April 17, 1945. L. A. GARDNER ET AL 2,373,675

PARTY LINE PRINTING TELEGRAPH SYSTEM

Filed July 19, 1941 7 Sheets-Sheet 1

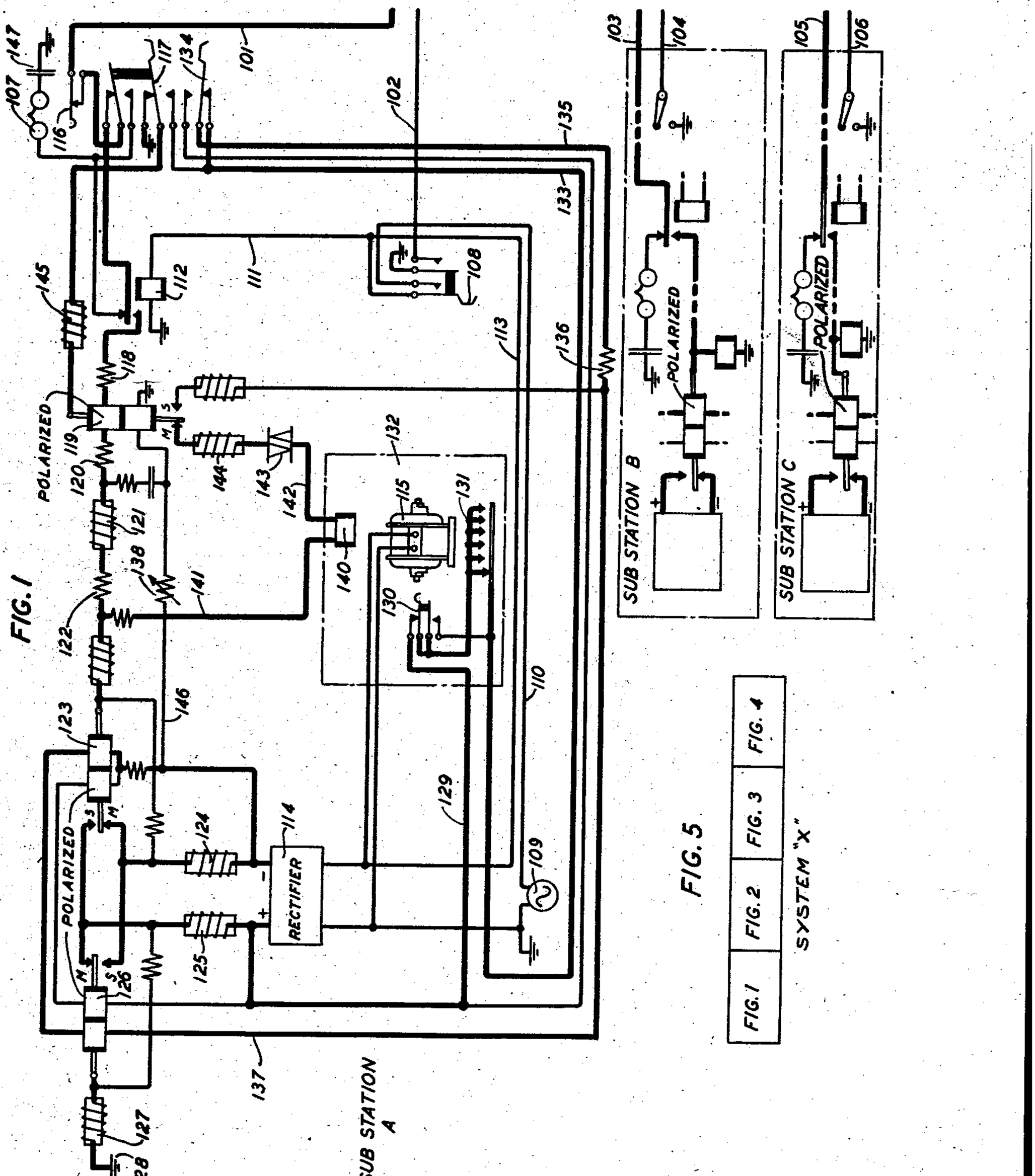

FIG. 1

FIG. 5

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PARTY LINE PRINTING TELEGRAPH SYSTEM

Filed July 19, 1941 7 Sheets-Sheet 2

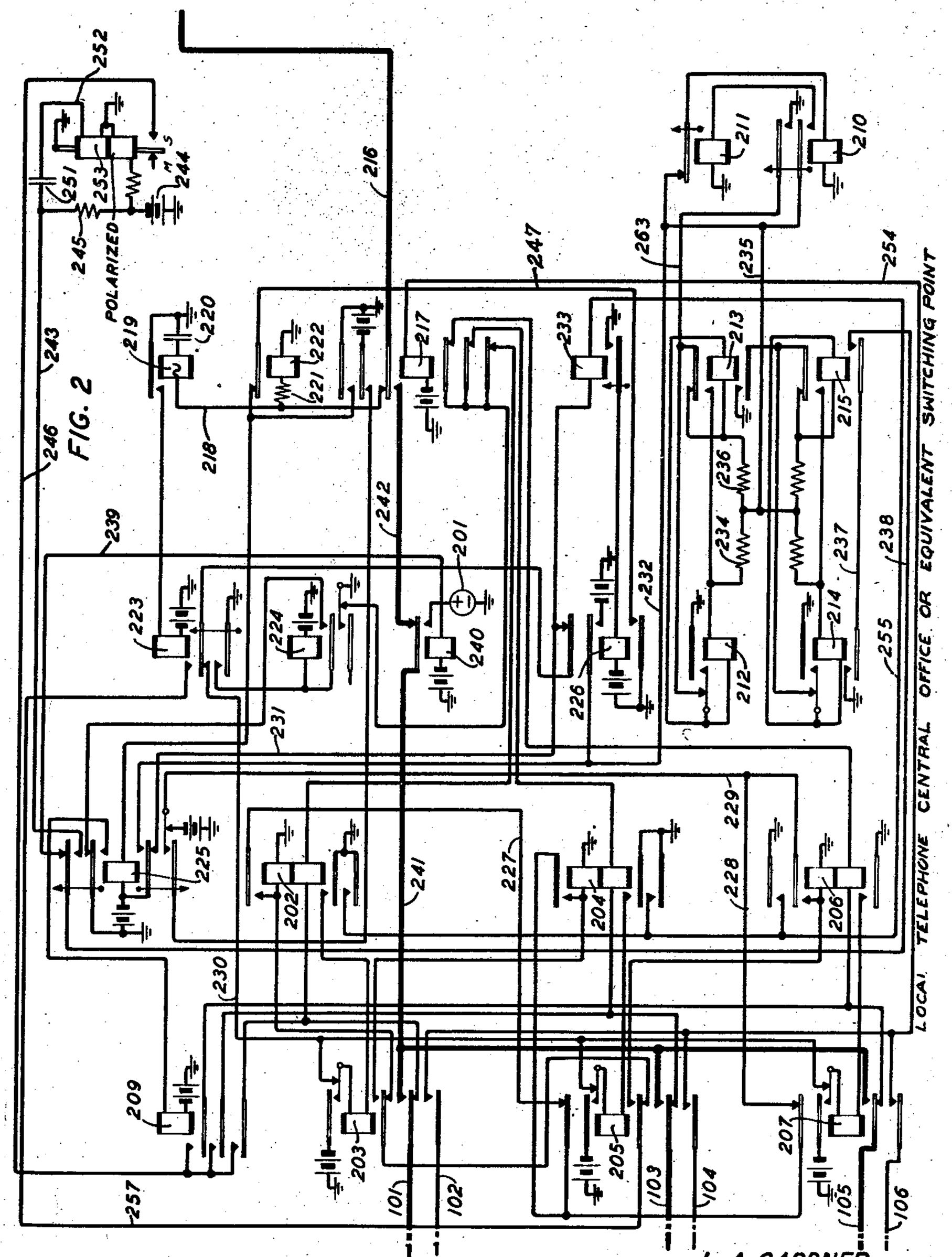

FIG. 2

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PARTY LINE PRINTING TELEGRAPH SYSTEM

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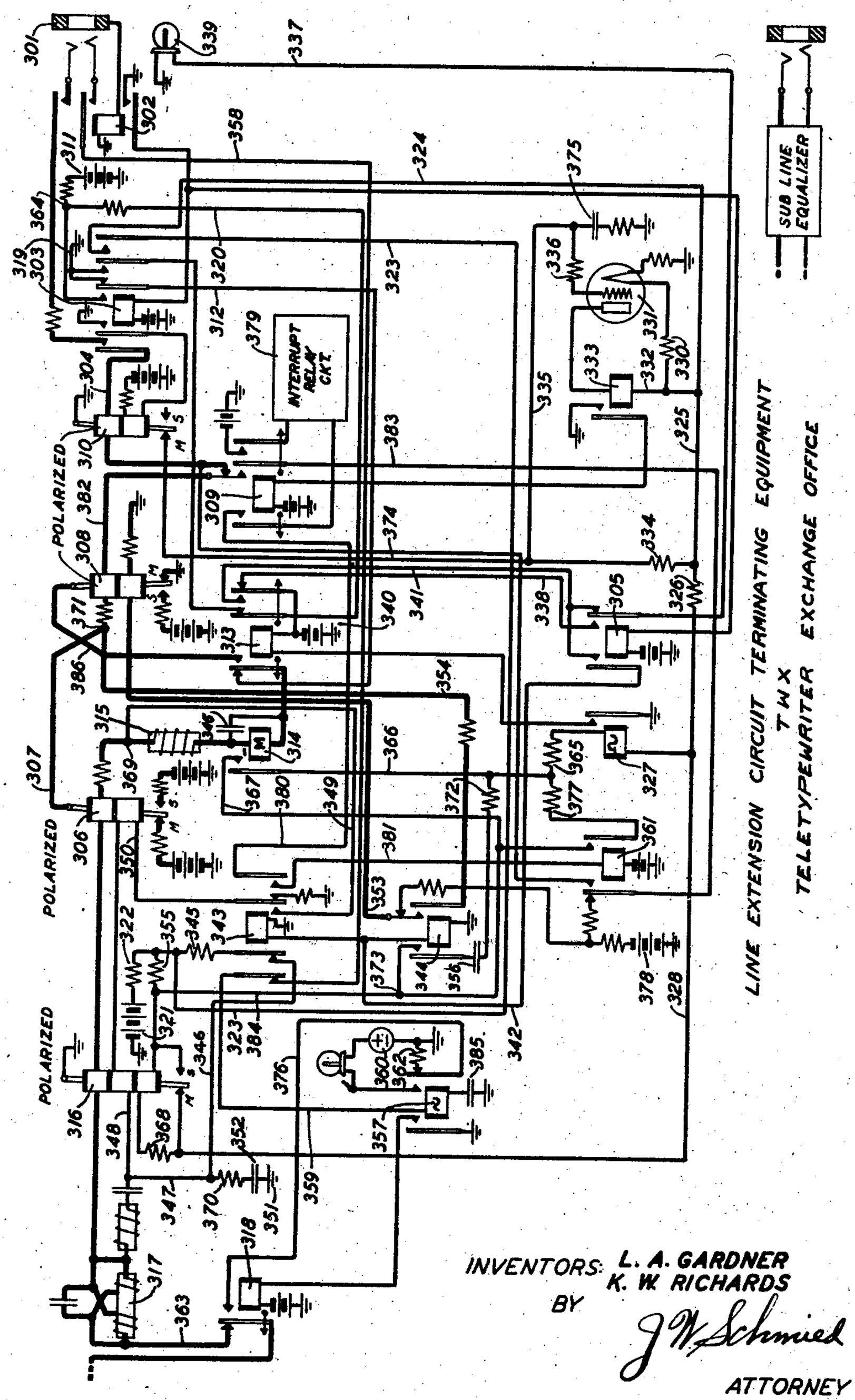

FIG. 3

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PARTY LINE PRINTING TELEGRAPH SYSTEM

