Oct. 30, 1945. L. A. GARDNER ET AL 2,388,136

PARTY-LINE PRINTING TELEGRAPH SYSTEM

Filed May 14, 1941 7 Sheets-Sheet 1

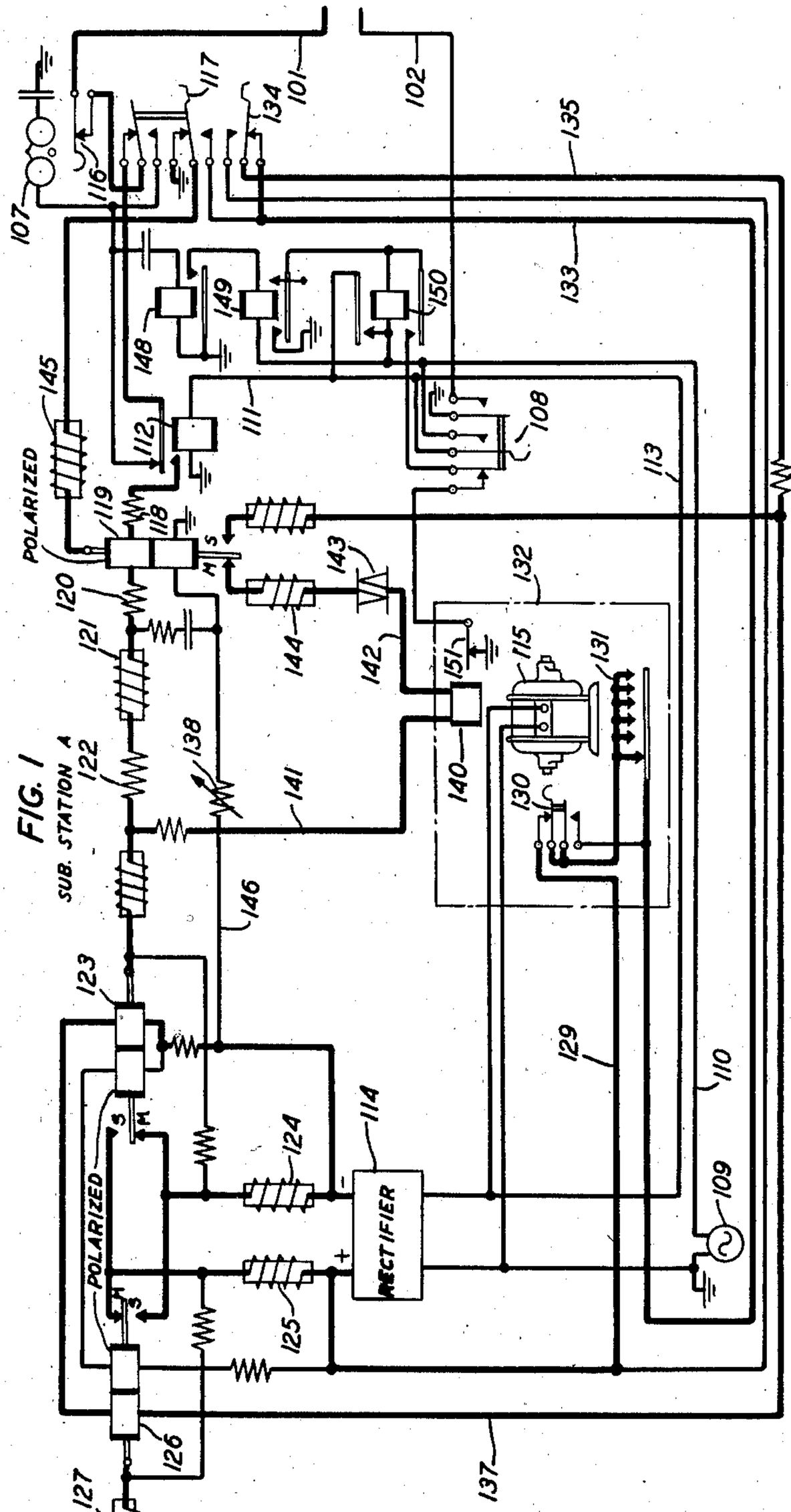

FIG. 1

FIG. 4

FIG. 1	FIG. 2	FIG. 3

SYSTEM "X"

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PARTY-LINE PRINTING TELEGRAPH SYSTEM

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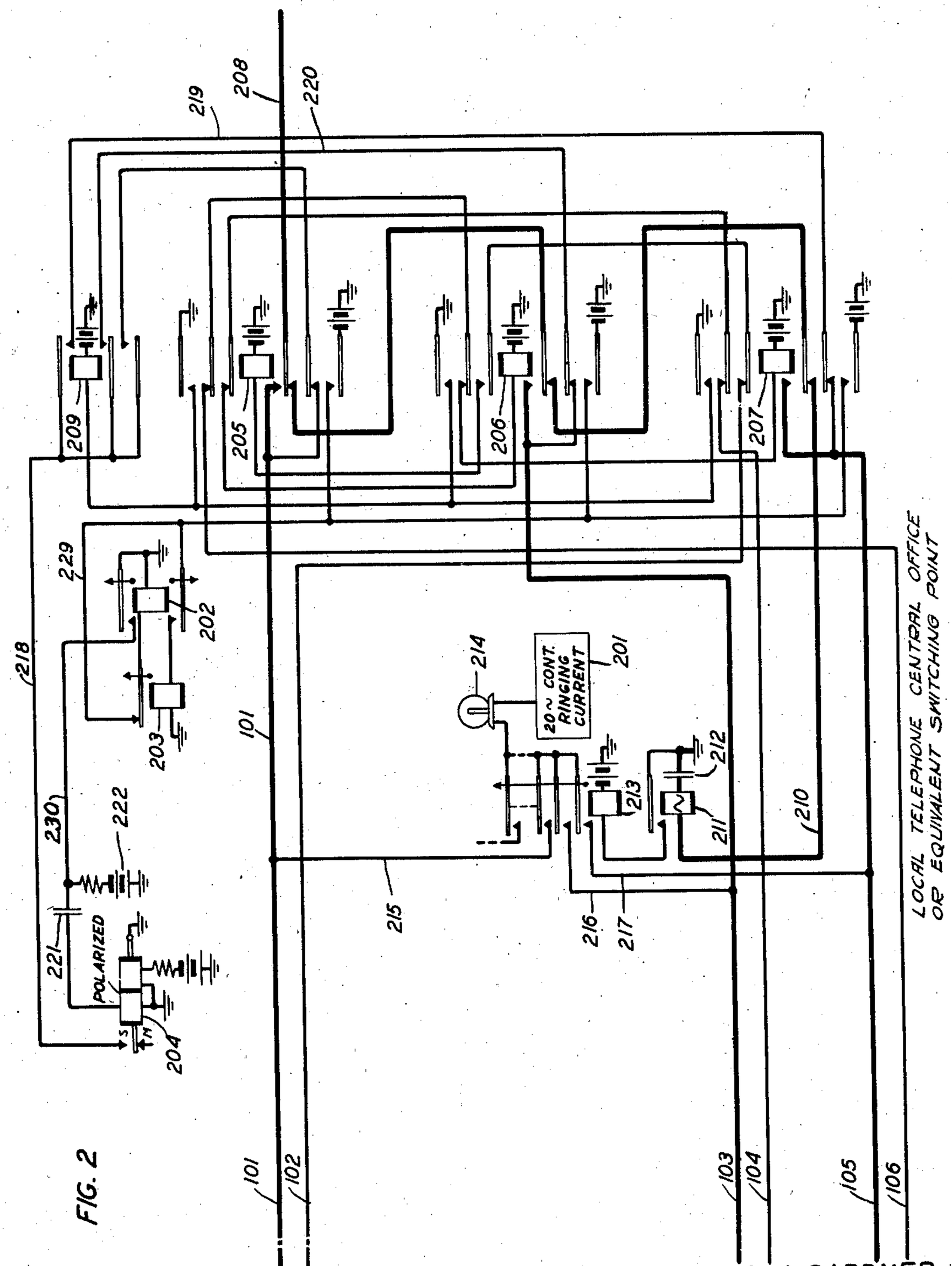

FIG. 2

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PARTY-LINE PRINTING TELEGRAPH SYSTEM

