 236 with the line for energizing the ringer 104. The circuit for ringer 104 is obvious and need not be traced. The apparatus of the subscriber's station is manually started by the station operator and the transmission of signals takes place between the trunk position and the subscriber's station.

A connection may be made by the trunk operator to the automatic private branch exchange, Fig. 5—B, by the operation of key 336 to the dial position. Key 338 is in this case also placed in the hold-and-split position. The operation of the keys in this manner establishes a circuit for relay 321 from battery, through resistance 222, winding of relay 221, contact 6 of key 336, to ground 360. A circuit is thus established for the operation of relay 323 from ground through contact 2 of relay 221, lower winding of relay 223, resistance 224, to battery. The line finder is thus operated as previously described but in this instance the winding of relay 401 is actuated from ground on the left contact of dial 615. The connector switch, Fig. 4—C, is operated by the transmission of dial impulses as previously described, which associates the station, Fig. 5—B, with the trunk operator's position. Signals may now be transmitted in the manner previously described.

What is claimed is:

1. In a trunking system for interconnecting telegraph lines entering central office switching systems, teletypewriter subscribers' stations connected with different central offices of the manually operable type and automatic switching type, a trunking central office with which said different offices are connected, trunk circuits in said trunking office having a printer set associable therewith, and means in the trunks of said trunking office including switching apparatus and pulsing apparatus for receiving calls from and interconnecting subscribers' stations entering said different offices.

2. In a trunking system for interconnecting telegraph lines entering central office switching systems, teletypewriter subscribers' stations connected with different central offices of the manually operable type and automatic switching type, a trunking central office with which said different

offices are connected, trunk circuits in said trunking office having a printer set associable therewith, means in the trunks of said trunking office including switching apparatus and pulsing apparatus for receiving calls from and interconnecting subscribers' stations entering said different offices, and means in said trunks for inserting a through-repeater circuit in between said interconnected stations.

3. In a trunking system for interconnecting telegraph lines entering central office switching systems, teletypewriter subscribers' stations connected with different central offices of the manually operable type and automatic switching type, a trunking central office with which said different offices are connected, trunk circuits in said trunking office having a printer set associable therewith, and means in the trunks of said trunking office including switching apparatus and pulsing apparatus for originating connections in the trunking office extending to subscribers' stations entering said different offices.

4. In a trunking system for interconnecting telegraph lines entering central office switching systems teletypewriter subscribers' stations connected with different central offices of the manually operable type and automatic switching type, a trunking central office with which said different offices are connected, trunk circuits in said trunking office having a printer set associable therewith, means in the trunks of said trunking office including switching apparatus and pulsing apparatus for receiving calls from and interconnecting subscribers' stations entering said different offices, and means in said trunks for splitting said connections for communicating by signals with either type of central office and with subscribers' stations entering said offices.

5. In a trunking system for interconnecting telegraph lines entering central office switching systems, teletypewriter subscribers' stations connected with different central offices of the manually operable type and automatic switching type, a trunking central office with which said different offices are connected, trunk circuits in said trunking office having a printer set associable therewith, means in the trunks of said trunking office including switching apparatus and pulsing apparatus for receiving calls from and interconnecting subscribers' stations entering said different offices, and means in said trunks for communicating with both said interconnecting stations simultaneously.

6. In a trunking system for interconnecting telegraph lines entering central office switching systems, teletypewriter subscribers' stations directly connected with different central offices including the manually operable type and the automatic switching type with trunk finder and connector switches, a trunking central office with which said different offices are connected, trunk circuits in said trunking office, means in the trunks of said trunking office for receiving calls from a manual office and completing a connection for said call from the manual office to a subscriber's station entering an automatic switching office, and means in said trunk circuit to cause the operation of a trunk finder in the distant automatic switching office upon the seizure of said trunk circuit at the manual office.

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