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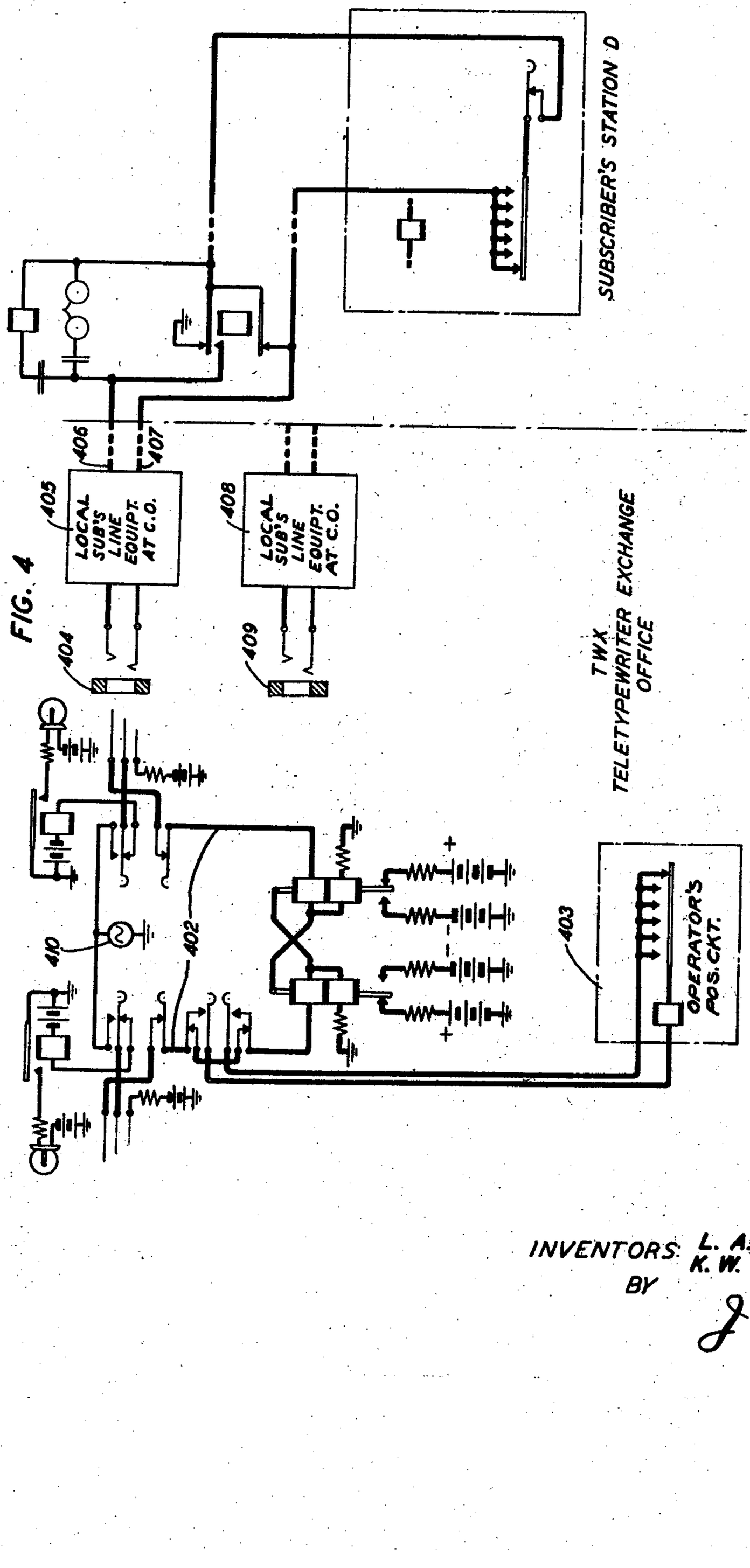

FIG. 4

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PARTY LINE PRINTING TELEGRAPH SYSTEM

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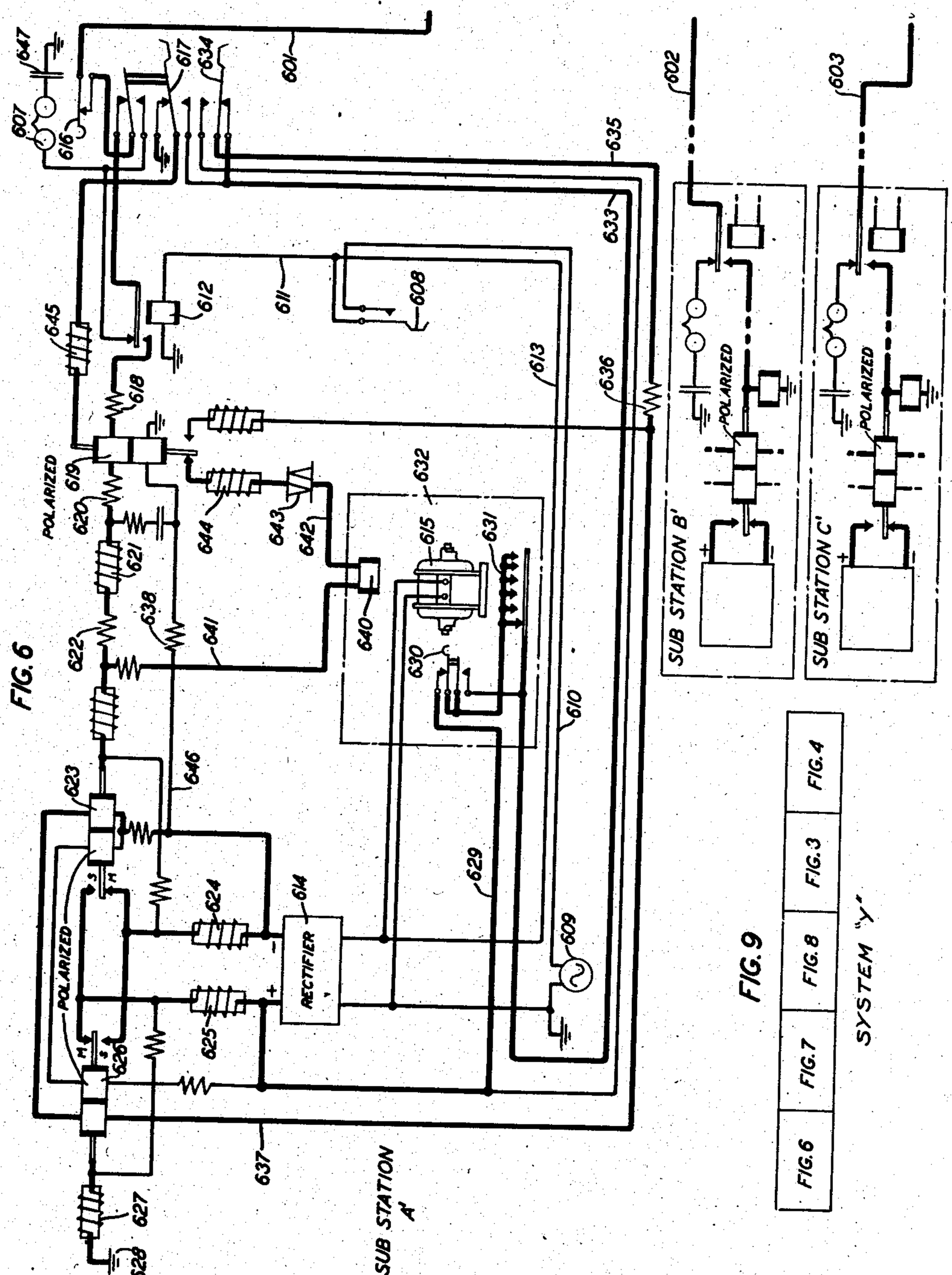

FIG. 6

FIG. 9

FIG.6	FIG.7	FIG.8	FIG.3	FIG.4

SYSTEM "Y"

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PARTY LINE PRINTING TELEGRAPH SYSTEM

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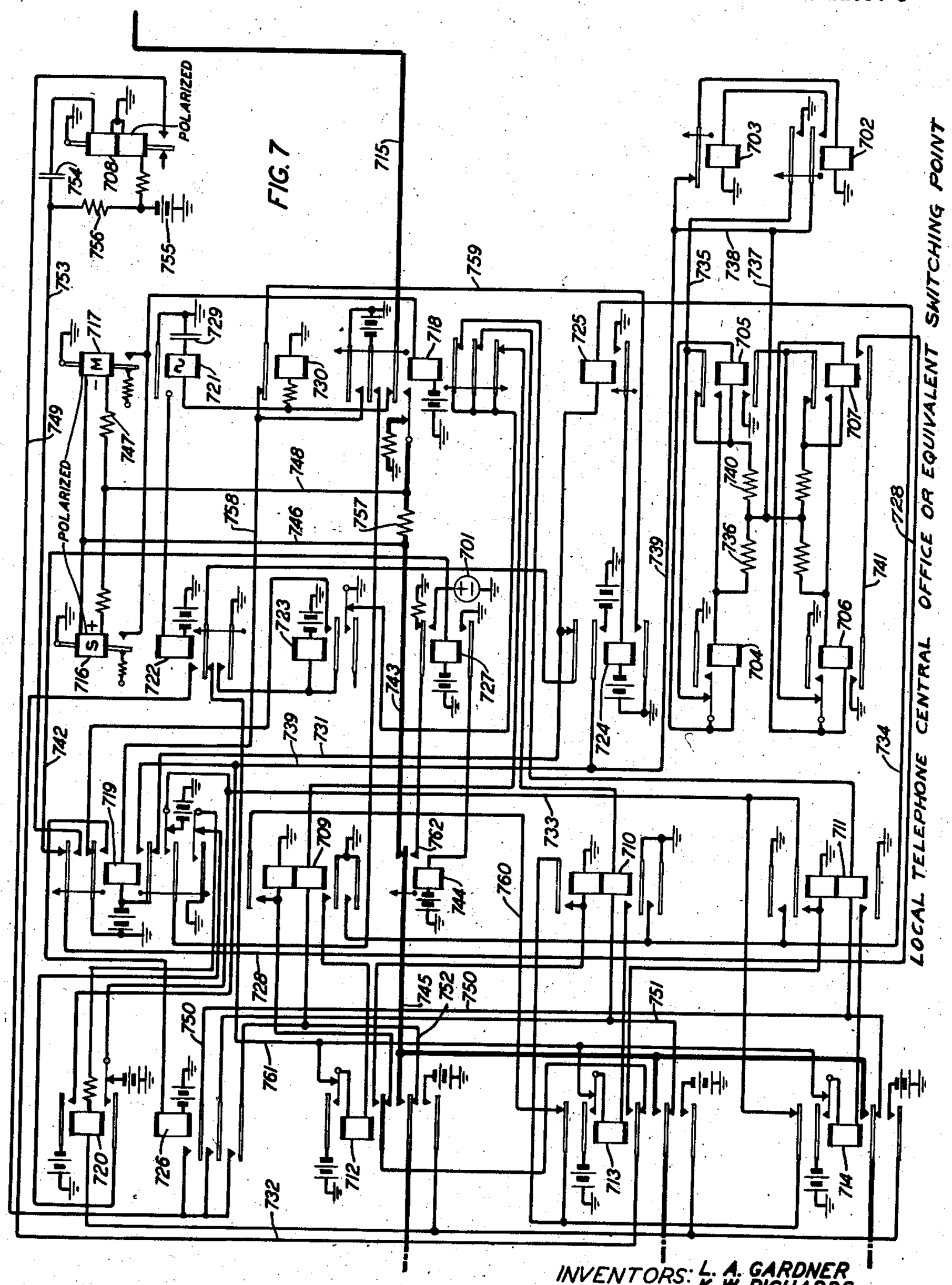
FIG. 7



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PARTY LINE PRINTING TELEGRAPH SYSTEM

Filed July 19, 1941 7 Sheets-Sheet 7

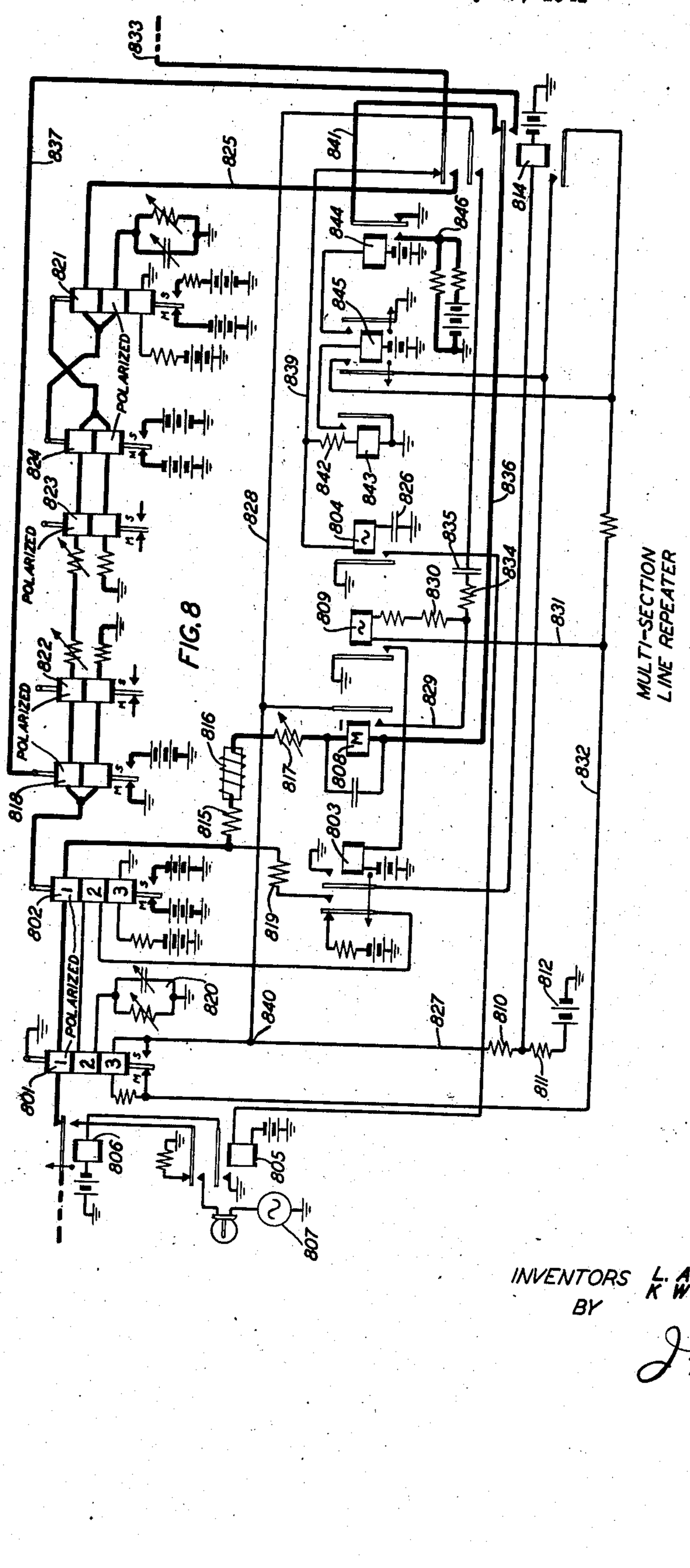

FIG. 8

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Patented Apr. 17, 1945 2,373,675

UNITED STATES PATENT OFFICE

2,373,675

PARTY LINE PRINTING TELEGRAPH SYSTEM

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Application July 19, 1941, Serial No. 403,116

11 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 wire telegraph line, channel or trunk.