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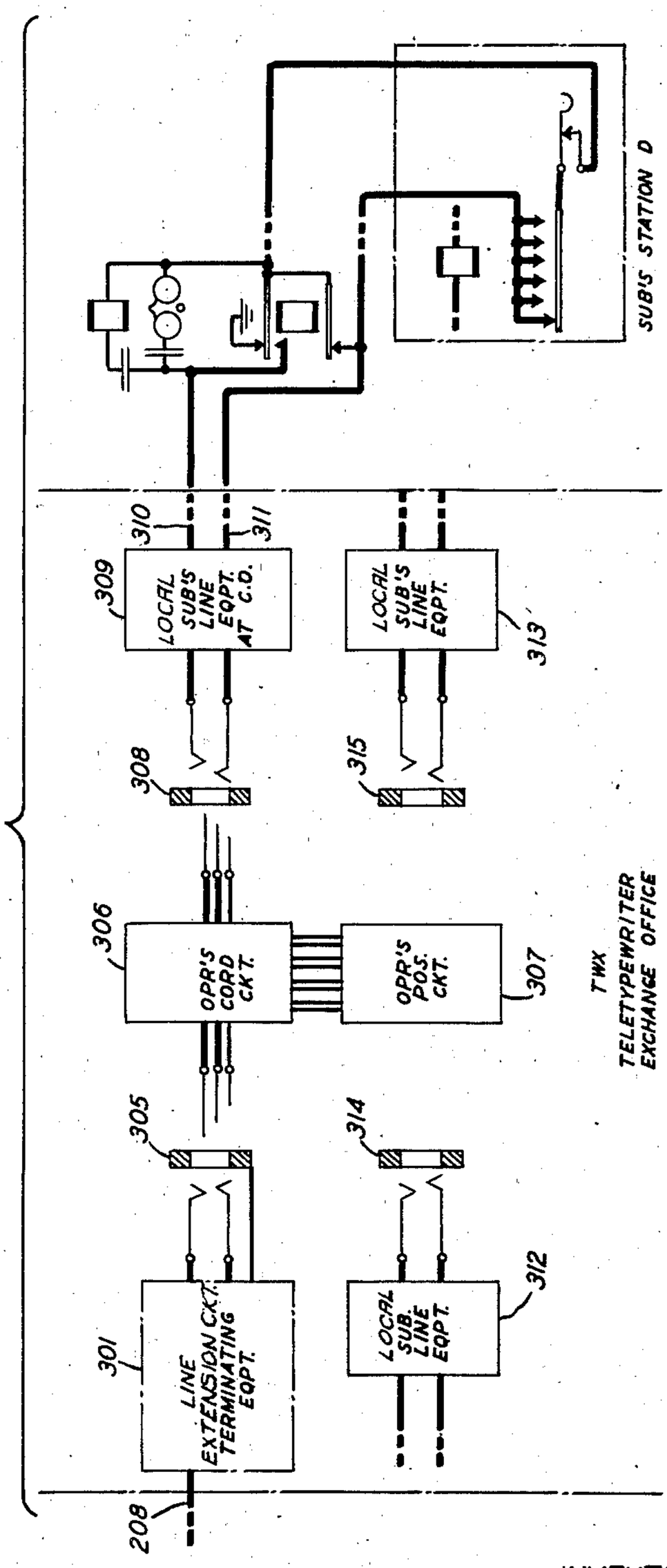
FIG. 3



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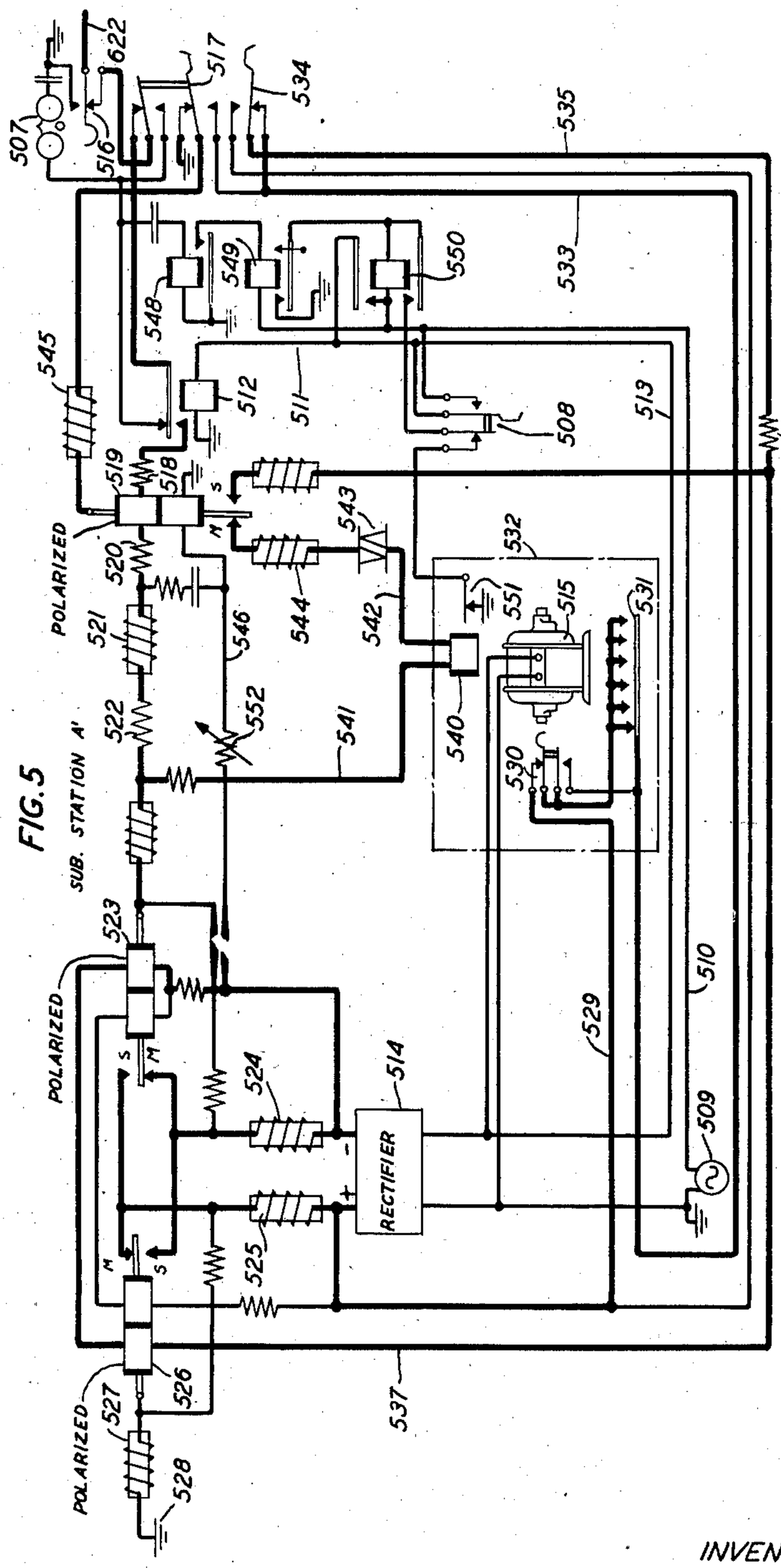

FIG. 5

FIG. 9

FIG. 5	FIG. 6	FIG. 7	FIG. 8

SYSTEM "Y"

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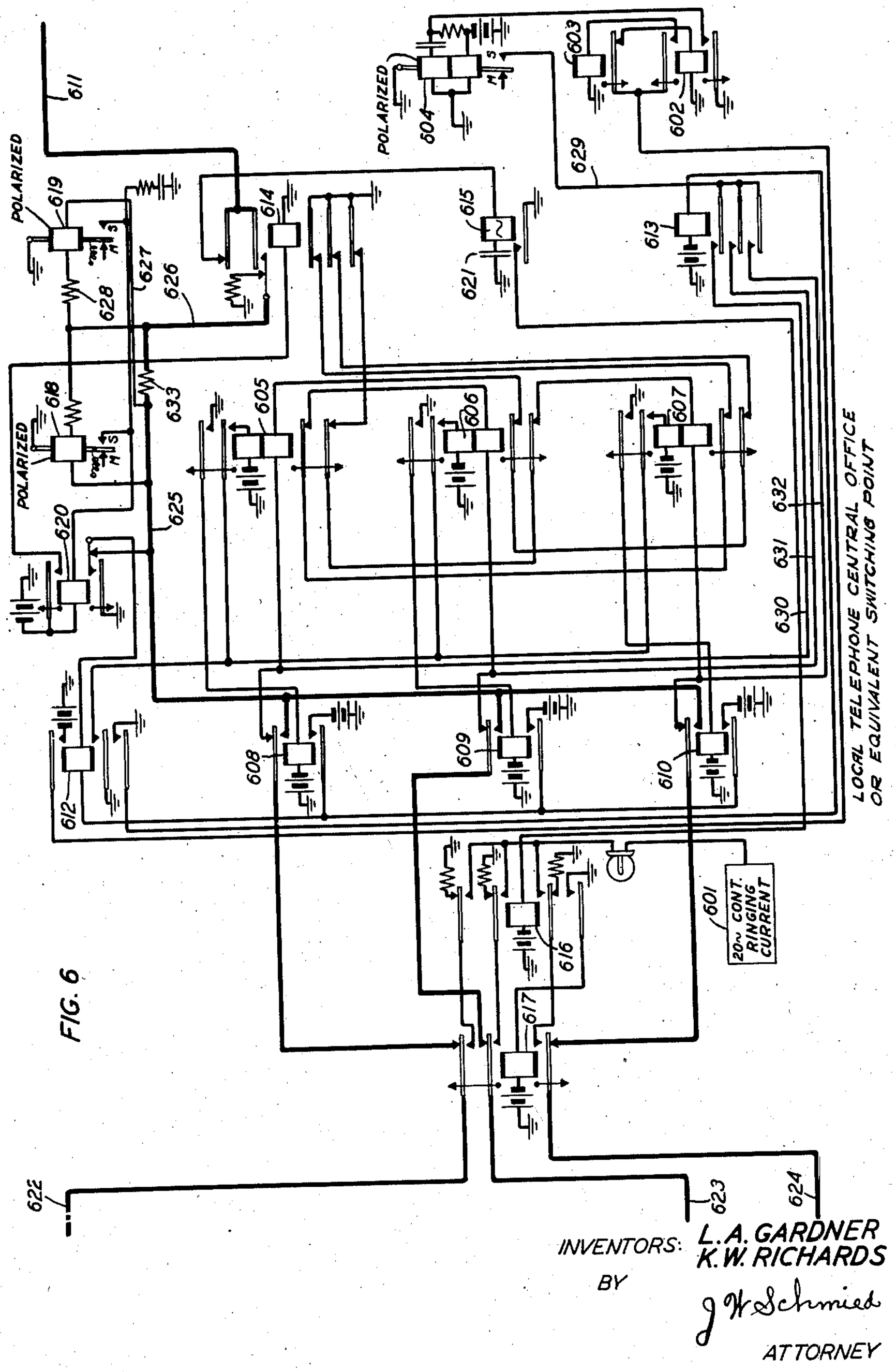