The problem with which this invention deals is that of giving a plurality of remote subscribers or remote outlying stations access to and service over a teletypewriter exchange by means of telegraphic trunks or channels less in number than the number of subscribers. The cost per mile of such trunks is great and their more efficient utilization is highly desirable. This problem has been solved successfully for groups of considerable numbers of subscribers, say fifteen to one hundred, by satellite systems; see patent to Lucek 2,228,279, dated January 14, 1941, for disclosure of a typical system. The problem has also been solved for smaller numbers of, say five to ten, subscribers in a group; see application of Large, Serial No. 377, 805, filed February 7, 1941. Systems have also been devised to serve two and in some cases three or more subscribers over a single trunk. See Locke 2,225,648, dated December 24, 1940, and Goodwin 2,257,677, dated Sept. 30, 1941, and Knandel 2,306,734, dated December 29, 1942. Therefore, a specific object of this invention is to provide improved and more efficient systems of this class or systems suitable for somewhat different service requirements. A copending application of the present inventors, Serial No. 393,324, filed May 14, 1941, relates to systems of this kind operating with code ringing, i. e., subscribers must answer only the number or combination of rings identifying their own station; in contradistinction one of the major features of the present invention is a semiselective automatic system of ringing whereby only the desired subscriber's bell is rung. Except for practical limitations of relay design, etc. and potential delays due to a busy trunk line the number of subscribers or outlying stations is unlimited.

An object of the invention is to improve systems whereby a plurality of subscriber stations may be provided with teletypewriter switching service over a single wire line, channel or trunk.

Another object of the invention is to provide for improved utilization a telegraph line, channel or trunk of the repeater 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 provide semi-selective ringing in a system which permits at any one time one only of a plurality of 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 semiautomatic selective 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 an improved system whereby any one of a plurality of subscriber stations may be operatively connected through the switching center to a multi-section line, channel or trunk.

Another object is to provide a system having a plurality of subscriber stations connected to a switching center with means thereat for operatively connecting any one of said stations to the exclusion of the other of said stations, to a multi-section half-duplex single wire 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 preceding objects wherein busy signals to inform a subscriber that the trunk is busy are transmitted in permutation code.

According to an embodiment of the present invention two or more teletypewriter subscriber stations are connected, in parallel, to a switching center by one or two wires and the switching center is connected to the exchange, or central, office by a single wire. The line between the exchange office and the switching center may be multisectional. Semiautomatic selective ringing is provided whereby the selection of one of said subscriber stations is made by a first, a second or a third pair of relays at the switching center, which pairs are respectively responsive to one, two or three rings by the operator at the exchange office. A source of busy signals is provided for transmitting to each subscriber station, permutation code signals, such as a series of "letters" or "K" or other known characters should a subscriber at said station 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

subscriber stations are locked out, or prevented, at the switching center, from being operatively connected to the line when one of the subscriber stations is operatively connected to the line for communication purposes.

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 said two arrangements may be operatively connected over a single wire, single or multisection line extending to the teletypewriter exchange office, each station of such line being operated half-duplex using polar signals, employing current reversals in one direction and differences of current in the other direction. Multisection lines in the main channel may include carrier, radio or any other suitable links.

The invention will now be described with respect to the accompanying drawings which illustrate two telegraph systems in 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 4, inclusive, and system Y consists of Figs. 6, 7, 8, 3 and 4. Both systems are equipped to furnish semiautomatic selective ringing for calling subscriber stations. System X comprises subscriber lines of two wires each between each of the subscriber stations and the switching center, and a single section, one-wire line for interconnecting the switching center and a teletypewriter exchange office, whereas system Y comprises lines of one 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 teletypewriter exchange office will hereinafter be referred to as the TWX 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;

Fig. 2 shows, in schematic form, the equipment 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 for semiautomatic selective 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 TWX office and designed to provide for semiautomatic selective ringing. The terminating equipment includes a repeater;

Fig. 4 shows, in diagrammatic form, the operator's cord and position circuits and a local subscriber's loop terminating equipment at the TWX office and the subscriber's teletypewriter set at a local subscriber station connected directly to the TWX office;

Fig. 5 shows the relative arrangement of Figs. 1, 2, 3 and 4;

Fig. 6 shows three toll line subcriber 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;

Fig. 7 shows, in schematic form, the equipment 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 a single wire which is utilized for performing three functions, namely, transmission, signaling and controlling. The equipment at this switching center provides for semiautomatic selective ringing for calling the subscriber stations;

Fig. 8 shows in schematic form, the equipment at an intermediate repeater point in a single-wire multisection line circuit with wiring adapted for semiautomatic selective ringing;

Fig. 9 shows the relative arrangement of Figs. 6, 7, 8, 3 and 4.

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 sufficient for a description and a 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 are similarly connected by their respective pairs of conductors 103 and 104 and 105 and 106. The upper conductor of each pair is for transmitting and signaling and the lower conductor is for controlling the connection established between its respective station and the switching center. The equipment at station A includes facilities for providing attended station service only 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 the control conductor 102, and the elements shown therein, such as relays 37, 41 and 42, "stop" contacts 35 and condenser 38, are omitted. These additional elements in the arrangement of Fig. 1 of United States Patent 2,143,000 provide for unattended station service and therefore are not required in the present invention.

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 on a semiautomatic selective basis any one of the subscriber stations, for example, should the switchboard operator desire to call any one of the subscriber stations A, B and C, the ringing key associated with the selected cord circuit, would be operated once for selecting station A, twice for selecting station B and thrice for station C. At the switching center three pairs of relays, namely, relays 202 and 203, relays 204 and 205, and relays 206 and 207 are provided to respectively respond to the 1, 2 and 3 intervals of ringing current received in response to the operation of the ringing key at the operator's switchboard. The first pair of relays 202 and 203 respond to one interval of ringing current and prepare a transmission circuit to station A, the second pair of relays 204 and 205 through an operating path closed by the operation of relay 203 responding to two intervals of ringing current and thereby release relays 202 and 203 and close a transmission circuit through to station B and the third pair of relays 206 and 207 through an operating path closed by the operation of relay 205 respond to the three intervals of ringing current and thereby release relays 204 and 205 and close a transmission circuit through to station C. At a

predetermined interval after the ringing key of the switchboard is first operated, say an interval of five seconds, ringing current is impressed on the transmission circuit extending to the desired subscriber station, the ringing current so applied from source 201 may be one second on and three seconds off, until the subscriber responds. Also common to stations A, B and C is a source of busy signals effected by polar relay 253 over a plurality of circuits extending through the armatures, in parallel, of relay 209 and a break contact and a lower armature of each of auxiliary line relays 203, 205 and 207, to the transmission conductors 101, 103 and 105, respectively associated with the auxiliary line relays, relay 253 being under control of an interrupter circuit comprising relays 210, 211, 212, 213, 214 and 215. Relay 253, upon being operated at predetermined intervals, causes to be produced at the teletypewriter of any one or more subscribers' stations a series of "letters" signals. The stations receiving said signals are those whereat the subscribers attempt to call by turning on the power switch when the line to the switchboard at the TWX office is in use by a subscriber at one of the other stations. Line relays 202, 204 and 206 are respectively provided for stations A, B and C and each is effective, when operated, to establish, in conjunction with its respectively associated auxiliary line relay, a connection to its own particular subscriber's station such as A, B or C. Party, or multistation, line 216 is of the single-wire type and represents the toll line extension circuit arranged for connection through the control, or switching, center of stations A, B and C. Line 216 terminates at the TWX office in the terminating equipment such as shown in Fig. 3, the opposite end being connected to jack 301 at the operator's switchboard. Arranged in proximity to jack 301 are operator's cord circuit 402, operator's position circuit 403, both of which may be somewhat similar to Fig. 2A of United States Patent 2,158,113, granted to K. E. Fitch on May 16, 1939. Another jack 404 at the operator's switchboard is part of a local subscriber's line terminating equipment 405 which, in turn, is connected by means of conductors 406 and 407 to local subscriber's station D. The local subscribers' line terminating equipment and the local subscriber station D may be similar to Fig. 5 of United States Patent 2,143,000, supra. Other line terminating equipments such as that designated 408, including jack 409, may be provided at the operator's switchboard and arranged for being connected through the operator's cord circuit to other subscribers' stations (not shown). The distance between the TWX 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 the subscribers' stations A, B and C, the operator at the switchboard connects one of several cord circuits, such as cord circuit 402 to jack 301 and then connects a ringing key to source 410 associated with cord circuit 402, say one operation of ringing key for station A, two operations for station B and three operations for station C.

The operator's cord circuit 402, upon being plugged into jack 301, operates sleeve relay 302 in a circuit traceable to grounded battery connected to the sleeve conductor of the cord circuit. Relay 302, upon operating, operates relays 303 and 305.

Relay 303, upon operating, (1) connects at its outer left armature and contacts the transmission conductor 304 to tip conductor of jack 301 and tip conductor of the calling plug of cord circuit 402, the circuit closed being traceable from grounded positive battery at the marking contact and armature of polarized receive relay 306, conductor 307, through the upper winding of polarized send relay 308, make-before-break contacts of relay 309, through the upper winding of polarized break relay 310, outer left-hand armature and contact of relay 303, to the above-mentioned tip conductors; (2) closes at its inner left armature and contact a circuit for energizing the biasing, or lower, winding of break relay 310; (3) closes at its outer right armature and contact a circuit traceable from grounded positive battery 321, resistance 322, conductor 323, outermost right-hand armature and contact of relay 303, conductors 324 and 325, resistance 326 to one side of the winding of relay 327, which is of the alternating current type; a parallel path extends over conductor 328 to the marking, or left-hand, contact and armature of polarized relay 316; another parallel path extends through resistance 330 to the filament of vacuum tube 331; another path extends through the winding of relay 333 to the plate of vacuum tube 331; still another path extends from conductor 325, resistance 334, conductor 335, through resistance 336 to the grid circuit of vacuum tube 331.

Relay 305, upon operating, (1) transfers lamp conductor 337 at its right-hand armature to its front contact which is connected over conductor 338, back contact and outer right-hand armature of relay 313, to grounded battery thereby causing line lamp 339 to light; (2) prepares at its left-hand armature and contact an operating circuit for relays 343 and 344 to await the operation of relay 313.

When the operator operates the ringing key of cord circuit 402 such as shown in United States Patent 2,158,113, supra, wherein the ringing key designated 231 therein, connects source 410 of ringing current, over ring conductor 358 in a circuit which extends over the contact and outer left-hand armature of relay 343, conductor 359, through the winding of relay 357, condenser 385, to ground. The operator's ringing key is operated once to call station A, twice to call station B and three times to call station C and relay 357 with the aid of condenser 385 will be operated accordingly, that is, for the duration of each operation of the key. Relay 357, upon operating, (1) closes at its left-hand armature and contact an obvious operating circuit for relay 318 and (2) at its right-hand armature and front contact a circuit extending from source 360 of grounded ringing current, conductor 376, front contact and armature of relay 318, transmission conductor 216, innermost upper armature and back contact of relay 217, through the winding of alternating current relay 219, condenser 220, to ground; and over a parallel path extending through resistance 221 and the winding of relay 222 to ground. Relay 318, upon operating, disconnects the line side of the terminal repeater from conductor 216 and applies ringing current over conductor 216 to operate alternating current relay 219.

When the operator releases the ringing key relay 357 releases thereby opening the ringing circuit and closing a circuit from conductor 216, through the armature and front contact of relay

318, armature and back contact of relay 357, to ground through resistance 362. The release of relay 357 opens the operating path of relay 318, but relay 318 being of the slow-to-release type does not release immediately but remains operated long enough for resistance 362 to discharge the line before the line conductor 216 is closed back to the line side of the terminal repeater via conductor 363.

Normally, that is during the idle condition, line conductor 216 terminates in a ground connection 319 via the innermost right-hand armature and back contact of relay 303. After the operator connects a cord circuit to line jack 301 and relay 303 is thereby operated, the line terminates in potentiometer tap 304 intermediate grounded positive battery 311 and ground connection 319, the potentiometer having a path to ground extending over the inner right-hand armature and contact of relay 313, and the middle right-hand armature and contact of relay 303. The positive voltage at tap 304 is applied to the line over conductor 312, back contact and left-hand armature of relay 313, through the winding of relay 314 and retardation coil 315, through the upper windings, in series, of receive relay 306 and relay 316, retardation coil 317, conductor 363, to line conductor 216. This voltage is insufficient to operate relay 314 even though maximum leakage is present on the line circuit, but will operate the sensitive relay 222.

The initial ringing period (about one second) will operate relay 219 and during the ringing period relay 222 may or may not release and in either case no action takes place. Relay 219, upon operating in response to the ringing current from source 360, closes an operating circuit for slow-to-operate relay 223. Relay 223 operates and closes an operating circuit for relay 224 which also operates. Relay 224, upon operating, (1) closes a locking circuit for itself over the back contact and inner upper armature of relay 225; and (2) removes ground at its make-before-break contact so that no subscriber's station can originate a connection after the initial ringing impulse. The first operation of relay 223 closes at its inner lower armature and front contact a circuit extending from grounded battery at the inner lower armature and back contact of relay 225, conductor 231, contact and outer upper armature of relay 226, inner lower armature and front contact of relay 223, conductor 257, innermost lower armature and back contact of relay 205, innermost lower armature and back contact of relay 203, through the upper, or primary, winding of line relay 202 to ground. Relay 202 operates and (1) locks in a circuit extending over its upper armature and contact, conductor 227, contact and outer upper armature of relay 205, outer upper armature and contact of relay 207, conductors 228 and 229 to grounded battery at the make-before-break contact of relay 225; and (2) at its inner lower armature and front contact connects ground to a circuit extending through the winding of and over the make-before-break contacts of auxiliary line relay 203, conductor 230, back contact and inner lower armature of relay 223; and when relay 223 returns to normal at the expiration of the first ringing pulse, grounded battery is furnished over conductor 231 and over the outer upper armature and back contact of relay 226. At the expiration of the first ringing pulse relay 203 operates and locks from grounded battery at its upper armature. Also, relay 202, upon operating, connects at its outer lower armature and front contact a ground connection to a circuit traceable over conductor 255 through the winding of relay 233, conductor 231, to grounded battery at the front contact and inner lower armature of relay 225. Relay 233 is of the slow-to-operate type and is timed to operate in about five seconds, as will be hereinafter explained.

A second ringing period, that is, the reapplication of grounded battery at the inner lower armature and back contact of relay 225 in a circuit extending over conductor 231, back contact and outer upper armature of relay 226, inner lower armature and front contact of relay 223, conductor 257, innermost lower armature and back contact of relay 205, innermost lower armature and front contact of relay 203, through the upper winding of line relay 204 to ground, causes the second line relay 204 to operate and lock up in a circuit traceable from ground, through its upper winding and its contact and upper armature, outer upper armature and back contact of relay 207, conductors 228 and 229 to grounded battery at the make-before-break contacts of relay 225. Relay 204, upon operating, closes at its inner lower armature and front contact a circuit for operating relay 205 which operates and locks up at its inner upper armature and front contact to grounded battery. Also relay 204, upon operating, closes at its outer lower armature and front contact a circuit traceable from ground, conductor 255, through the winding of relay 233, conductor 231, to grounded battery at the back contact and inner lower armature of relay 225. As hereinbefore stated, relay 233 is of the slow-operate type and therefore has not as yet operated. Relay 205, upon operating, opens at its outer upper armature and back contact, the locking circuit for relay 202 which now releases and causes the release of relay 203. At the expiration of the second ringing interval, relay 223 releases.

A third ringing interval again causes relay 223 to operate thereby closing a circuit from grounded battery at the inner lower armature and back contact of relay 225, conductor 231, outer upper armature and back contact of relay 226, inner lower armature and front contact of relay 223, conductor 257, innermost lower armature and front contact of relay 205, through the upper winding of the third line relay 206 to ground. Relay 206 operates and locks up in a circuit traceable over the front contact and inner upper armature, conductor 229 to grounded battery at the make-before-break contacts of relay 225. Also relay 206, upon operating, closes at its lower armature and contact an operating circuit for relay 207, the circuit being traceable through the winding and make-before-break contacts of relay 207, conductor 230, to the back contact and inner lower armature of relay 223, outer upper armature and contact of relay 226, conductor 231 to grounded battery at the back contact and inner lower armature of relay 225. Relay 207 operates and closes a locking circuit for itself from grounded battery at its inner upper armature and front contact. Relay 207, upon operating, opens at its outer upper armature and back contact, the locking circuit for relay 204 which releases and causes the release of relay 205. Relay 206, upon operating, closes at its outer upper armature and contact, a circuit for increasing the energization of relay 233.

Now that the three ringing intervals have been completed, say in five seconds, which is the op-

erating time of slow-to-operate relay 233, the relay is now sufficiently energized and therefore operates to close an obvious operating circuit for relay 226 which operates. During the operating time (five seconds) of relay 233, the operator must ring one, two or three to select the desired station and do so only once.

When relay 226 operates, grounded battery at the inner lower armature and back contact of relay 225 is removed at the outer upper and back contact of relay 226, this grounded battery having been used for selecting line relays 202, 203 and 206. Also relay 226, upon operating, connects at its inner upper armature and front contact grounded battery to start conductor 232, back contact and armature of slow-to-release relay 211, through the winding of slow-to-release relay 210 to ground.

Relay 210 operates and at its inner upper armature and contact applies grounded battery over start conductor 232, to the winding of relay 211. Relay 211 operates and opens at its armature and contact the operating path for relay 210. Inasmuch as relay 210 is of the slow-to-release type, it is maintained operated a short interval after the operation of relay 211 and then releases to open the operating path for relay 211. Inasmuch as relay 211 is of the slow-to-release type, it is also maintained operated for a short interval after the release of relay 210 and then releases to reoperate relay 210 which in turn reoperates relay 211. This cycle continues as long as the grounded battery is maintained at the inner upper armature and contact of relay 226. The operation and release of relay 210 in recurring cycles applies approximately sixty impulses per minute, to a circuit traceable from ground at the outer upper armature and contact of relay 210, conductor 263, make-before-break contact of and through the winding of relay 212, resistance 234, conductor 235, start conductor 232, to grounded battery at the inner upper armature and contact of relay 226. The first closure of ground over conductor 263 operates relay 212 which locks up at its contacts and upper armature to ground and relay 213 remains normal since ground is present on both ends of the winding of relay 213. On the first open condition of the operating circuit for relay 212, ground is removed from one end of the winding of relay 213, and since grounded battery via conductor 235 and resistance 236 is present on the other end, relay 213 operates. The second closure of ground at the outer upper armature and contact of relay 210 completes an operating circuit extending through the upper armature and front contact of relay 213 to one end of the winding of relay 212 and since ground is present on the other end of relay 212, relay 212 is shunted and relay 213 remains operated on the second release of relay 210 whereby ground at the outer upper armature and contact is removed, relay 213 releasing. Subsequent sixty impulses per minute causes relays 212 and 213 to operate and release as just described. This reduces the sixty impulses per minute ground to thirty impulses per minute furnished to the relays 214 and 215. Relays 214 and 215 operate in a manner similar to relays 212 and 213, respectively, and further reduce the sixty impulses per minute to one second closed and three second open interrupted ground pulses. These pulses are transmitted over conductors 237 and 238, outer upper armature and back contact of relay 225, conductor 239, through the winding of relay 240 to grounded battery and relay 240 operates each time a ground is connected to conductor 238 which is referred to hereinafter as the interrupted ground conductor. During the one second operate time of relay 240 ringing current from source 201 is connected at the front contact and armature of relay 240 to conductor 241, the middle lower armature and front contact of one of the auxiliary line relays 203, 205 and 207, depending upon which one of these relays remains operated at the conclusion of the ringing interval set up by the operator at the switchboard, and then over a transmission conductor, such as conductor 101 for station A, to the ringer at the subscriber's station, say ringer 107 at station A. The selected station will be rung automatically at the termination of the five second operating period of relay 233.

Subscriber answers

The subscriber in response to the operation of the station ringer, say ringer 107, operates power switch 108. Power switch 108, upon being operated, completes a path from grounded alternating current source 109, conductor 110, left-hand contacts of the switch, conductor 111, through the winding of relay 112 to ground, and relay 112 operates. 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 key 117, armature and back contact of relay 112, resistance 118, through the upper winding of receive relay 119, resistance 120, retardation 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 connection 128. The energized rectifier supplies a source of potential difference between its terminals and thus to the circuit including ground connection 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 and the left-hand biasing windings, in series, of send relays 126 and 123, respectively, 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 set 132, conductor 133, normal contacts of line-in key 134, conductor 135, regulating resistance 136, conductor 137, through the left-hand and the right-hand operating windings, in series, of send relays 126 and 123, respectively, 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 contact 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 the 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 TWX office. The varistor elements 143 may be a pair of copper oxide rectifiers connected in opposing multiple as shown. One rectifier alone may be used or the rectifier may be used in shunt to a condenser. The purpose of the rectifier is to furnish a resistance that will automatically vary with any change in voltage. For example, the pair of rectifiers shown in the drawings have a very high resistance when relatively low voltages are impressed across the terminals thereof and a relatively low resistance at high voltages. Hence when unduly high voltages appear in the printer magnet circuit the varistor elements as a unit protect the printer magnet against current surges. 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.

During the idle condition after switch 108 is operated and the potential applied to the line by rectifier 114 is of negative polarity and when the cut-through relay 217 is operated as will be hereinafter described, the negative potential so applied holds the repeater relays through the system in the positions shown. Power switch 108, upon being operated, connects ground at its right-hand contact to control conductor 102 of a circuit which extends over the outermost lower armature and front contact of relay 203 (assuming that relay 203 had been in an operated position when ringing current from source 201 was applied for transmission over a line conductor such as conductor 101), conductor 254, through the winding of cut-through relay 217, to grounded battery. Relay 217 operates and at its innermost upper armature transfers line conductor 216 from relay 219 and 222 to the transmission conductor 101 via the armature and back contact of relay 240 and the back contact and middle lower armature of relay 203. Relay 222 releases when relay 217 operates. Also relay 217, upon operating, closes at its outermost upper armature and contact an obvious operating circuit for relay 225 which operates. Relay 225 upon operating (1) transfers interrupted ground conductor 238 from ringing conductor 239 to conductor 243, condenser 251, conductor 252, through the upper winding of polarized relay 253 to ground; (2) closes at its inner upper armature and front contact, an operating circuit for relay 209 which operates; (3) releases at its inner upper armature and back contact relay 224; (4) opens at its inner lower armature and back contact the operating circuit for relay 233 which releases and in turn effects the release of relay 226; (5) maintains at its inner lower armature and front contact grounded battery to start conductor 232, even though relay 226 is released; and (6) transfers grounded holding battery for any one of line relays 202, 204 and 206, say in this case relay 202, from its make-before-break contacts to its outer lower armature and front contact which is connected to the front contact and middle upper armature of relay 217 which is now in an operated position. Polarized relay 253 is provided to furnish busy signals as will be hereinafter described.

Negative voltage on the transmission line conductor 101 is now impressed on transmission conductors 241, 242 and 216, armature and back contact of relay 318, conductor 363, through the uppermost winding of polar relay 316 and the upper winding of polar relay 306, retardation coil 315, through the winding of relay 314, left-hand armature and back contact of relay 313, conductor 312, innermost right-hand armature and front contact of relay 303, to potentiometer tap 364 which is of positive polarity. Relay 314 operates and polarized relays 316 and 306 of the repeaters remain in the positions shown. Relay 314, upon operating, closes at its armature and contact a circuit extending from grounded positive battery 321, resistance 322, conductor 323, outermost right-hand armature and contact of relay 303, conductors 324 and 325, resistance 326, through the winding of alternating current relay 327, resistance 365, conductor 366, armature and contact of relay 314, conductor 367, through the lowermost winding of polarized relay 316, resistance 368, marking, or left-hand, contact of relay 316 to ground. Relay 327 operates and connects at its armature and contact an obvious operating circuit for relay 313 which operates. Relay 313, upon operating, opens at its outer right-hand armature and back contact, the operating circuit for call lamp 339 which now becomes extinguished. Relay 313, upon operating, completes at its outer right armature and front contact the circuit hereinbefore prepared at relay 305 for operating relays 343 and 344 both of which now operate.

Relay 343, upon operating, (1) opens at its inner left armature and contact, a circuit traceable from grounded positive battery 321, resistances 322 and 345, inner left-hand armature and contact of relay 343, conductor 347, through the middle winding of polar relay 316 and the lower winding of polar relay 306 to ground at its inner right-hand armature and back contact whereby the idle marking condition is removed from polar relays 316 and 306 of the repeater; (2) at its inner right armature and front contact, closes the artificial line circuit which extends from apex 369, conductor 349, front contact and inner right-hand armature of relay 343, conductor 350, through the lower winding of relay 306 and the middle winding of relay 316, conductors 348 and 347, resistance 370, condenser 352 to ground connection 351; (3) opens at its outer left-hand armature and contact the operating circuit for relay 357; and (4) prepares at its outer right-hand armature and contact the operating circuit for relay 361.

Relay 344, upon operating, (1) closes at its right-hand armature and front contact, the artificial line circuit which extends from apex 371, conductor 354, right-hand armature and contact of relay 344, conductor 353, through the lower winding of send relay 308 to ground; (2) closes at its left-hand armature and contact a path for holding relay 327 operated during the time the subscriber is sending at which time relay 316 follows the signals and relay 314 is shunted by condenser 335, the path so closed extending through resistance 372, condenser 356, left-hand armature and contact of relay 344, to tap 373. The action is as follows: During the time that relay 316 is on its marking, or left-hand, contact, resistance 326 at one end of the winding of relay 327 is grounded, and grounded battery through resistances 322 and 355 and the front contact and left-hand armature of relay 344, charges condenser 356 and the current through resistances 372 and 365 and winding of relay 327 to ground at the marking contact of relay 316 holds relay 327 in an operated position; when relay 316 operates to its spacing, or right-hand, contact, one side of condenser 356 and resistances 372 and 365 is grounded and the current in relay 327 re-

verses and continues to hold relay 327 operated. During long marking or long spacing signals, relay 314 operates to hold relay 327 operated. The biasing current in the lower winding of relay 310 tends to operate the relay to a spacing, or right-hand, contact, but the marking current in the loop or upper winding of relay 310 is twice as great and in the opposite direction so the relay is operated to its marking, or left-hand, contact. Ground connected to the armature and marking, or left-hand, contact of relay 310 is impressed on a circuit extending over conductors 374 and 335 to maintain condenser 375 discharged during the time the loop to the subscriber's circuit is in marking condition. During the normal transmission period, relay 310 will follow the transmission signals. The circuit is now ready for communication between the subscriber and the operator at the switchboard. All subscriber stations other than the one answering the call are locked out because the operating circuit for their respective line relays is opened by the removal of ground at the make-before-break contacts of relay 224 via a back contact and armature of relay 217.