FIG. 6

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PARTY-LINE PRINTING TELEGRAPH SYSTEM

Filed May 14, 1941 7 Sheets-Sheet 6

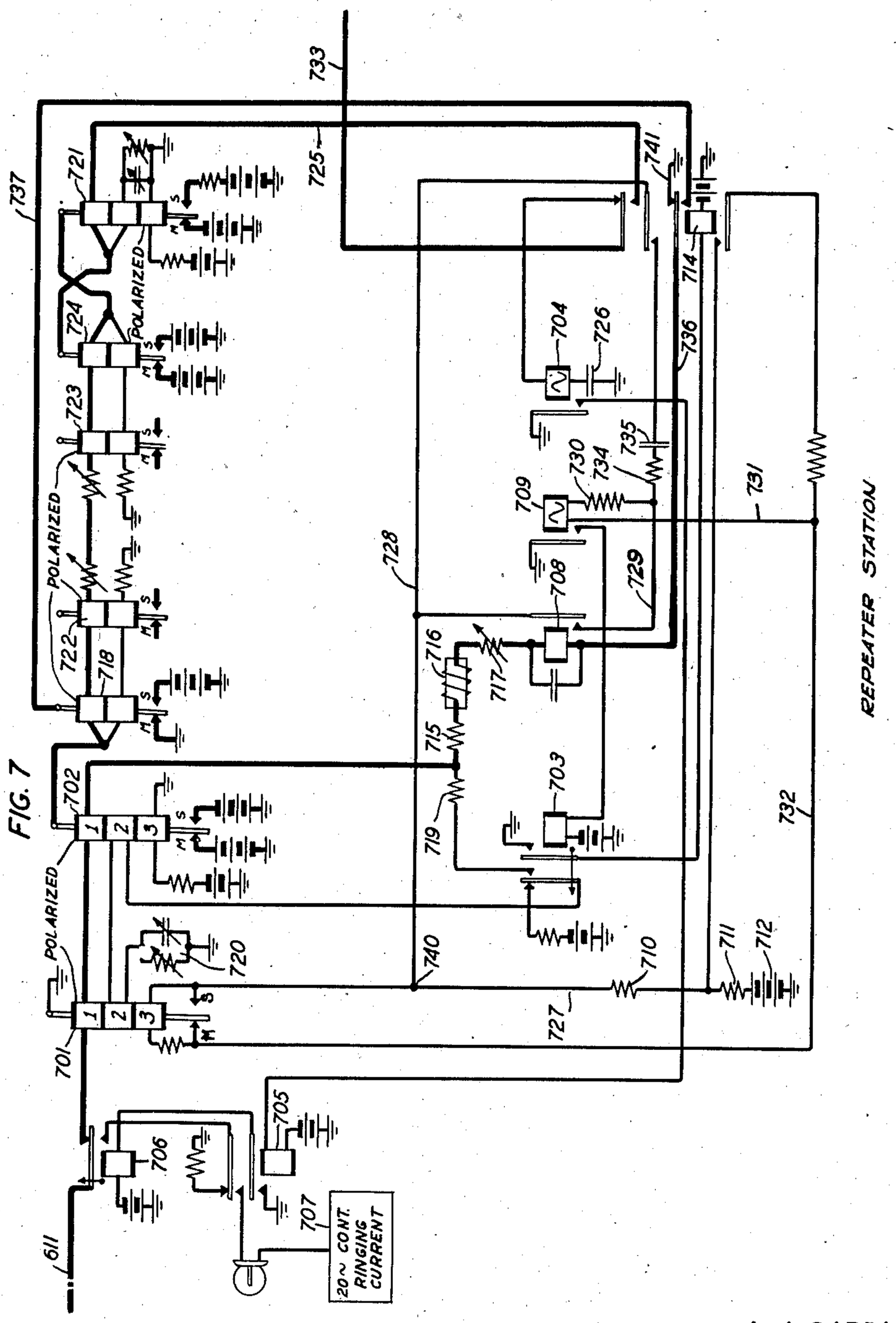

FIG. 7

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PARTY-LINE PRINTING TELEGRAPH SYSTEM

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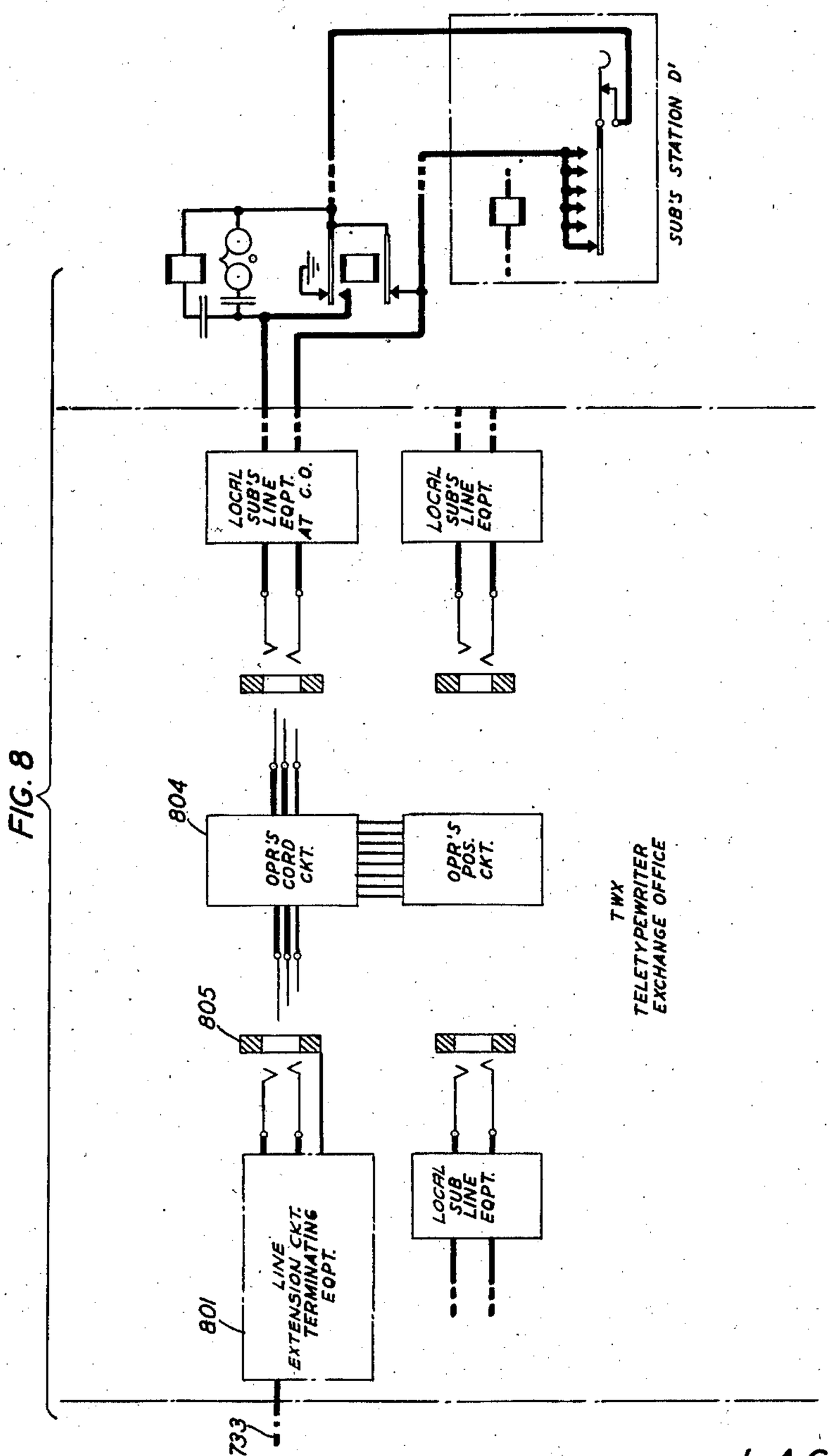

FIG. 8

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Patented Oct. 30, 1945 2,388,136

UNITED STATES PATENT OFFICE

2,388,136

PARTY-LINE PRINTING TELEGRAPH SYSTEM

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Application May 14, 1941, Serial No. 393,324

9 Claims. (Cl. 178—2)

This invention relates to a communication system for transmitting signaling impulses over telegraph lines or channels and more particularly to a telegraph system for connecting a plurality of outlying telegraph subscriber stations to a central exchange office over a single telegraph line, channel or trunk.

An object of the invention is to provide a plurality of subscriber stations with teletypewriter switching service over a single line, channel or trunk.

Another object of the invention is to lock out, or prevent, a subscriber station of a party-line group from using a line, channel or trunk when another of the subscriber stations is operatively connected to the same line, channel or trunk.

Another object is to utilize a telegraph line, channel or trunk of the repeatered type as a means of operatively extending through a local control, or switching, center, any one of a plurality of subscriber stations to a remote central office thereby giving the subscriber a party-line service over said line, channel or trunk.