Busy line indication

When a busy condition exists on a calling subscriber's line, relays 225 and 209 are operated in a manner as hereinbefore described and the interrupted ground is applied to conductors 238 and 243. The initial application of ground to lead 243 discharges condenser 251 and the subsequent removal of ground allows condenser 251 to charge in a circuit extending from grounded battery 244, resistance 245, condenser 251, through the upper winding of relay 253 to ground. This charging current is of sufficient value and in a direction to momentarily overpower the biasing current in the lower winding of the relay and to operate the armature thereof to its spacing, or right-hand, contact. This ground that is applied to conductor 243 is connected for about twenty milliseconds and at the rate about once per second.

With relay 209 operated, this intermittent twenty millisecond ground is applied to conductor 246, contacts and armatures of relay 209, and over back contact and lower armature of the auxiliary line relay associated with the subscriber station whereat a call is attempted when the toll line is engaged in a connection to one of the other stations. The intermittent ground when applied to a transmission conductor, such as conductors 101, 103 and 105, will produce a series of "letters" signals at the teletypewriter of a subscriber who attempts to call by turning on the power switch when the line to the switchboard is in use by a party at another of the stations. These signals cause a sufficient amount of current in the proper direction through the line winding of the receiving relay such as relay 119 at station A, to overpower the biasing current in the lower winding of such relay for a period of time required to produce the "letters" signal. The subscriber who initiated the subsequent call, after noting these signals, shuts off the power and places another call at a later time.

Subscriber disconnects

The subscriber turns off power switch 108 thereby removing grounded negative potential from transmission conductor 101 and ground from conductor 102. The removal of ground from conductor 102 opens the circuit traceable over the outermost lower armature and front contact of relay 203, conductor 254, through the winding of relay 217 and relay 217 releases. Relay 217, upon releasing, releases relay 225. Relay 225, upon releasing, removes grounded battery from the start conductor 232 and the interrupter circuit comprising relays 210, 211, 212, 213, 214 and 215 is restored to normal. Likewise, interrupted ground is removed from conductor 238 whereby the busy, or "letters," signals are discontinued. During the release time of slow-to-release relay 225, which time is about one-half second, the holding battery for line relay 202 is lost because relay 217 releases as soon as the power switch 108 is turned off. Line relay 202 and its associated auxiliary line relay 203 release. Relay 225, upon releasing, causes relay 209 to release.

The removal of negative potential from the transmission conductor 101 causes the release of relay 314 and, in turn, the release of relay 327. Relay 327, upon releasing, causes the release of relay 313 and relay 313, upon releasing, closes at its outer right-hand armature and back contact, the operating circuit for lighting supervisory lamp 339 as a signal to the switchboard operator to remove cord circuit 402 from jack 301. Relay 313, upon releasing, also releases relays 343 and 344; disconnects conductor 216 from conductor 386, and when cord circuit 402 is removed and relay 303 releases applies ground at the back contact and left-hand armature of relay 313 to a circuit extending through the winding of relay 314, retardation coil 315, through the upper windings, in series, of relays 306 and 316, back contact and armature of relay 318, transmission conductor 216. Relays 343 and 344, upon releasing, apply grounded batteries 321 and 378 to two biasing circuits, one extending over the inner left-hand armature and contact of relay 343, conductors 346, 347 and 348, through the middle winding of relay 316 and the lower winding of relay 306 to ground at the inner right-hand armature and back contact of relay 343 and the other from grounded battery 378, make-before-break contacts of relay 344, conductor 353, through the lower winding of relay 308 to ground. When the switchboard operator disconnected from the line terminating equipment by disconnecting the cord circuit relay 305 also released and the circuit restored to normal.

Recall signal from the subscriber

A recall signal is given to the operator at the switchboard by the subscriber momentarily operating a recall key, such as key 116 at station A, several times. While the key is operated, the line is opened to direct current and relay 314 releases and in turn relays 327, 313, 343 and 344 release. Relay 313 functions as hereinbefore described for a disconnect signal and supervisory lamp 339 lights. Relays 343 and 344 release and open the alternating current operating path of relay 327 and furnish grounded battery for holding the terminal repeater relays 306, 316 and 308 in a marking condition in the same manner as hereinbefore described under disconnect. The alternate opening and closing of the line by the operation of the recall key causes supervisory lamp 339 to flash.

Break signal from the subscriber

When the subscriber operates the break signal key, such as key 130 at station A, positive spacing polarity will be applied to the line at the subscriber's station during the time the break key is operated. The repeater in the line terminating equipment at the switchboard will repeat this

spacing condition so that relay 314 continues to hold relay 327 and its associated relays operated. Break relay 310 operates to its spacing, or right-hand, contact. When the subscriber restores break key 130, negative marking polarity will be applied to the line at the subscriber's station and the terminal repeaters including relay 310 operate to their marking contacts and the circuit is in condition for the transmission of telegraph signals. If the subscriber sends a break signal exceeding six seconds, vacuum tube 331 will function as hereinafter described under "Trouble break" but otherwise performs no useful function at this time.

Break signal to subscriber

A break signal incoming from the supervisory repeater produces a spacing condition in the subscriber's loop circuit. This spacing condition in the loop is immediately repeated through the line to the subscriber's set. Relay 310 is operated to its spacing, or right-hand, contact under the influence of its biasing current.

Relay 314 continues to hold relay 327 and its associated relays operated. The operation of relay 310 to its spacing contact removes ground from condenser 375 and allows the condenser to charge from grounded positive battery 321, over conductors 323, 324 and 325 through resistance 334 and over conductor 335. When the loop is closed to marking, relay 310 operates to marking and discharges condenser 375 thereby preventing condenser 375 from obtaining enough of a charge to cause vacuum tube 331 to draw plate current.

Trouble break

Vacuum tube 331 with its associated apparatus is designed to detect a break signal of six seconds or more through the supervisory repeater. With relay 303 operated, the filament of tube 331 lights. As long as relay 310 is in marking condition, condenser 375 is discharged and the tube does not draw plate current. If, however, the break exceeds approximately six seconds, condenser 375 has had time to charge from grounded positive battery 321 through resistance 334 to a potential as high as that of the filament. Therefore the grid connected through the current limiting resistance 336 causes plate current to flow and operate relay 333. Relay 333, upon operating, operates slow-to-release relay 309. Relay 309, upon operating, (1) connects grounded battery at its outer right-hand armature and contact to a source 379 of interrupted ground such as produced over conductor 238 in Fig. 2, and the source is connected to a circuit extending over the left-hand armature and contact of relay 309, conductor 380, outer right-hand armature and contact of relay 343, conductor 381, through the winding of relay 361 to grounded battery and (2) transfers the loop transmission lead 382 from the terminal repeater to a path extending over conductor 383 to the inner left-hand armature of relay 361. Relay 361 operates and releases when the interrupter opens and closes ground to the winding of relay 361 in recurring cycles. When the interrupter closes the operation of relay 361 removes grounded negative battery 378 from conductor 383 and closes a loop through to the associated supervisory repeater circuit. If the supervistory repeater circuit is still spacing, relay 310 remains on its spacing, or right-hand, contact and relays 333, 309 and 361 remain operated and the terminal repeater sends a spacing signal out over transmission conductor 216 to the subscriber's station. Also, relay 361, upon operating, closes at its right-hand armature and contact a path extending from ground at the armature and spacing contact of relay 316, conductor 384, contact and right-hand armature of relay 361, resistances 377 and 365, through the winding of relay 327, conductors 325 and 324, outer right-hand armature and contact of relay 303, conductor 323, to grounded battery 321 whereby relay 327 is held operated during the spacing interval. Relay 314 is under control of the subscriber's station only when the terminal repeater sends a marking signal out on the line. This takes place when relay 361 releases thus opening the holding path of relay 327, leaving it under the control of relay 314. Transmission conductor 382 is again connected through the back contact of relay 361 to grounded negative battery 378. This operates send relay 308 of the associated terminal repeater to marking and ground is sent out over transmission conductor 216 to the subscriber's station. If relay 361 is operated and the space signal changes to marking polarity in the loop circuit, relay 310 will operate to its marking, or left-hand, contact which discharges condenser 375 thereby cutting off plate current in vacuum tube 331. Relay 333 therefore releases which will in turn release relays 309 and 361 and the circuit will be ready for communication.

If the subscriber disconnects during a trouble break, which causes relays 333, 309 and 361 to operate, relay 314 will release on the first marking pulse sent by the terminal repeater and relay 327 will release, thus releasing relay 313 which functions as hereinbefore described under "Subscriber disconnects." If the loop is still spacing, the operator receives the disconnect signal, and relay 333 and 309 will be operated. When the switchboard operator removes the supervisory repeater patching cord, relays 303 and 305 will release and open the operating circuit of the vacuum tube 331 and the biasing windings of relay 310. Relay 333 will release and open the holding path of relay 309 causing it to release and the circuit will be restored to normal.

The subscriber may send a recall or disconnect signal during the time the line is marking when a trouble break exists on the loop side of the terminal repeater. When this condition exists the line circuit times out after approximately six seconds and causes the repeater to send alternate marking and spacing signals over the line to the subscriber. The operator will go in on the circuit and operate the split key (not shown but associated with the cord circuit) in order to determine to which side of the supervisory repeater circuit the trouble is coming. This will change the loop back to the marking condition and when relay 361 operates on the next spacing pulse, the transmission path is closed through the terminal repeater and relay 310 will operate to its marking, or left-hand, contact, and the circuit will function as hereinbefore described under "Trouble break."

Operator abandons call

Assume that relays 202 and 203 or relays 204 and 205 or relays 206 and 207 are operated due to the operator pulsing with ringing current, as hereinbefore described. If the subscriber does not answer after a specified time, the operator removes the cord circuit from jack 301 and thereby opens the operating circuit for relay 222. Relay 222, upon releasing, establishes an operating circuit for relay 225, the circuit being traceable

from ground at the lower armature and contact of relay **226**, conductor **247**, upper armature and contact of relay **222** through the winding of relay **225** to grounded battery. Relay **225** operates and thereby removes the holding battery for the operated line relay of relays **202**, **204** and **206**. Relay **225** also removes the holding battery for relay **233**. Relay **233** releases in about one second after relay **225** operates and the release of relay **233** releases relay **226** thereby causing the release of relay **225** and all relays are now returned to idle condition. In case the busy, or "letters," signal circuits function during the momentary operation of relay **225**, no action takes place because at this time the transmission conductor at each subscriber's station, such as conductor **101** at subscriber A, is terminated in the ringer and condenser circuit such as ringer **107** and condenser **147** at station A.

Subscriber calls

Assume that the subscriber at station A desires to make a call to the operator's switchboard, power switch **108** is operated to its "on" position whereby the station set is placed in an operated condition as hereinbefore described and ground is connected over control conductor **102** to the outermost lower armature of relay **203**. With the subscriber's set at station A in an operated condition, negative potential is applied to transmission conductor **101**, middle lower armature and back contact of relay **203**, through the lower winding of relay **202**, contact and outermost lower armature of relay **217**, to ground at the make-before-break contacts of relay **224**. Line relay **202** operates and locks in a circuit traceable from ground at its front contact and upper armature, conductor **227**, back contact and outer upper armature of relay **205**, outer upper armature and back contact of relay **207**, conductors **228** and **229**, to grounded battery at the make-before-break contacts of relay **225**. Relay **202**, upon operating, closes at its inner lower armature and front contact an operating circuit for auxiliary line relay **203** which is traceable from ground, inner lower armature and contact of relay **202**, through the winding of relay **203** and its make-before-break contacts, conductor **230**, back contact and inner lower armature of relay **223**, outer upper armature and back contact of relay **226**, conductor **231**, to grounded battery at the inner lower armature and back contact of relay **225**. Relay **203** operates and locks to grounded battery at its upper armature and front contact. Relay **203**, upon operating, completes a circuit hereinbefore prepared when power switch **108** was operated and connected ground to control conductor **102**, the circuit being traceable over the outermost lower armature and front contact of relay **203**, conductor **254**, through the winding of relay **217** to grounded battery. Relay **217** operates and in conjunction with the operation of relay **203** transmission conductor **101** is connected through to transmission conductor **216**. The negative potential now impressed on transmission conductor **216** extends through a circuit traceable over the armature and back contact of relay **318**, conductor **363**, through the retardation coil **317**, the uppermost winding of relay **316** and the upper winding of relay **306**, retardation coil **315**, through the winding of relay **314**, left-hand armature and back contact of relay **313** to ground at the innermost right-hand armature and back contact of relay **303**. Relay **314**, upon operating, connects grounded battery **321** to a circuit extending through resistances **322** and **355**, conductors **384** and **367**, armature and contact of relay **314**, conductor **366**, resistance **365**, through the winding of relay **327**, conductor **328**, to ground at the marking contact and armature of relay **316**. Relay **327** operates and closes at its armature and contact an operating circuit for relay **313**. Relay **313**, upon operating, transfers at its left-hand armature and contact transmission lead **216** to the armature of send relay **308** and closes at its outer right armature and front contact, a circuit extending from grounded battery over conductor **341**, back contact and right-hand armature of relay **305**, conductor **337** to light lamp **339**. The operator, upon noting the lighting of lamp **339**, inserts the answering plug of cord circuit **402** into jack **301** to complete the establishment of the connection as hereinbefore described.

SYSTEM Y

As hereinbefore stated, system Y consists of Figs. 6, 7, 8, 3 and 4 and is designed for use with a party, or multistation, tool line extension circuit having two or more sections and arranged to operate on a semiautomatic selective ringing basis.

Referring to Fig. 6, the equipment at station A′ is shown is 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′. Stations A′, B′ and C′ are identical with stations A, B and C 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. 7 shows in schematic form the equipment at the control, or switching, center. Common to stations A′, B′ and C′ is a source **701** of continuous ringing current for calling any one of the subscribers' stations. Also common to stations A′, B′ and C′ is a source of busy signals effected by relays **702** and **703** which are arranged during the establishment of a connection to alternately operate at regular recurring intervals whereby relays **704**, **705**, **706** and **707** operate in sequential cycles to place interrupted ground on a circuit for operating polarized relay **708**. Relay **708**, in response to the interrupted ground, transmits current pulses over the transmission conductor extending to a subscriber's station at which a call is attempted when the toll line extension circuit is engaged by a subscriber at another station, these current pulses producing a busy signal at the teletypewriter of the subscriber attempting to interfere with a busy line. Line relays **709**, **710** and **711** are respectively provided for stations A′, B′ and C′ and auxiliary line relays **712**, **713** and **714** are respectively utilized when operated for controlling an established connection between the respectively associated subscribers' stations and line **715** which represents the toll line extension circuit.

Polar relays **716** and **717** are normally held in the positions shown, by mechanical biasing springs. All relays are normally released, **708** is normally held in its marking, or left-hand, position by the biasing current flowing through its lower winding. Relays **716** and **717** are used in conjunction with cut-through relay **718** which is of the slow-to-release type, for providing a closed path for the signals transmitted from any

one of subscribers' stations A', B' and C'. The transmission signals from any one of the subscribers' stations reverses the direction of line current in accordance with the marking and spacing conditions of the line. Relay 717 is poled for operation when the subscriber's station teletypewriter set is marking and relay 716 is poled for operation when the subscriber's station teletypewriter set is spacing. Therefore, relay 718 which, as hereinbefore stated, is slow to release and is operated in response to the operation of either relay 716 or 717, will remain in its operated position during the transmission to supply the holding ground for relay 719 which, when operated, furnishes ground for holding relay 720. Holding relay 720 provides grounded battery for maintaining the interrupted ground relays operating to furnish the busy signals when any subscriber's station is connected through to the toll circuit conductor 715.

Fig. 8 shows a schematic circuit arrangement of the multisection line repeater conditioned for semiautomatic selective 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. 8 polar relay 801 in the supervisory circuit and polar receive relay 802 in the repeater circuit are held to their marking, or left-hand, position by a holding current in a circuit extending from grounded battery at the back contact and left-hand armature of relay 803, through the middle windings, in series, of relays 802 and 801 to grounded network 820. When a switchboard operator rings after connecting a cord circuit to the toll line extension multistation circuit, the ringing current operates alternating current relay 804 and, in turn, causes relay 805 to operate. Relay 805, upon operating, operates slow-to-release relay 806 and connects source 807 of 20-cycle ringing current over the operated contacts of relay 806 to transmission conductor 715 to operate the ringing equipment in the control circuit as will be hereinafter described.

Figs. 3 and 4 are used in system Y also and represent the toll line extension terminating equipment at the operator's switchboard in the TWX office. The terminating equipment like that at the multisection line repeater station is arranged for semiautomatic selective ringing also.

Method of Operation

Operator calls

Assuming that a connection is desired with one of the subscribers' stations A', B' and C', the operator at the switchboard connects one of several cord circuits, such as cord circuit 402, to jack 301, and then connects a ringing key to source 410 associated with cord circuit 402, say one operation of ringing key for station A', two operations for station B' and three operations for station C'.

The operator's cord circuit 402 upon being inserted into jack 301 operates sleeve relays 302 in a circuit traceable through grounded battery connected to the sleeve conductor on the cord circuit. Relay 302, upon operating, operates relays 303 and 305.

Relay 303, upon operating, (1) connects at its outer left armature and contacts transmission conductor 304 to the tip conductor of jack 301, tip conductor of the calling plug of cord circuit 402, the circuit closed being traceable from grounded positive battery at the marking contact and armature of polarized receive relay 306, conductor 307, through the upper winding of polarized send relay 308, make-before-break contact of relay 309, through the upper winding of polarized break relay 310, outer left-hand armature and contact of relay 303, to the above-mentioned tip conductors; (2) closes at its inner left armature and contact a circuit for energizing the biasing, or lower, winding of break relay 310; (3) closes at its outer right-hand armature and contact a circuit traceable from grounded positive battery 321, resistance 322, conductor 323, armature and contact of relay 303, conductors 324 and 325, resistance 326 to one side of the winding of relay 327, which is of the alternating current type; a parallel path extends over conductor 328 to the marking, or left-hand, contact and armature of polarized relay 316; another parallel path extends through resistance 330 to the filament of vacuum tube 331; another path extends through the winding of relay 333 to the plate of vacuum tube 331; and still another path extends from conductor 325, resistance 334, conductor 335, through resistance 336 to the grid circuit of vacuum tube 331.

Relay 305, upon operating, (1) transfers lamps conductor 337 at its right-hand armature from its back to its front contact which is connected over conductor 338, back contact and outer right-hand armature of relay 313 to grounded battery, thereby causing line lamp 339 to light; and (2) prepares at its left-hand armature and contact an operating circuit for relays 343 and 344 which circuit closes when relay 313 operates.

When the operator operates the ringing key of cord circuit 402, wherein the ringing key connects source 410 of ringing current, over ring conductor 358 in a circuit which extends over the contact and outer left-hand armature of relay 343, conductor 359, through the winding of alternating current relay 357, condenser 385 to ground. The operator's ringing key is operated once to call station A', twice to call station B' and thrice to call station C' and relay 357 will be operated accordingly, that is, for the duration of each operation of the key. Relay 357, upon operating, (1) closes at its left-hand armature and contact an obvious operating circuit for relay 318; and (2) at its right-hand armature and front contact a circuit extending from source 360 of grounded ringing current, conductor 376, front contact and armature of relay 318, transmission conductor 833, outermost upper armature and back contact of relay 814, conductor 839, through the winding of the alternating current relay 804, condenser 826 to ground; and over a parallel path extending through resistance 842 and the winding of relay 843 to ground. Relay 318, upon operating, disconnects the line side of the terminal repeater from conductor 833 and applies ringing current over conductor 833 to operate alternating current relay 804, the operating circuit for which was just described.

When the operator releases the ringing key, relay 357 releases and opens the ringing circuit and closes a circuit from conductor 833, through the armature and front contact of relay 318, armature and back contact of relay 357 to ground through resistance 362. The release of relay 357 opens the operating path of relay 318, but relay 818 being of the slow-to-release type does not release immediately but remains operated long enough for resistance 362 to discharge line conductor 833 before the line conductor is closed back through the line side of the terminal repeater via conductor 383.

During the idle condition, that is, when the

system is normal, line conductor 833 terminates in a ground connection 319 via the innermost right-hand armature and back contact of relay 303. After the operator connects a cord circuit to line jack 301 and relay 303 is thereby operated, the line terminates in tap 364 of positive polarity of a potentiometer having grounded battery 311 at one end and ground connection 319 at the other end, the potentiometer having a path to ground extending over the inner right-hand armature and contact of relay 313, middle right-hand armature and contact of relay 303. The positive voltage at tap 364 is applied to the line over conductor 312, back contact and left-hand armature of relay 313, through the winding of relay 314 and retardation coil 315 through the upper winding of received relay 306 and the upper winding of relay 316, retardation coil 317, conductor 363, to line conductor 833. This voltage is insufficient to operate relay 314 even though maximum leakage is present on the line circuit but will operate the sensitive relay 843.

The initial ringing period (about one second) will operate relay 804 and during the ringing period relay 843 may or may not release and in either case no action takes place. Relay 804 responds to the ringing current from source 360 and closes an operating circuit for relay 805. Relay 805 operates and closes at its inner upper armature and contact an obvious operating circuit for a slow-to-release relay 806. Relay 806 operates to connect source 807 of continuous ringing current over the front contact and outer upper armature of relay 805, front contact and armature of relay 806, transmission line conductor 715, which at the control center is connected over the innermost upper armature and back contact of relay 718, through the winding of alternating current relay 721, condenser 729 to ground. The initial ringing period (about one second) will operate relay 721 and during the ringing period relay 730 may or may not release and in either case no action takes place. Relay 721, upon operating, responds to the ringing current from source 807, whereby relays 722 and 723 are in turn operated during the ringing interval. Relay 722, being of the slow-to-operate type, delays its operation until slightly after relay 721 pulls up in response to the ringing current. Relay 723, upon operating, (1) closes at its inner lower armature and contact a locking circuit for itself, which circuit extends over the back contact and inner upper armature of relay 719 to ground; and (2) removes ground at its make-before-break contact so that no subscriber station can establish a connection after the initial ringing impulse has been transmitted. The first operation of relay 722 closes at its inner lower armature and front contact a circuit traceable from grounded battery at the innermost lower armature and back contact of relay 719, conductor 731, back contact and outer upper armature of relay 724, inner lower armature and front contact of relay 722, conductor 732, innermost armature and back contact of relay 713, innermost armature and back contact of relay 712, through the upper winding of relay 709, to ground and relay 709 operates and locks at its upper armature and contact in a circuit traceable over the back contact and outer upper armature of relay 713, outer upper armature and back contact of relay 714, conductor 733, to grounded battery at the make-before-break contact associated with the middle lower armature of relay 719.

Relay 709, upon operating, connects ground at its inner lower armature and front contact to a circuit extending through the winding and the make-before-break contacts of relay 712 to the back contact and inner lower armature of relay 722 and when relay 722 returns to normal at the expiration of the first ringing pulse, the circuit is extended over the outer upper armature and back contact of relay 724 to grounded battery at the inner lower armature and back contact of relay 719. Relay 712 operates and is locked to grounded battery at its upper armature and front contact. Also relay 709, upon operating, connects ground at its lower armature and front contact to a circuit traceable through the winding of relay 725 to grounded battery at the inner lower armature and back contact of relay 719. Relay 725 which is of the slow-to-operate type is timed to operate in about five seconds. The function of relay 725 will be explained hereinafter.

A second ringing period will cause relay 722 to again operate and reapply grounded battery over the inner lower armature and back contact of relay 719, through the back contact and outer upper armature of relay 724, the inner lower armature and front contact of relay 722, the innermost lower armature and back contact of relay 713, the innermost lower armature and front contact of relay 712, through the upper winding of relay 710 to ground. Relay 710 operates and locks through its upper winding in a circuit traceable over its upper armature and front contact, outer upper armature and back contact of relay 714 to grounded battery at the inner make-before-break contacts of relay 719. Relay 710, upon operating, connects ground at its inner lower armature and front contact in a circuit extending through the winding and make-before-break contact of relay 713 to the back contact and inner lower armature of relay 722 and when relay 722 again returns to normal at the expiration of the second ringing period the circuit is extended over the outer upper armature and back contact of relay 724 to grounded battery at the innermost lower armature and back contact of relay 719. Relay 713 operates and locks to grounded battery at its inner upper armature and front contact. Relay 713, upon operating, opens at its outer upper armature and back contact a locking circuit for relay 709 which releases and causes the subsequent release of relay 712.

A third ringing period again causes the operation of relay 722 which, upon operating, again connects grounded battery at the innermost lower armature and back contact of relay 719 to a circuit traceable over the outer upper armature and back contact of relay 724, inner lower armature and front contact of relay 722, innermost lower armature and front contact of relay 713, through the upper winding of relay 711 to ground. Relay 711 operates and locks in a circuit traceable over its inner upper armature and front contact to grounded battery at the inner make-before-break contacts of relay 719. Also, relay 711, upon operating, connects ground at its lower armature and contact to a circuit traceable through the winding and the make-before-break contact of relay 714, back contact and inner lower armature of relay 722 and when relay 722 again restores to normal after the expiration of a third ringing period, the circuit is extended over the back contact and outer upper armature of relay 724 to grounded battery at the back contact and innermost lower armature of relay 719. Relay 714 operates and locks to grounded battery at its inner upper armature and back contact. Relay 714,

upon operating, opens at its outer upper armature and back contact the locking circuit for relay **710**. Relay **710** releases and thereby causes the release of relay **713**. Relay **711**, upon operating, connects ground at its outer upper armature and front contact to a circuit for maintaining relay **725** energized.

Now that the three ringing intervals have been completed, say in five seconds, which is the operating time of slow-to-operate relay **725**, the relay now becoming sufficiently energized, therefore, operates and closes an obvious operating circuit for relay **724** which operates. During the operating time (five seconds) of relay **725**, the operator must ring 1, 2 or 3 to select the desired station and do so only once. At the expiration of the five-second interval, ringing current is impressed on transmission conductors **601**, **602** or **604** depending upon which of subscribers' stations A', B' and C' is desired in the completion of the connection, the ringing current so applied being derived from source **701**. The ringing current is applied during each one-second operate time of relay **727**, and is repeated until the subscriber at the called station responds. Relay **727** is employed for connecting source **701** of continuous ringing current to the transmission conductor extending to the called subscriber's station and this relay is operated by interrupted ground transmitted over conductor **728**. Interrupted ground conductor **728** is also employed for operating relay **708** which produces a busy signal each time a subscriber attempts to make a call when the toll line is busy.

Assume that the connection desired by the operator is to station A' in which event there will be only one ringing interval. Relay **709**, upon operating, closes at its inner lower armature and front contact an operating circuit for relay **712**, the circuit being traced from ground over the inner lower armature and front contact of relay **709**, through the winding of relay **712**, at its make-before-break contact, back contact and inner lower armature of relay **722**, outer upper armature and back contact of relay **724**, conductor **731**, back contact and innermost lower armature of relay **719** to grounded battery, the closure of this circuit being completed when relay **722** returns to normal at the expiration of the ringing interval. Relay **712** operates and locks to grounded battery at the upper armature and front contact of relay **712**. Also relay **709**, upon operating, closes at its outer lower armature and front contact a circuit extending from ground, conductor **734**, through the winding of relay **725**, conductor **731**, to grounded battery at the innermost lower armature and back contact of relay **719**. Relay **725** is of the slow-to-operate type and requires five seconds to operate.