Another object of the invention is to permit at any one time one only of a plurality of subscriber stations to be operatively connected at the switching center to a telegraph line extending through one or more repeater stations to a telegraph exchange office.

Another object is to provide a system responsive to code ringing whereby any one of a plurality of subscriber stations may be operatively connected through the switching center to a line, channel or trunk, to the exclusion of the other of said subscriber stations connected to the same line, channel or trunk.

Another object is to provide a system whereby any one of a plurality of subscriber stations may be operatively connected through the switching center to a multisection line, channel or trunk extending to a teletypewriter exchange office.

Another object is to provide a system having a plurality of subscriber stations connected to the switching center with means thereat for operatively connecting any one of said stations, to the exclusion of the other of said stations, to a multisection line, channel or trunk extending through a plurality of repeater stations, in series, and a source of busy signals at said switching center for automatically informing a subscriber at one or more of said subscriber stations when another of said subscriber stations is operatively connected to said line, channel or trunk.

Another object is to provide a system in accordance with the immediately preceding object wherein the busy signals transmitted from said source are in permutation code.

According to an embodiment of the present invention a multistation teletypewriter line is connected to a teletypewriter exchange office. Three or more subscriber stations may be connected, in parallel, to a switching, or control, center by one or two wires and the switching center may be connected by a single wire of the single or multisection type to one or more repeater stations, in series, for repeating communication signals to the teletypewriter exchange office. A code ringing source is provided at the switching center whereby calls may be made to any one of a plurality of subscriber stations connected to the line on the basis of one, two and three rings respectively assigned to such stations. A source of busy signals is provided at the switching center for transmitting to each of a plurality of subscriber stations permutation code signals, such as a series of "letters" or other known characters should any subscriber at such stations attempt to establish a connection to the line at a time when the line is in use by a subscriber at another of said stations. The idle stations of said plurality are prevented at the switching center from being operatively connected to the line when one of said subscriber stations is operatively connected to the line.

A feature of the invention is the provision of a system wherein each of a plurality of subscriber stations may be connected to the switching center by one or two single-wire circuits and either of such two arrangements may be operatively connected over a single-wire, single or multisection line extending to the teletypewriter exchange office, each section of such line being operated half-duplex employing current reversals in one direction and differences of current in the other direction.

The invention will now be described with respect to the accompanying drawings which illustrate two telegraph systems in each of which an embodiment of the invention is satisfactorily adapted. The drawings are arranged into two groups respectively identified herein as systems X and Y. System X consists of Figs. 1 to 3, inclusive, and system Y consists of Figs. 5 to 8, inclusive. Both systems are equipped to furnish code ringing for calling subscriber stations. System X comprises lines of two wires each between each of the subscriber stations and the switching center, and a single section line for interconnecting the switching center and the teletypewriter exchange office, whereas system Y comprises lines

of a single wire each between each of the subscriber stations and the switching center, and a multisection line interconnecting the switching center and the teletypewriter exchange office.

The drawings are as follows:

Fig. 1 shows three toll line subscriber teletypewriter stations A, B and C. Station A is shown in schematic form and each of stations B and C is shown in diagrammatic form, it being understood that the equipment at each of stations B and C is the same as that shown at station A with the exception that stations B and C are equipped for attended station service only.

Fig. 2 shows the equipment, in schematic form, at the switching center located in the community of subscriber stations A, B and C. It will be noted that each of the subscriber stations A, B and C is connected to the switching center by two wires, one for transmission and signaling and the other for control purposes. The equipment at the switching center provides code ringing for calling the subscriber stations.

Fig. 3 shows a single-wire circuit connecting the switching center to a toll line extension circuit terminating equipment located in the distant teletypewriter exchange office. The terminating equipment includes a repeater. Also in Fig. 3 are shown in diagrammatic form the equipment at the teletypewriter exchange office and the equipment at a local subscriber station connecting directly to the office.

Fig. 4 shows the relative arrangement of Figs 1, 2 and 3.

Fig. 5 shows three toll line subscriber teletypewriter stations A′, B′ and C′. Station A′ is shown in schematic form and each of stations B′ and C′ is shown in diagrammatic form, it being understood that the equipment at each of stations B′ and C′ is the same as that shown at station A′ except that stations B′ and C′ are equipped for attended service only.

Fig. 6 shows the equipment, in schematic form, at the switching center located in the community of subscriber stations A′, B′ and C′. It will be noted that each of subscriber stations A′, B′ and C′ is connected to the switching center by a single wire which is utilized for three functions, namely, transmission, signaling and control. The equipment at this switching center provides code ringing for calling the subscriber stations.

Fig. 7 shows the equipment, in schematic form, at an intermediate repeater point in a multisection line circuit with wiring adapted for use with code ringing.

Fig. 8 shows the single-wire multisection line terminating in a switchboard at the teletypewriter exchange office. Also in Fig. 8 are shown in diagrammatic form the equipment at the exchange office and the equipment at a local subscriber station connected directly to the exchange office.

Fig. 9 shows the relative arrangement of Figs. 5, 6, 7 and 8.

SYSTEM X

General Description

Inasmuch as station A is shown in detail, and stations B and C are substantially similar to station A, a description of the equipment employed at station A and the method of operation of such equipment is believed to be sufficient for a description and method of operation of the equipment at each of stations B and C which are shown in diagrammatic form. Station A is connected to the switching center by two conductors **101** and **102**. Stations B and C and similarly connected by their respective pairs of conductors **103** and **104**, and **105** and **106**. The upper conductor of each pair is for signaling and transmitting and the lower conductor is for controlling the connection established between each of the stations and the switching center. The equipment at station A includes facilities for providing unattended station service, if desired, and is identical with Fig. 1 of United States Patent 2,143,000 granted to W. W. Cramer et al. on January 10, 1939, except that the power switch at station A has an extra pair of contacts for grounding control conductor **102**. The equipment at each of stations B and C is identical with Fig. 5 of United States Patent 2,143,000 except that no facility for unattended station service is provided, stations B and C being arranged to operate on the basis of attended station service only.

Fig. 2 shows a schematic circuit arrangement of the equipment located at the switching center. Common to stations A, B and C is a source **201** of continuous ringing current for calling by code any one of the subscriber stations, for example, one ring for station A, two rings for station B and three rings for station C. At station A which is equipped for both unattended and attended station service, relay **148** is responsive to one prolonged ringing signal as compared with the one ringing signal of short duration used when the station is arranged as an attended station. Also, common to stations A, B and C is a busy signal source. The busy signals are transmitted by the alternate operation and release of relays **202**, **203** and **204** to produce a series of "letters" signals at the teletypewriter of a subscriber at one of the stations, whereat an attempt is made to call by turning on the power switch when the line to the switchboard is in use by a subscriber at one of the other stations. Line relays **205**, **206** and **207** are respectively provided for stations A, B and C and utilized when operated for controlling an established connection between the respectively associated subscriber stations and line **208**. Relay **209** when operated by any one of the line relays serves to connect the source of busy signals over the normal contacts of any one or more of the line relays which are in normal condition at the time. The source **201** of continuous ringing current is under control of alternating current relay **211** and slow-release relay **213**.

Party, or multistation, line **208** is of the single-wire type and represents the toll line extension circuit arranged for connection through the control, or switching, center to any one of stations A, B and C. Line **208** terminates in the repeater of the toll line terminating equipment at the operator's switchboard in the teletypewriter exchange office, the toll line terminating equipment including jack **305**. The toll line terminating equipment may be similar to Fig. 2 of United States Patent 2,143,000, supra. Arranged in proximity to jack **305** is operator's cord circuit **306** and operator's position circuit **307**, both of which may be similar to Figs. 3 and 4, respectively, of United States Patent 2,143,000. Another jack **308** at the operator's switchboard is part of a local subscriber's line terminating equipment **309** which, in turn, is connected by means of conductors **310** and **311** to the local subscriber's station D. The local subscriber's line terminating equipment and the local subscriber's station D may be similar to Fig. 5 of United States Patent 2,143,000. Other line terminating equipment such as those

designated 312 and 313, respectively, including jacks 314 and 315 may be provided at the operator's switchboard and arranged for connecting the operator's cord circuit to other subscribers' stations (not shown). The distance between the teletypewriter exchange office and subscribers' stations A, B and C is assumed to be considerable and therefore requires a toll line including the necessary repeaters.

Method of Operation

Operator calls

Assuming that a connection is desired with one of subscribers' stations A, B and C, the operator connects one of several cord circuits such as cord circuit 306 to jack 305 and then operates a ringing key (not shown) associated with cord circuit 306, say one operation of the ringing key for station A, two operations for station B and three operations for station C. Station A which has assigned to it one interval of ringing current is shown as being arranged as hereinbefore stated for both attended and unattended station service because of its having one ring signal only. For unattended station service, the one ring signal will be for a prolonged interval sufficient to operate slow-to-operate relay 149, relay 148 operating first and then followed, in turn, by relays 149 and 150. Relays 149 and 150, upon operating, energize rectifier 114 and start teletypewriter motor 115. Stations B and C are arranged for attended station service only and therefore have no relays corresponding to relays 148, 149 and 150 or motor stop contacts corresponding to those designated 151. This ringing current is transmitted through toll line terminating equipment 301 and line conductor 208 to the switching center. Should the call be to station A, one normal operation of the ringing key (not shown) would cause one interval of ringing current to be transmitted over the innermost lower armature and back contact of each of line relays 205, 206 and 207, in turn, conductor 210, through the winding of alternating current relay 211, condenser 212 to ground. Relay 211 would operate in response to the ringing current and thereby operate relay 213.

Relay 213 which is of the slow-to-release type, upon operating, closes at its armatures and contacts three circuits extending from common source 201 of continuous ringing current, through the indicating lamp 214, over conductors 215, 216 and 217, in parallel paths respectively extending over transmitting conductors 101, 103 and 105 to the ringer at each of stations A, B and C, the ringer at station A being designated 107.

The subscriber at station A upon identifying the single interval of ringing current will respond by operating power switch 108. Power switch 108, upon being operated, completes a path from grounded alternating current source 109, conductor 110, middle contacts of the switch, conductor 111, through the winding of relay 112 to ground. A path parallel to that extending over conductor 111, extends over conductor 113 through rectifier 114 and printer motor 115 in parallel. Rectifier 114 is energized and printer motor 115 starts operating. Relay 112, upon operating, closes a circuit from line 101, through recall key 116, test-out key 117, armature and contact of relay 112, resistance 118, through the upper winding of receive relay 119, resistance 120, retardation, or choke, coil 121, resistance 122, armature and marking, or lower, contact of send relay 123, retardation coil 124, negative terminal to positive terminal of rectifier 114, retardation coil 125, marking, or upper, contact and armature of send relay 126, retardation coil 127 to ground 128. The energized rectifier supplies a source of potential difference between its terminals and thus to the circuit including ground 128 and line conductor 101. Rectifier 114, upon becoming energized, also causes current to flow in two parallel paths, one extending from the positive terminal of the rectifier through the right-hand biasing winding of send relay 126 and the left-hand biasing winding of send relay 123 to the negative terminal of the rectifier and the other from the positive terminal of the rectifier, conductor 129, break key 130, transmitting contacts 131 of subscriber's teletypewriter 132, conductor 133, normal contacts of line-in key 134, conductor 135, regulating resistance 136, conductor 137, through the respective left-hand and the right-hand operating windings, in series, of send relays 126 and 123, to the negative terminal of the rectifier. Printer magnet 140 of subscriber's teletypewriter 132 is also normally energized by current flowing from rectifier 114 over a circuit including conductor 141, through the winding of printer magnet 140, conductor 142, varistor elements 143, retardation coil 144, marking, or left-hand, contact and armature of receive relay 119, retardation coil 145, to ground at the lower normal contacts of key 117. The biasing, or lower, winding of receive relay 119 is energized over conductor 146 and resistance 138, and serves to operate receive relay 119 to its spacing, or right-hand, position when line 101 is opened. Resistance 138 is of the adjustable type in order that it may be adjusted to suit conditions of the line through the control unit to the switchboard at the teletypewriter exchange office. A further description of the various elements in the circuit shown in Fig. 1 may be had by referring to United States Patent 2,143,000, supra. Power switch 108, upon being operated, connects ground at its outermost right-hand contacts to control conductor 102 of a circuit which extends over the contact and innermost upper armature of each of line relays 207 and 206, in series, through the winding of line relay 205 to grounded battery. Relay 205, which is the line relay for station A, operates and (1) at its outermost upper armature and contact closes an operating circuit for relay 209 which operates to connect at its upper armature and contact and its inner lower armature and contact busy signal conductor 218 to two parallel paths, one extending over conductor 219, middle lower armature and contact of relay 207, line conductor 105 and the other extending over conductor 220, middle lower armature and contact of relay 206, line conductor 103, whereby should the subscriber at either of stations B or C originate a call while station A is using line 208, the subscriber so attempting such call would receive a busy signal; (2) at both its middle upper and its inner upper armature respectively opens two paths whereby the subscribers of either of stations B or C could not operate their respective station line relays should such subscribers attempt to initiate a call while line 208 is connected to station A; (3) at its inner lower armature connects line 208 to conductor 101 for communication purposes between the operator at the teletypewriter exchange office and the subscriber at station A; (4) at its middle lower armature disconnects the source of busy signal from station A; and (5) at its outermost lower armature connects grounded battery

to start conductor 229 whereby relay 202 is operated to cause the busy signal to be transmitted by polarized relay 204 as will be hereinafter described. Therefore a line relay such as any one of relays 205, 206 and 207 causes, when operated, the subscribers' stations other than that which caused the line relay to operate, to be locked out from any established connection to the line and prevents an operator at the teletypewriter exchange office from establishing two simultaneous connections to the alternating current relay 211 to transmit code ringing currents.

The marking current flowing from rectifier 114 operates the calling-in circuit at the switchboard of the teletypewriter exchange office thereby causing the line lamp associated with line 208 to operate in a manner as described in United States Patent 2,143,000, supra.

Idle condition

The line 208 at the control, or switching center, shown in Fig. 2, is, during an idle period, open to direct current inasmuch as it is connected in a circuit extending over the innermost lower armature and back, or normal, contact of each of line relays 205, 206 and 207, in series, to conductor 210 through the winding of alternating current relay 211, condenser 212 to ground, condenser 212 serving to block direct current and relay 204 which is of the polarized type and serves to transmit the busy signal is normally held on its marking, or lower, contact by current flowing in its biasing, or right-hand, winding.

Operator calls

The operator at the teletypewriter exchange office connects a cord circuit to line 208 in the usual way and thereby causes a lamp located at the switchboard and associated with the selected line, to light. The operator then operates the ringing key associated with the selector cord circuit to transmit in code, that is, one signal to called station A, two signals to called station B, three signals to called station C. Ringing current over line 208 from the switchboard causes alternating current relay 211 to operate. Relay 211, upon operating, causes supplementary ring relay 213 which is of the slow-to-release type to transmit ringing in unison with operator's ringing key from source 201 at the switching center to subscribers' stations A, B and C simultaneously. The supplementary relay 213 is inserted between relay 211 and each of station line conductors 101, 103 and 105 to prevent line "hits" from causing false operation of the subscribers' station ringers. In response to the "one," "two" and "three" rings, the subscriber at the called station operates the power switch corresponding to switch 108 at station A and the connection is established for communication purposes as hereinbefore described for a call from subscriber's station A to the teletypewriter exchange office. When the operator at the teletypewriter exchange office observes the line lamp extinguished he knows that the established connection is prepared for transmission.

Busy signal

The operation of any one of line relays 205, 206 and 207 connects ground to the winding of relay 209 which operates, and at the same time grounded battery is connected to the start conductor 229 whereby relay 202 is operated in an obvious circuit. Relay 202, upon operating, applies grounded battery on start conductor 229 to operate relay 203. Relay 203, upon operating, opens the operating path of relay 202. Relay 202, being of the slow-to-release type, holds momentarily after its operating circuit is opened and then releases thereby removing grounded battery from the operating circuit of relay 203. Relay 203 which is also of the slow-to-release type holds momentarily after its operating circuit is opened and then releases thereby again closing the operating circuit of relay 202 which reoperates, and in turn, causes relay 203 to reoperate. Inasmuch as relays 202 and 203 are of the slow-to-release type, about one-half second release, ground will be applied to conductor 220 for about one-half second and removed for about one-half second alternately. These cycles continue as long as a line relay, such as relay 205, 206 and 207, remains operated. The operation and release of relay 202 applies approximately sixty impulses per minute provided to transmit a busy signal.

The initial application of ground to conductor 230 discharges condenser 221 which is normally charged to a potential equivalent to that of battery 222 and the subsequent removal of ground from conductor 230 allows condenser 221 to recharge to its former potential. This charging current flows through the operating, or left-hand, winding of relay 204 and is of sufficient volume and flows in such a direction as to momentarily overpower the biasing current in the right-hand winding of the relay.

In response to this charging current, relay 204 operates to its spacing, or upper, contact for a period of 20 milliseconds and at the rate of once per second. This intermittent 20 millisecond ground is applied to conductor 218, all armatures and contacts of relay 209, middle lower armature and back contact of all line relays, except the one which is operated. This intermittent ground when applied to conductor 218 will produce "letters" signals at the teletypewriter of the subscriber which attempts to call by turning on the station power switch when the line in the switchboard is in use by another subscriber. This momentary ground produces "letters" signals at the station teletypewriter because it causes a sufficient amount of current to flow in the proper direction through the line, or upper, winding of receive relay 119 to overpower the biasing winding of this receive relay for a period of time required to produce the "letters" signals. The subscriber attempting to call, after noting this signal, restores the power switch.

Break signal

The transmission of a break signal performs the same function as described in United States Patent 2,143,000, supra.

Subscriber recalls

A recall signal is transmitted by operating the recall key, such as key 116 at station A. This momentarily opens the line circuit and produces a recall signal at the switchboard in the usual way. Since the power switch at the subscriber's station remains operated, the associated line relay holds the connection through the control unit.

Subscriber disconnects

The disconnect signal is transmitted by turning off the power switch which removes ground at the outermost right-hand contacts of the switch from the control conductor 102 for station A and deenergizes the rectifier such as that designated 114 for station A whereby current no longer flows in the transmission conductor, such

as conductor 102 for station A, to cause the associated line relay, such as relay 205, to release. The line at the switchboard reverts to the normally open condition at the switching center which produces a disconnect signal at the switchboard as a result of no current in the line. The release of the line relay releases relay 209 and also removes grounded battery from the start conductor 229 to prevent further operations of relays 202 and 203 and thereby disconnects the busy, or "letters," signal.