Inasmuch as there is only one ringing impulse transmitted, relay **725** will wait five seconds and will then operate. Relay **725**, upon operating, closes an obvious operating circuit for relay **724** which operates. Also relay **724**, upon operating, connects at its inner upper armature and front contact grounded battery to a circuit traceable over the back contact and armature of relay **703**, through the winding of relay **702** to ground.

Relay **702** operates and at its inner upper armature and contact applies ground to the winding of relay **703**. Relay **703** operates and opens at its armature and contact the operating path of relay **702**. Inasmuch as relays **702** and **703** are slow-to-release types the former is maintained operated a short interval after the operation of relay **703** and the latter is maintained operated for a short interval after the release of relay **702**. Relay **703**, upon releasing, causes relay **702** to reoperate, which in turn reoperates relay **703**. This cycle continues as long as grounded battery is maintained at the inner upper armature and contact of relay **724**. The operation and release of relay **702** in recurring cycles apply approximately sixty impulses per minute to a circuit traceable from ground at the outer upper armature and contact of relay **702**, conductor **735**, make-before-break contact of relay **704**, then through the winding of relay **704**, resistance **736**, conductors **737**, **738** and **739** to grounded battery at the inner upper armature and contact of relay **724**. The first closure of ground over conductor **735** operates relay **704** which locks to ground at its front contact and armature, and relay **705** remains normal since ground is present on both ends of the winding of relay **705**. On the first open condition of the operating circuit for relay **704**, ground is removed from one end of the winding of relay **705** and since grounded battery via conductors **737**, **738** and **739** to grounded battery the other end, relay **705** operates. The second closure of ground at the outer upper armature and contact of relay **702** completes an operating circuit extending through the upper armature and front contact of relay **705** to one end of the winding of relay **704** and since ground is present on the other end of relay **704**, relay **704** is shunted and relay **705** remains operated on the second release of relay **702** whereby ground at the outer upper armature and contact is removed. Relay **705** releases. Subsequent sixty impulses per minute causes relays **704** and **705** to operate and release in regular recurring intervals as just described. This reduces the sixty impulses per minute to ground to thirty impulses per minute first to the relays **706** and **707**. Relays **706** and **707** operate in a manner similar to relays **704** and **705**, respectively, and further reduce the sixty impulses per minute to one second closed and three seconds open interrupted ground pulses. These pulses are transmitted over conductors **741** and **728**, outer upper armature and back contact of relay **719**, conductor **742**, through the winding of relay **727** to grounded battery and relay **727** operates each time a ground is connected to conductor **728** which is referred to herein as the interrupted ground conductor. Relay **727** operates and thereby causes relay **744** to operate. During the one-second operate time of relay **727**, ringing current from source **701** is connected at the front contact and upper armature of relay **727**, conductor **762**, front contact and upper armature of relay **744**, conductor **745**, front contact and middle lower armature of relay **710**, line conductor **601**, recall key **616**, upper make contact of key **617**, armature and back contact of relay **612**, through the ringer **607**, condenser **646** to ground and the ringer at station A is rung automatically at the termination of the five-second operating period of relay **725**.

Subscriber answers

The subscriber in response to the operation of station ringer **607** operates power switch **608**. Power switch **608**, upon being operated, completes a path from grounded alternating current source **609**, conductor **610**, contacts of the switch, conductor **611**, through the winding of relay **612**, to ground. Relay **612** operates. A path parallel to that extending over conductor **611** extends over conductor **613** through rectifier **614** and printer

motor 615 in parallel. Rectifier 614 is energized and printer motor 615 starts operating. Relay 612, upon operation, closes a circuit from line 601, through recall key 616, test key 617, armature and back contact of relay 612, resistance 618, through the upper winding of receive relay 619, resistance 620, retardation coil 621, resistance 622, armature and marking, or lower, contact of send relay 623, retardation coil 624, negative terminal to positive terminal of rectifier 614, retardation coil 625, marking, or upper, contact and armature of send relay 626, retardation coil 627, to ground connection 628. The energized rectifier supplies a source of potential difference between its terminals and thus to the circuit including ground connection 628 and line conductor 601. Rectifier 614, upon becoming energized, also causes a curent to flow in two parallel paths; one extending from the positive terminal of the rectifier, through the right-hand biasing winding of send relay 626 and the left-hand biasing winding of send relay 623, to the negative terminal of the rectifier and the other from the positive terminal of the rectifier, conductor 629, break key 630, transmitting contacts 631 of subscriber teletypewriter set 632, conductor 633, normal contacts of the line-in key 634, conductor 635, regulating resistance 636, conductor 637 through the left-hand and right-hand operating windings, in series, of send relays 626 and 623 respectively to the negative terminal of the rectifier. Printer magnet 640 of subscriber's teletypewriter 632 is operated by current flowing from rectifier 614, in a circuit including conductor 641, through the winding of printer magnet 640, conductor 642, varistor elements 643, retardation coil 644, marking, or left-hand, contact and armature of receive relay 619, retardation coil 645, to ground at the lower normal contact of key 617. The biasing, or lower, winding of receive relay 619 is energized over conductor 646 and resistance 638 and serves to operate relay 619 to its spacing, or right-hand, position when line 601 is opened. Resistance 638 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 TWX office. A further description of the various elements in the circuit shown in Fig. 1 may be had by referring to Fig. 1 of U. S. Patent 2,143,000, supra.

During the idle condition after switch 608 is operated and the potential applied to the line by rectifier 614 is of negative polarity and when the cut-through relay 718 is operated as will be hereinafter described, the negative potential so applied holds the repeater relays throughout the system in the positions shown.

Power switch 608, upon being operated, causes marking, or negative, voltage from rectifier 614 to be applied to line conductor 601 which extends in a circuit traceable over the middle lower armature and front contact of relay 712, conductor 745, armature and back contact of relay 744, conductors 743 and 746, through the winding of polarized relay 717, resistance 747, conductor 748, to ground at the make-before-break contacts of relay 718. Relay 717 is poled to operate on marking, negative voltage, and therefore at this time relay 717 operates to close an obvious operating circuit for cut-through relay 718. Relay 718 which is of the slow-to release type, operates (1) to extend transmission conductor 601 to toll line conductor 715; (2) closes at its outermost upper armature and contact an operating circuit for slow-to-release relay 719; (3) prepares at its middle upper armature and contact an extension to the holding circuit for relay 709; and (4) opens at its lower armatures and contacts the operating circuit for line relays 709, 710 and 711. Relay 719, upon operating, (1) completes at its middle lower armature and front contact the extension of the holding path for line relay 709; (2) closes at its outermost lower armature and front contact an operating circuit for holding relay 720; (3) at its innermost lower armature and front contact connects grounded battery to start conductor 739 and thereby closes an operating circuit for relay 702; (4) closes at its inner upper armature and front contact an operating circuit for relay 726; and (5) prepares at its outer upper armature and front contact an operating circuit for polarized relay 708. Relay 720, upon operating, (1) closes at its upper armature and contact a path for maintaining grounded battery connected to start conductor 739 and (2) provides at its lower armature and contact a holding circuit for itself and relay 709 in the event relay 719 releases. Relay 726, upon operating, closes at its armatures and contacts the busy signal path extending from the spacing contact of relay 708, conductor 749, to conductors 750, 751 and 752, in parallel, whereby busy signals may be furnished by relay 708 to any one of subscribers' stations A', B' and C' which attempts to initiate a connection to toll line conductor 715 when such line is at the time establishing or in an established connection.

The negative potential of rectifier 614 is now applied to toll line conductor 715 which extends over the armature and back contact of relay 806 through winding No. 1, in series, of polarized relay 801 and polarized receive relay 802, resistance 815, retardation coil 816, resistance 817, through the winding of relay 808, conductor 836, innermost upper armature and back contact of relay 814 to ground at the armature and back contact of relay 844. Relays 801 and 802 remain in their marking positions as shown and relay 808 operates and closes a circuit extending from grounded battery 812, resistances 811 and 810, conductors 827 and 828, armature and contact of relay 808, conductor 829, resistance 830, through the winding of alternating current relay 809, conductors 831 and 832, marking contact and armature of relay 801 to ground. Relay 801 operates. Relay 809, upon operating, closes an obvious operating circuit for slow-to-release relay 803. Relay 803, upon operating, operates relay 814 and removes at its back contact and outer left armature grounded battery from the biasing winding No. 2 of receive relay 802 and of relay 801. Also, relay 803, upon operating, completes the other part of the apex circuit which part extends over resistance 819, front contact and outer left-hand armature of relay 803 through the No. 2 biasing winding of relays 802 and 801, in series, to grounded artificial line network 820. Relay 814, upon operating, establishes the alternating current path for holding relay 809 operated, while relay 801 is following the signals transmitted from the teletypewriter at subscriber's station A' and the teletypewriter at the operator's position, the circuit changing in accordance with the operation of relay 801. When relay 801 is in its marking position, as shown, the alternating current circuit, as hereinbefore stated, is traceable from ground at the armature and marking contact of relay 801, conductors 832 and 831, through the winding of relay 809, resistances 830 and 834, condenser 735, contact and middle armature of relay

814, conductors 828 and 827, to grounded battery 812. With relay 801 in its spacing position, the alternating current circuit is shunted by a path direct to ground at the spacing contact. Also, relay 814, upon operating, (1) transfers the toll line extension circuit conductor 833 from the winding of ring relay 804 to the transmission conductor 825 which extends through the upper winding of receive relay 821 to grounded negative battery at the marking, or left-hand, contact of send relay 824; and (2) transfers the conductor 836 from ground connection at the back contact and armature of relay 844 to transmission conductor 837 which extends to ground at the marking contact of send relay 818.

The negative potential of rectifier 614 is now applied over toll line conductor 833, armature and back contact of relay 318, conductor 363, retardation coil 317, through the uppermost winding of polarized relay 316 and upper winding of polarized receive relay 306, retardation coil 315, through the winding of relay 314, left-hand armature and back contact of relay 313, conductor 312, innermost right-hand armature and front contact of relay 303 to potentiometer tap 364 which is of positive polarity. Relay 314 operates and closes at its armature and contact, a circuit extending from grounded positive battery 321, resistance 322, conductor 323, outermost right-hand armature and contact of relay 303, conductors 324 and 325, resistance 326, through the winding of alternating current relay 327, resistance 365, conductor 366, armature and contact of relay 314, conductor 367, through the lowermost winding of polarized relay 316, resistance 368, marking, or left-hand, contact of relay 316 to ground. Relay 327 operates and connects at its armature and contact an obvious operating circuit for relay 313 which operates. Relay 313, upon operating, (1) opens at its outer right-hand armature and back contact, the operating circuit for call lamp 339 which now becomes extinguished, indicating to the operator that the call has been answered; (2) completes at its outer right-hand armature and front contact, the circuit hereinbefore prepared by relay 305 for operating relays 343 and 344, both of which now operate; and (3) transfers its left-hand armature from its back contact to its front contact which is connected to ground over the armature and marking contact of send relay 308.

Relay 343, upon operating, (1) opens at its inner left-hand armature and contact, a circuit traceable from grounded positive battery 321, resistances 322 and 345, inner left-hand armature and contact of relay 343, conductor 346, through the middle winding of polar relay 316 and the lower winding of relay 306 to ground at the inner right-hand armature and back contact whereby the idle marking condition is removed from polarized relays 316 and 306 of the repeater; (2) connects at its inner right-hand armature and front contact the artificial line circuit which extends from apex 369, conductor 349, front contact and inner right-hand armature of relay 343, conductor 350, lower winding of relay 306 and middle winding of relay 316, conductors 348 and 347, resistance 370, condenser 352 to ground connection at 351; (3) opens at its outer left-hand armature and contact the operating circuit for alternating current relay 357; and (4) prepares at its outer right-hand armature and contact the operating circuit for relay 361.

Relay 344, upon operating, (1) closes at its right-hand armature and front contact the artificial line circuit which extends from apex 371, conductor 354, right-hand armature and contact of relay 344, conductor 353, through the lower winding of send relay 308 to ground; and (2) closes at its left-hand armature and contact a path for holding alternating current relay 327 operated during the time the subscriber or operator is sending at which time relay 316 follows the signals and relay 314 is shunted by condenser 346, the path so closed extending through resistance 372, condenser 356, left-hand armature and contact of relay 344 to tap 373. The action is as follows: during the time that relay 316 is on its marking, or left-hand, contact, resistance 326 at one end of winding 327 is grounded, and current from grounded battery 321 flows through resistances 322 and 355 and the front contact and left-hand armature of relay 344 (charging condenser 356), through resistances 372 and 365 and winding of relay 327 to ground at the marking, or left-hand, contact of relay 316, thereby holding relay 327 in an operated position. When relay 316 operates to its spacing, or right-hand, contact, one side of condenser 356 and resistances 372 and 365 becomes grounded and the current in relay 327 reverses and continues to hold relay 327 operated. During long marking or long spacing signals, that is, sufficiently long to charge condenser 346 to its full value, relay 314 operates to hold relay 327 operated.