Operator abandons a call

No relays are operated other than ringing relays 211 and 213 which are directly under control of the ringing key of the switchboard, no action takes place other than the operator ceases ringing if the subscriber does not answer.

SYSTEM Y

General Description

As hereinbefore stated, system Y consists of Figs. 5, 6, 7 and 8 and is designed for use with a party, or multistation, toll line extension circuit having two or more sections.

Referring to Fig. 5, the equipment at station A' is shown in schematic form and that at each of stations B' and C' is shown in diagrammatic form. The equipment at each of stations B' and C' is identical with that at station A' except that station A' is equipped for both attended and unattended station service whereas stations B' and C' are equipped for attended station service only. Stations A', B' and C' are identical with stations A, B and C, respectively, employed in System X hereinbefore described, except that stations A', B' and C' have no control conductors such as conductor 102 at station A, conductor 104 at station B and conductor 105 at station C, the transmitting and signaling conductor at each station of System Y serving for control purposes also.

Fig. 6 shows in schematic form the equipment at the control, or switching, center. Common to stations A', B' and C' is a source 601 of continuous ringing current for calling by code any one of the stations, for example, one ring for calling station A', two rings for calling station B' and three rings for calling station C'. At station A' which, as hereinbefore stated, is equipped for unattended service, slow-to-operate relay 549 is responsive to one prolonged ringing signal as compared with the one ringing signal of short duration used with station A arranged on an attended station basis. Also, common to stations A', B' and C' is a source of busy signals effected by relays 602, 603 and 604 for producing the "letters" signals at the teletypewriter of a subscriber at one of the stations, at which an attempt is made to call by turning on the power switch when the line to the switchboard at the teletypewriter exchange office is in use by a subscriber at another of the stations. Line relays 605, 606 and 607 are respectively provided for stations A', B' and C' and supplementary relays 608, 609 and 610 are respectively utilized when operated for controlling an established connection between the respectively associated subscriber's station and line 611. Relay 612 when operated by any one of the supplementary line relays 608, 609 and 610, causes relay 613 to operate. Relay 613, upon operating, serves to connect the source of busy signals over the normal contacts of any one or more of relays 608, 609 and 610 which are in normal condition at the time.

The source 601 of continuous ringing current is under the control of relays 614, 615, 616 and 617. Relay 615 is of the alternating-current type and relay 617 is of the slow-to-release type. Polar relays 618 and 619 are normally held in the positions shown, by mechanical biasing springs. All relays are normally released and polar relay 604 is normally held in its marking, or left-hand, position by the biasing current flowing through its lower winding. Relays 618 and 619 are used, in conjunction with slow-to-release relay 620, when transmitting signals from any one of subscribers' stations A', B' and C'. A transmission signal from any one of the subscribers' stations reverses the direction of line current for the marking and the spacing conditions and relay 619 is poled for operation when the subscriber's station teletypewriter set is marking and relay 618 is poled for operation when the subscriber's station teletypewriter set is spacing. Therefore relay 620, which as hereinbefore stated, is slow to release, will remain in its operated position during the transmission to supply the holding ground for relay 612 and the source of busy signal. Also relay 620, when operated, furnished holding battery for operating cut-through relay 614 whereby the subscriber's line is connected over conductors 611 and through to the multisection line repeater.

Fig. 7 shows a schematic circuit arrangement of the multisection line repeater conditioned for code ringing. In the idle condition all relays in the multisection line repeater are in their released positions as shown. At the left-hand side of Fig. 7 polar relay 701 in the supervisory circuit and polar receive relay 702 in the repeater circuit are held to their marking, or left-hand, positions by a holding current in a circuit extending from grounded battery at the outer left-hand armature and back contact of relay 703, through their respective windings No. 2 in series. When a switchboard operator rings after connecting a cord circuit to the toll line extension multistation circuit, the ringing current operates alternating-current relay 704 and, in turn, relay 705. Relay 705 upon operating, operates slow-to-release relay 706 and connects source 707 of 20 cycle ringing current over the operated contacts of relay 706 to conductor 611 to operate alternating-current relay 615. Relay 615 operates to effect the code ringing to the subscriber's station as hereinbefore described. When the called subscriber answers by operating the power switch at the called station, negative voltage is applied to a circuit extending over conductor 611, through the winding of relay 708, to ground. Relay 708 operates. Relay 709 operates in a circuit traceable from ground at the marking, or left-hand, contact and armature of relay 701, conductor 732, through its winding, resistance 730, armature and contact of relay 708, resistances 710 and 711, and grounded battery 712. Relay 709, in turn causes the operation of relays 703 and 714. Slow-to-release relay 703, upon operating, (1) operates relay 714, and (2) removes at its armature and back contact, the holding battery for relays 701 and 702 and at its outer armature and front contact completes the apex for the line circuit extending through winding No. 1 of relay 701, one path extending through resistance 715, retardation coil 716, resistance 717, winding of relay 708, innermost upper armature and front contact of relay 714, to ground at the marking, or left-hand, contact and armature of polarized send relay 718; and the other path extending through resistance 719 which is of equal value to resistance 715, front

contact and outer left-hand armature of relay 703, windings No. 2, in series, of relays 702 and 701, artificial line network 720, to ground. Relay 714, upon operating, (1) establishes an alternating-current circuit for holding alternating-current relay 709 operated while relay 701 is following the signals received from conductor 611, the alternating-current path being traceable from grounded battery 712, resistances 711 and 710, point 740, conductor 728, middle upper armature of relay 714, condenser 735, resistances 734 and 730, through the winding of relay 709, conductors 731 and 732, marking, or left-hand, contact and armature of relay 701 to ground. The point 740 is effectively connected to ground and conductor 728, alternately, and the condenser 735 is alternately charged and discharged during the time that signals are being received from conductor 611; (2) transfers toll line conductor 733 from ring-up relay 704 to conductor 725 which extends through the line repeater including receive relay 721; (3) transfers conductor 736 from the calling ground connection 741 to conductor 737 which extends to the armature of send relay 718; and (4) establishes a biasing current for winding No. 3 of relay 701 so that the relay armature remains on the contact to which it was actuated by the current in winding No. 1. As soon as conductor 725 is connected to conductor 733, marking negative battery from relay 724 flows into the toll line terminating equipment represented by box 801 at the operator's switchboard, to extinguish the lamp associated with the selected cord circuit, in the same manner as when the subscriber answers the call in System X as hereinbefore described.

Receive relay 702 serves to repeat the communication signals incoming over conductor 611, through the upper windings, in series, of send relay 718, break relays 722 and 723 and send relay 724 whereby the latter relay repeats the signals over conductors 725 and 733 to the repeater in the toll line terminating equipment 801 at the central teletypewriter exchange office, operator's cord circuit 804 to the operator's teletypewriter set. During communication relays 709, 703 and 714 function to hold the communication circuit closed.

Method of Operation

Operator calls

Assuming that a connection is desired with a subscriber's teletypewriter at station A', B' or C', the operator connects one of several cord circuits, such as cord circuit 804, to a jack, such as jack 805, and then operates a ringing key (not shown) associated with cord circuit 804, say one operation of ringing key for station A', two operations for station B' and three operations for station C'. Station A' which has assigned to it "one" interval of ringing current is shown as being arranged for unattended as well as attended station service because of it having one ring signal only. For unattended station service the one ring signal will be for a prolonged interval sufficient to operate slow-to-operate relay 549. Stations B' and C' are arranged for attended station service only and, therefore, have no relays corresponding to relays 548, 549 and 550, or motor-stop contacts corresponding to those designated 551. This ringing current is transmitted through toll line terminating equipment 801, line conductor 733, outermost upper armature and back contact of relay 714, through the winding of alternating-current relay 704, condenser 726 to ground. Relay 704 responds to the ringing current and sets up a similar operation of relay 705. Relay 705 responds to vibratory operation of relay 704 and at its inner armature and contact closes an operating circuit for relay 706 which operates but being of the slow-to-release type remains operated during each of the one, two or three intervals of ringing current transmitted from the operator's switchboard at the teletypewriter exchange office. Also relay 705, upon operating, closes at its upper armature and front contact a source 707 of 20-cycle continuous ringing current to line conductor 611.

The ringing current incoming at the switching, or control, center over conductor 611 flows in a circuit traceable over the outer upper armature and contact of relay 614, through the winding of alternating-current relay 615, condenser 621, to ground. Relay 615 responds to the ringing current incoming over conductor 611 and closes an operating circuit for relay 616 which operates in accordance with the vibratory action of relay 615. Relay 616 upon operating, closes an operating circuit for relay 617 which operates and being of the slow-to-release type, remains operated during the time that ringing current is applied to the subscriber station lines for operating the subscriber set ringers, such as ringer 507 at station A'. Ground connections are furnished at the back contacts of relay 616 for discharging the condenser which is in series with the ringer, between applications of ringing current.

Should the call be to station A', one normal operation of the ringing key (not shown) at the teletypewriter exchange office switchboard would cause one short interval of ringing current to be transmitted over each of conductors 622, 623 and 624 to respectively operate the ringers at stations A', B' and C'. Inasmuch as it is hereinbefore assumed that station A' is being called, the subscriber at station A' upon identifying the single interval of ringing current responds by operating power switches 508. The subscribers at stations B' and C' upon hearing the single interval of ringing current will ignore the call. Power switch 508, upon being operated, completes a path from grounded alternating-current source 509, conductor 510. right-hand contacts of the switch, conductor 511, through the winding of relay 512 to ground. A path parallel to that extending over conductor 511 extends over conductor 513 through rectifier 514, and printer motor 515 in parallel. Rectifier 514 is energized and printer motor 515 starts operating. Relay 512, upon operating, closes a circuit from line conductor 622, recall key 516, test-out key 517, armature and front contact of relay 512, resistance 518, through the upper winding of receive relay 519, resistance 520, retardation coil 512, resistance 522, armature and marking, or lower, contact of send relay 523, retardation coil 524, negative terminal to the positive terminal of rectifier 514, retardation coil 525, marking, or upper, contact of send relay 526, retardation coil 527 to ground 528. The energized rectifier 514 supplies a source of potential difference between its terminals and thus to the circuit including ground 528 and line conductor 622. Rectifier 514, upon becoming energized, also causes current to flow in two parallel paths, one extending from the positive terminal of the rectifier, through the right-hand biasing winding of relay 526 and the left-hand biasing winding of relay 523, to the negative terminal of the rectifier, and the other path extending from the positive terminal of the rectifier, conductor 529,

break key **530**, transmitting contact **531** of subscriber's teletypewriter set **532**, conductor **533**, normal contacts of line-in key **534**, conductor **535**, regulating resistance **536**, conductor **537**, through the left-hand and the right-hand operating windings, in series, of send relays **526** and **523**, to the negative terminal of the rectifier. Printer magnet **540** of subscriber's teletypewriter set **532** is also normally energized by current flowing from rectifier **514**, over conductor **541**, through the winding of the printer magnet, conductor **542**, varistor elements **543**, retardation coil **544**, marking, or left-hand, contact and armature of receive relay **519**, retardation coil **545**, to ground at the lower normal contact of key **517**. The biasing, or lower, winding of receive relay **519** is energized in a circuit extending over conductor **546** and variable resistance **552** and serves to operate relay **519** to its spacing, or right-hand, position when spacing polarity is added to line **622**. A further description of the functions of the various elements in the circuits shown in Fig. 5 may be had by referring to United States Patent 2,143,000 supra.

When the called subscriber at station A' answers by turning on the power switch **508**, marking, or negative, voltage is applied to line conductor **622** which extends in a circuit traceable over the outermost upper armature and back contact of relay **617**, upper armature and back contact of relay **608**, through the lower winding of line relay **605**, back contact and inner lower armature of line relay **606**, outer lower armature and back contact of line relay **607**, back contact and middle lower armature of cut-through relay **614** to ground. Relay **605** operates and (1) at its outer upper armature closes an operating circuit for a supplementary line relay **608**; (2) at its inner lower armature opens the operating circuit for line relay **606**; (3) at its outer lower armature opens the operating circuit for line relay **607**; and (4) at its inner upper armature prepares a locking circuit for itself. Relay **605**, upon operating, prevents the other line relays **606** and **607** from operating during the time that a connection is established with subscriber station A'. Relay **608** operates and thereby (1) closes at its lower armature a circuit extending from grounded battery, lower armature of relay **608**, through the winding of holding relay **612**, normal contacts of relay **620**, conductors **625** and **626**, make-before-break contacts of relay **614** to ground, and (2) extends conductor **622** at its upper armature and front contact, to conductors **625** and **626** to ground at the make-before-break contacts of relay **614**. Relay **612** operates and (1) closes at its upper armature an operating circuit for relay **602**; (2) completes at its inner lower armature the locking circuit for relay **605**; and (3) closes at its outer lower armature the operating circuit for relay **613**. The condition of line conductor **622** is at this time marking and in such condition, as hereinbefore stated, causes relay **619** to operate in a circuit traceable over conductor **627**, through the winding of relay **619**, resistance **628**, conductor **626**, to ground at the make-before-break contacts of relay **614**. Relay **619**, upon operating, closes the operating circuit for relay **620**. Relay **620**, upon operating, closes the operating circuit for cut-through relay **614** which operates and cuts through the conductor **626** to the toll line extension circuit conductor **611**. The subscriber station A' line conductor **622**, having marking, or negative, voltage at the station end, is now connected over the upper armature and back contact of relay **706**, through the No. 1 windings, in series, of relays **701** and **702**, resistance **715**, retardation coil **716**, resistance **717**, through the winding of relay **708** to ground at the innermost upper armature and back contact of relay **714**. Relay **708** operates and closes a circuit extending from grounded battery **712**, resistances **711** and **710**, conductors **727** and **728**, armature and contact of relay **708**, conductor **729**, resistance **730**, through the winding of holding relay **709**, conductors **731** and **732**, marking or left-hand contact and armature of relay **701** to ground. Relay **709**, upon operating, closes an operating circuit for relay **703**. Relay **703**, upon operating, operates relay **714** and removes grounded battery from the biasing winding of receive relay **702** and relay **701**. Also relay **703**, upon operating, completes the other part of the apex circuit which part extends over resistance **719**, front contact and outer left armature of relay **703**, through the No. 2 biasing windings of relays **702** and **701**, in series, to grounded artificial line network **720**. Relay **714**, upon operating, establishes the alternating-current path for holding relay **709** operates while relay **701** is following the signals transmitted from subscriber's station A', the circuit changing in accordance with the operation of relay **701**. When relay **701** is in its marking condition, as shown, the alternating current circuit, as hereinbefore stated, is traceable from ground at the armature and marking contact of relay **701**, conductor **732** and **731**, through the winding of relay **709**, resistances **730** and **734**, condenser **735**, contact and middle armature of relay **714**, conductors **728** and **727**, resistances **710** and **711**, to grounded battery **712**. With relay **701** in its spacing position, the alternating-current circuit is shunted to ground at the spacing contact. Also relay **714**, upon operating, transfers the toll line extension circuit conductor **733** from the winding of ring relay **704** to the transmission conductor **725** which extends through the upper winding of receive relay **721** to grounded negative battery at the marking, or left-hand, contact of send relay **724**. Also, relay **714**, upon operating, transfers transmission conductor **736** from ground connection **741** to transmission conductor **737** which extends to ground at the marking contact of send relay **718**. As soon as grounded negative battery at the marking contact of relay **724** is connected over conductor **725**, to toll line extension circuit conductor **733**, the cord lamp at the switchboard becomes extinguished indicating to the operator that the subscriber at station A' has answered.

Busy line indication

The operation of the "letters" signal circuit depends, as hereinbefore described under System X, on the alternate operation of two slow-to-release relays, such as relays **602** and **603**, whereby the charging current in the upper winding of a polarized relay, such as relay **604**, is of sufficient volume and in the direction to momentarily overpower the biasing, or lower, winding of relay **604** and to operate the armature of relay **604** to its spacing contact. This ground is applied for about 20 milliseconds to conductor **629** at the rate of once per second. With relay **613** operated, this intermittent 20 milliseconds ground is applied to each of the three lower armatures of relay **613** and their respectively associated conductors **630**, **631** and **632**. In the event that a subscriber at any station attempts to originate a call when the line to the switchboard is in use by a subscriber

at one of the other stations, the intermittent timed pulses of current will be transmitted over the back contact and upper armature of supplementary line relay, such as line relay **608** for station A', relay **609** for station B' and relay **610** for station C', to the conductor extending to the station whereat such call is attempted. The intermittent pulses produce "letters" signals at the station teletypewriter whereat the second call is attempted.

Break signals

The break signals perform the same functions as in the subscriber's station set described for Fig. 1 of United States Patent 2,143,000, supra.

Subscriber recalls

The subscriber momentarily operates recall key, such as key **516**, at subscriber's station A', which removes the transmitting negative potential from the station line circuit and supplies ground toward the control, or switching, center. Since the normal condition at the marking contact of send relay in the switchboard terminating repeater circuit (send relay is designated **65** in Fig. 2 of United States Patent 2,143,000, supra) is grounded, the voltage drop across resistor **633** falls to zero and neither relay **619** or **618** is operated. Hence relays **620** and **614** release. The release of relay **620** connects the winding of relay **612** over the normal contacts of relay **620** to transmission line conductor **625** and relay **612** remains operated in the line circuit extending to ground at the subscriber station A'. Since relay **612** remains operated, the line connection previously established by the operation of the associated line relays, such as relays **605** and **608** for the line to station A', remains intact. The release of relay **614** terminates the switchboard line conductor **611** in the winding of ringing relay **615**. With the substitution of ground at the subscriber station for the negative potential, and the application of an open circuit (alternating-current relay **615** and condenser **621**) to one end of the switchboard line conductor **611** and with ground at the marking contact of send relay **718**, connected to the opposite end of conductor **611**, relay **708** releases. The release of relay **708** effects the release of alternating-current relay **709**, which, in turn, causes the release of relay **703** and **714** and opens line conductor **733** to the switchboard to effect the operation of the cord lamp. The above functions are completed while the power switch at the subscriber's station is in its "off" position. When the power switch is again operated to its "on" position, relays so released are reoperated. In response to each momentary release operation of the power switch at the power station, the cord lamp at the switchboard is extinguished and therefore in response to a recall signal the cord lamp is caused to flash a recall signal.

Subscriber disconnects

The subscriber turns off the power switch such as switch **508** at station A' which removes the source of power **509** from the station equipment. All operated elements release and all energized devices deenergize thereby placing an open condition on station A' transmission conductor, such as at relay **512** for conductor **622**. This differs from the condition when a recall signal is transmitted in which case ground is connected to conductor **622**. In response to the disconnect signal, relay **612** is released and in turn the line relays, such as relays **605** and **608** for station A', release. Also relays **618** and **619** are released when line conductor **622** is opened and thereby cause relay **620** to release. Relay **612**, upon releasing, releases relays **613**, **602** and **603**. At the multisection line repeater relays **708**, **709**, **703** and **714** release in response to the release of relay **614** and a permanent open signal is thereby transmitted to the switchboard to light the cord lamp.

Subscriber calls

Should the subscriber at station A' originate a call, as for example by turning on power switch **508**, negative potential of rectifier **514** is applied to station transmission conductor **622** to operate relay **605** as hereinbefore described when the subscriber at station A' was assumed to have answered a call originated by the operator at the teletypewriter exchange office. Relays **608**, **612**, **614**, **619**, **620**, **613**, **602**, **603** and **604** operate accordingly. At the multistation line repeater relays **708**, **709**, **703** and **714** operate as hereinbefore described. The negative potential of the rectifier **514** applied to the line circuit causes current to flow over the line circuit and thereby causes repeater **801** and the toll line extension terminating equipment **802** to operate in a manner described in United States Patent 2,143,000, supra, to light the call lamp (not shown) at the operator's switchboard. The operator responds and the operations completed by the operator are the same as hereinbefore described.

Operator abandons call

Should the operator desire to abandon the call while transmitting code ringing signals, it would only be necessary to cease ringing. No relays in either the multisection line repeater or the control circuits are in a locked position during the ringing period, all operated relays will be in the toll line terminating circuit **802** and these will release when the operator removes the cord circuit from the jack of the called line.

COMBINED SYSTEMS

It is understood that Figs. 1 and 2 may be combined with Figs. 7 and 8 to make another system and that Figs. 5 and 6 may be combined with Fig. 3 to constitute still other systems. The multisection line employed in System Y is operated half-duplex using polar sending-differential receiving operation over each section of the line, that is, each section is operated half-duplex with polar signals being transmitted from one end of each section and signals with a current difference being transmitted from the other end of each section. The section shown extending between Figs. 6 and 7 receives from one end polar signals from the armature and contacts of each of send relays **523** and **526** and from the other end "medium current" and "high current" signals transmitted from the respective contacts of send relay **718**. Similarly, the section shown extending between Figs. 7 and 8 receives from one end polar signals from the armature of send relay **724** and from the other end "medium current" and "high current" signals transmitted from the contacts, respectively, of relay **65** shown in Fig. 2 of United States Patent 2,143,000, supra.

What is claimed is:

1. A telegraph system comprising a main telegraphic trunk transmission circuit, a switching center at which said circuit terminates, a plurality of telegraphic stations equipped with transmission and reception apparatus for permutation code, a local circuit connecting each of said

stations to the switching center, each of said stations comprising a starting element, means at said switching center operable by the operation of any one of said starting elements to connect the station of said element to said trunk circuit at said switching center, and means also controlled by operation of said element to condition all other of said stations, said conditioning means comprising instrumentalities at said switching center for supplying permutation code signals to all said other circuits and said conditioning means having other means, when operated, to supply said code signals to the permutation code reception apparatus associated with any other starting element upon operation of said other starting element.

2. A telegraph system comprising a main telegraphic trunk transmission circuit, a switching center at which said circuit terminates, a plurality of telegraphic stations, each having transmission and reception apparatus for permutation code, a local circuit comprising two paths connecting each of said stations to the switching center, each of said stations having a starting element, individual electromagnetic means at said switching center responsive, over one of said paths, to the operation of said starting element, means at said switching center operable by the operation of any one of said starting elements to connect the station of said starting element over the other of said paths to said trunk circuit at said switching center, and means also controlled by operation of said element to condition all other of said stations, said conditioning means comprising instrumentalities at said switching center for supplying permutation code signals over said other path of said other circuit, and said conditioning means having other means, when operated, to supply said code signals to the permutation code reception apparatus associated with any other starting element upon operation of said other starting element.

3. A telegraphic system comprising a main telegraphic trunk transmission circuit, a switching center at which said circuit terminates, a plurality of telegraphic stations each having transmission and reception apparatus for permutation code, a local circuit comprising a single path connecting each of said stations to the switching center, each of said stations having a starting element, individual electromagnetic means at the switching center responsive over said path to the operation of said starting element, means at said switching center operable by the operation of any one of said starting elements to connect the station of said element over said path to said trunk circuit at said switching center, and means also controlled by the operation of said element to condition all other of said stations, said conditioning means comprising instrumentalities at said switching center for supplying permutation code signals over said path, and said conditioning means having other means, when operated, to supply said code signals to the permutation code reception apparatus associated with any other starting element upon operation of said other starting element.

4. A telegraphic system comprising a main telegraphic trunk transmission circuit having at one end a source of code ringing current signals and at each end a source of permutation code signals, a switching center at which said circuit terminates, a plurality of telegraphic stations equipped with transmission and reception apparatus for permutation code, a local circuit connecting each of said stations to the switching center, each of said stations having a starting element, means at said switching center operable by operation of any one of said starting elements to connect the station of said operated element to said trunk circuit at said switching center, means also controlled by operation of said element to condition all other of said stations, said conditioning means comprising instrumentalities at said switching center for supplying permutation code signals to all said other local circuits and said conditioning means having other means, when operated, to supply said code signals to the permutation code reception apparatus associated with any other starting element upon operation of said other starting element, and one of said stations comprising means responsive to a prolonged operative connection of said code ringing current source to said trunk circuit for starting the transmission and reception apparatus at said one station independently of said starting element at said one station.

5. A telegraphic system comprising a main telegraphic trunk transmission circuit, a source of code ringing signals connectable to one end of said trunk circuit, a switching center at which the other end of said trunk circuit terminates, electromagnetic devices at said switching center, a plurality of telegraphic stations equipped with transmission and reception apparatus for permutation code, a local circuit connecting each of said stations to said switching center, each of said stations having a starting element, said switching center comprising a plurality of paths for connecting said trunk circuit with any one of said local circuits, certain of said electromagnetic devices included in one of said paths and responsive to code ringing signals in one or more intervals from said source for causing said intervals of code ringing signals to be repeated over each of said local circuits, one of said local circuits including means arranged to respond to the code ringing signals in an interval of relatively long duration to automatically operate the transmission and reception apparatus for permutation code independently of said starting element, and other of said electromagnetic devices included in said other path and responsive to signals from any one of said transmission and reception apparatus for connecting the local circuit associated with said one apparatus to said trunk circuit for communication purposes.

6. A telegraphic system comprising a single wire telegraphic half-duplex operated trunk transmission circuit using polar sending-differential receiving operation, a switching center at which said trunk circuit terminates, a plurality of telegraphic stations equipped with transmission and reception apparatus for permutation code, a local circuit of a plurality of conductors connecting each of said stations to said switching center, one of said conductors arranged to transmit message signals and the other arranged for controlling the connection established with said trunk circuit through said switching center, each of said stations having a starting element, means at said switching center operable by operation of any one of said starting elements to connect the station of said element to said trunk circuit at said switching center, and means also controlled by operation of said element to condition all other of said stations to prevent said other stations from being connected to said trunk circuit when engaged in the established connection with the station of said starting element, said conditioning

means comprising instrumentalities at said switching center for supplying permutation code signals to all said other circuits, and arranged, when operated, to supply said permutation code signals to the permutation code reception apparatus associated with any other starting element upon operation of said other starting element.

7. A telegraphic system comprising a multisection single wire telegraphic half-duplex operated trunk transmission circuit using polar sending-differential receiving operation, a switching center at which said trunk circuit terminates, a plurality of telegraphic stations, a local circuit of a single-wire conductor type connecting each of said stations to said switching center, said single-wire conductor being arranged to transmit message signals and to control the connection established with said trunk circuit through said switching center, each of said stations having a starting element, means at said switching center operable by operation of any one of said starting elements to connect the station of said element to said trunk circuit at said switching center, and means controlled by operation of said elements to condition all other of said stations to prevent said other stations from being connected to said trunk circuit when engaged in an established connection with the station of said starting element.

8. A telegraphic system comprising a multisection single-wire telegraphic half-duplex operated trunk transmission circuit using polar sending-differential receiving operation, a switching center at which said trunk circuit terminates, a plurality of telegraphic stations, a local circuit of a plurality of conductors connecting each of said stations to said switching center, one of said conductors being arranged to transmit message signals and the other arranged for controlling the connection established with said trunk circuit through said switching center, each of said stations having a starting element, means at said switching center operable by operation of any one of said starting elements to connect the station of said element to said trunk circuit at said switching center and means also controlled by operation of said element to condition all other of said stations to prevent said other stations from being connected to said trunk circuit when engaged in an established connection with the station of said starting element.

9. A telegraphic system comprising a main telegraphic trunk transmission circuit, a switching center at which one end of said trunk terminates, a plurality of lines from said switching center to individual outlying stations including individual ringers, a main station at the opposite end of said trunk, means including means operable at any one of said outlying stations to extend its individual line (during an idle condition of said trunk) to said main office, disconnect means including means operable at said station to discontinue said extension, means including operable means at said main office to selectively ring one of said outlying stations as a signal to establish such an extended connection, and means operative incident to selective ringing of one of said stations when unattended to cause equipment at said station to establish the desired extension for the purpose of sending a message from said main station to and recording it at said one station, and means operative under control of said main station to discontinue such extension of the line of said one station.

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