Biasing current in the lower winding of relay 310 tends to operate the relay to its spacing contact, but marking current in the loop, or upper, winding of relay 304 is twice as great and in the opposite direction so that the relay is operated to its marking, or left-hand, contact. Ground connected to the armature and marking, or left-hand, contact of relay 310 is impressed on a circuit extending over conductors 374 and 335 to maintain condensers 375 discharged during the time the loop to the subscriber's circuit is in marking condition. During the normal transmission period, relay 310 will follow the transmission signals. The circuit is now ready for communication between the subscriber and the operator at the switchboard. All subscribers' stations other than the one answering the call are locked out because the operating circuit for their respective line relays is opened by the removal of ground at the make-before-break contact of relay 723 via the back contacts and armatures of relay 718. As hereinbefore stated, the extinguishing of call lamp 339 when relay 313 operated is an indication to the operator at the switchboard that the subscriber has answered.

Busy line indication

When a busy condition exists on a calling subscriber line, relays 719 and 726 are operated in a manner as hereinbefore described and the interrupted ground is applied to conductors 728 and 753. The initial application of ground to lead 753 discharges condenser 754 and the subsequent removal of ground allows condenser 754 to charge in a circuit extending from grounded battery 755, resistance 756, condenser 754, through the upper winding of relay 708 to ground. This charging current is of sufficient value and in a direction to momentarily overpower the biasing current in the lower winding of the relay and to operate the armature thereof to its spacing, or right-hand, contact. This ground that is applied to conductor 753 is connected for about twenty milliseconds and at the rate of about once per second.

When relay 726 operated, this intermittent twenty-millisecond ground is applied to conductor 749, contacts and armatures of relay 726, back contact and armature of the auxiliary line relay associated with the subscriber's station whereat a call is attempted when the toll line is engaged in a connection to one of the other stations. The intermittent ground when applied to a transmission conductor, such as conductors 601, 602 and 603, will produce a series of "letters" signals at the teletypewriter of a subscriber who attempts to call by turning on the power switch when the line to the switchboard is in use by a party at another of the stations. These signals cause a sufficient amount of current in the proper direction through the line winding of the receiving relay such as relay 619 of station A' to overpower the biasing current in the lower winding of such relay for a period of time required to produce the "letters" signals. The subscriber attempting to call after noting these signals shuts off the power and places another call at a later time.

Subscriber disconnects

The subscriber turns off power switch 608 thereby removing grounded negative potential from transmission line conductor 601, through the removal of power source 609. All operated elements release and all energized devices deenergize, thereby placing an open condition on station A' transmission conductor 601. This differs from the condition when a recall signal is transmitted in which case ground is connected to conductor 601 several times momentarily. Since during the normal condition the marking, or left-hand, contact of send relay 818 is connected to ground, the voltage drop across resistance 757 falls to zero and neither of relays 717 nor 716 will be operated. Inasmuch as the disconnect signal is a prolonged interval of deenergization of transmission conductor 601 and therefore relays 717 and 716 remain in the positions shown, slow-release relays 718 and 719 release. Relay 718 releases first and thereby removes at its middle upper armature the holding battery for the locking circuit of relay 709. Relay 709 releases causing the release of auxiliary line relay 712. The release of relay 719 causes relays 720 and 726 to release as well as stopping the interrupting operation of the busy relays 702, 703, 704, 705, 706, 707 and 708. Relays 725 and 724 release, in turn, after the release of line relay 709.

At the multisection line repeater, the zero voltage on toll line conductor 715 causes relay 808 to release which, upon releasing, causes relays 809 and 803 to restore to normal. The repeater relays are accordingly restored to their normal condition in which they are shown. The release of relay 803 effects the release of relay 814.

With zero voltage applied to the repeater at the toll line terminating circuit at the switchboard, relay 314 releases. Relay 314, upon releasing, causes the release of relays 327, 343, and 344. Relay 327, upon releasing, releases relay 313. Relay 313, upon releasing, causes call lamp 339 to light steadily thereby indicating to the operator that a disconnect signal has been transmitted in response to which the operator at the switchboard will remove cord circuit 402 from jack 301 and relays 303 and 305 release.

Recall signal from the subscriber

A recall signal is given to the operator at the switchboard by the subscriber momentarily operating recall key, such as key 616 at station A', several times. While the key is operated, ground is connected to both ends of the toll line, as for example, ground at the upper contact of recall key 616 and ground at the marking, or left-hand, contact and armature of send relay 818. At the multisection line repeater relay 808 releases for each deenergization in the toll line circuit, but relay 803 being of the slow-to-release type, remains operated to hold relay 814 operated during the time that the toll line circuit is deenergized. The recall signals are repeated to toll line conductor 833 and in the repeater circuit at the toll line terminating equipment at the operator's switchboard, relay 314 releases for each deenergization of the toll line. Relay 314, upon releasing, causes to release, in turn, relays 327, 313, 343 and 344. Relay 313, upon releasing, functions as hereinbefore described for disconnect signals and supervisory call lamp 339 lights. Relays 343 and 344 release and open the alternating current operating path of relay 327 and furnish grounded battery for holding the terminal repeater relays 306, 316 and 308 in marking condition. The alternate deenergization and energization of the toll line by the operation of the recall key causes supervisory call lamp 339 to flash.

Break signal from the subscriber

When the subscriber operates the break signal key, such as key 630 at station A', positive spacing polarity will be applied to the line at the subscriber's station during the time the break signal key is operated. The repeater in the toll line terminating equipment at the switchboard will repeat this spacing condition so that relay 314 continues to hold relay 327 and its associated relays operated. Break relay 310 operates to its spacing, or right-hand, contact. When the subscriber restores break key 630, negative marking polarity will be reapplied to the line at the subscriber's station and the terminal repeaters including relay 310 operate to their marking contacts and the circuit is in condition for transmission of telegraph signals. If the subscriber sends a break signal exceeding six seconds, vacuum tube 331 will function as hereinafter described under "Trouble break" but otherwise performs no useful function at this time.

Break signal to subscriber

A break signal incoming from the supervisory repeater produces a spacing condition in the subscriber's loop circuit. This spacing condition in the loop is immediately repeated through the line to the subscriber's set. Relay 310 is operated to its spacing, or right-hand, contact under the influence of its biasing current.

Relay 314 continues to hold relay 327 and its associated relays operated. The operation of relay 310 to its spacing contact removes ground from condenser 375 and allows the condenser to charge from grounded positive battery 321, over conductors 323, 324 and 325 through resistance 334 and over conductor 335. When the loop is closed to marking, relay 310 operates to marking and discharges condenser 375 thereby preventing condenser 375 from obtaining enough of its charge to cause vacuum tube 331 to draw plate current.

Trouble break

Vacuum tube 331 with its associated apparatus is designed to detect a break signal of six seconds or more, through the supervisory repeater. With relay 303 operated, the filament of tube 331 lights.

As long as relay 310 is in marking condition, condenser 375 is discharged and the tube does not draw plate current. If, however, the break exceeds approximately six seconds, condenser 375 has had time to charge from grounded positive battery 321, through resistance 334, to a potential as high as that of the filament. Therefore the grid connected through the current limiting resistance 336 causes plate current to flow and operate relay 333. Relay 333, upon operating, operates relay 309. Relay 309, upon operating, (1) connects grounded battery at its outer right-hand armature and contact to a source 378 of interrupted ground such as produced over conductor 728 in Fig. 7 and the source is connected to a circuit extending over the left-hand armature and contact of relay 309, conductor 380, outer right-hand armature and contact of relay 343, conductor 381, through the winding of relay 361 to grounded battery; and (2) transfers the loop transmission lead 382 from the terminal repeater to a path extending over conductor 383, to the left-hand armature of relay 361. Relay 361 operates and releases when the interrupter opens and closes ground to the winding of relay 361 in recurring cycles. When the interrupter closes, the operation of relay 361 removes grounded negative battery 378 from conductor 383 and closes a loop through the associated supervisory repeater circuit. If the supervisory repeater circuit is still spacing, relay 310 remains on its spacing, or right-hand, contact and relays 333, 309 and 361 remain operated and the terminal repeater sends a spacing signal out over transmission conductor 833 to the subscriber's station. Also relay 361, upon operating, closes at its right-hand armature and contact a path extending from ground at the armature and spacing contact of relay 316, conductor 384, contact and right-hand armature of relay 361, resistances 377 and 365 through the winding of relay 327, conductors 325 and 324, outer right-hand armature and contact of relay 303, conductor 323 to grounded battery 321 whereby relay 327 is held operated during the spacing interval. Relay 314 is under control of the subscriber station only when the terminal repeater sends a marking signal out on the line. This takes place when relay 361 releases thus opening the holding path of relay 327, leaving it under control of relay 314. Transmission conductor 382 is again connected through the back contact of relay 361 to grounded negative battery 378. This operates send relay 308 of the associated terminal repeater to marking and ground is sent out over transmission conductor 833 to the subscriber station. If relay 361 is operated and the space signal changes to marking polarity in the loop circuit, relay 310 will operate to its marking, or left-hand, contact which discharges condenser 375 thereby cutting off plate current in vacuum tube 331. Relay 333 therefore releases which will in turn release relays 309 and 361 and the circuit will be ready for communication.

If the subscriber disconnects during a trouble break, which has caused relays 333, 309 and 361 to operate, relay 314 will release on the first marking pulse sent by the terminal repeater and relay 327 will release, thus releasing relay 313 which functions as hereinbefore described under "Subscriber disconnects." If the loop is still spacing, the operator receives the disconnect signal and relays 333 and 309 will be operated. When the switchboard operator removes the supervisory repeater patching cord 402, relays 302 and 305 will release and open the operating circuit of the vacuum tube 331 and the biasing winding of relay 310. Relay 333 will release and open the operating circuit of relay 309 causing it to release and the circuit will be restored to normal.

The subscriber may send a recall or a disconnect signal during the time the line is marking when a "trouble break" exists on the loop side of the terminal repeater. When this condition exists the line circuit times out after approximately six seconds and causes the repeater to send alternate marking and spacing signals over the line to the subscriber. The operator will go in on the circuit and operate the split key (not shown but associated with the cord circuit) in order to determine which side of the supervisory repeater circuit the trouble is coming. This will change the loop back to the marking condition and when relay 361 operates on the next spacing pulse, the transmission path is closed through the terminal repeater and relay 310 will operate to its marking, or left-hand, contact and the circuit will function as hereinbefore described under "Trouble break."

Operator abandons call

Assume that relays 709 and 712, or relays 710 and 713, or 711 and 714 are operated due to the operator pulsing with ringing current as hereinbefore described. When the operator inserted cord circuit into jack 301 and relays 302, 303 and 305 operated, potentiometer tap 364 impressed a positive potential on the winding of relay 843 at the conclusion of the five-second ringing interval. Relay 843 operated and in turn operated relays 845 and 844. Relay 845 which is of the slow-to-release type, upon operating, takes over the function of maintaining biasing current through the lowermost winding of relay 801 and relay 844, upon operating, connects at potentiometer tap 846, positive potential to a circuit extending over conductors 841 and 836, through the winding of relay 808, retardation coil 816, resistance 815, through the uppermost winding, in series, of relays 802 and 801, back contact and armature of relay 806, toll line conductor 715, innermost upper armature and back contact of relay 718, through the winding of relay 730 to ground. Relay 730 operates. Relay 814 has not as yet operated inasmuch as the subscriber at the called station has not operated the power switch, such as switch 688 at station A'. Relay 808 does not respond to the low positive potential of potentiometer tap 846. If the subscriber does not answer after a specified time, the operator removes the cord circuit from jack 301, thereby causing the release of relays 302, 303 and 305. The removal of the low positive voltage at potentiometer tap 364 causes relay 843 to release and in turn the release of slow-to-release relays 845 and 844. The removal of the low positive voltage of potentiometer tap 846 causes relay 730 to release. Relay 730, upon releasing, closes the operating circuit for relay 719 which may be traced from grounded battery, through the winding of relay 719, conductor 758, back contact and armature of relay 730, conductor 759, to ground at the contact and lower armature of relay 724 which operated at the expiration of the five-second ringing interval. Relay 719 operates and thereby closes an operating circuit for holding relay 720, the circuit being traceable from ground at the outermost lower armature and front contact of relay 719, through the winding of relay

720, to grounded battery at a lower armature of one of the auxiliary line relays 712, 713 or 714, whichever one happens to be operated in response to the ringing current. Relay 720 operates and disconnects at its lower armature and make-before break contact, grounded battery from the locking circuit of either line relays 709, 710 or 711, whichever happens to be operated in response to the ringing current. Assume that line relay 709 is operated in response to the ringing current, then relay 709 releases when relay 720 operates, and the release of relay 709 releases auxiliary line relay 712, with which it is associated. Relay 719, upon operating, removes at its innermost lower armature and back contact the holding battery for relay 725. Relay 725 releases in about one second after relay 719 operates and the release of relay 725 releases relay 724 thereby causing the release of relay 719 and all relays are now returned to idle condition. In case the "letters" signal circuits function during the momentary operation of relay 719, no action takes place because at this time the transmission conductor at each subscriber's station, such as conductor 601 at station A', is terminated in the ringer and condenser circuit, such as ringer 607 and condenser 647 at station A'.

Subscriber calls

Assume that the subscriber at station A' desires to make a call to the operator's switchboard, power switch 608 is operated to its "on" position whereby the station set is placed in an operating condition as hereinbefore described. With the subscriber set at station A' in an operated condition, negative potential is applied to transmission conductor 601, middle lower armature and back contact of relay 712, conductor 752, through the lower winding of line relay 709, back contact and outermost lower armature of relay 718, to ground at the make-before-break contact of relay 723. Line relay 709 operates and locks in a circuit traceable from ground at its front contact and upper armature, conductor 760, back contact and outer upper armature of relay 713, outer upper armature and back contact of relay 714, conductor 733, to grounded battery at the inner make-before-break contact of relay 719. Relay 709, upon operating, closes at its inner lower armature and contact, an operating circuit for auxiliary line relay 712 which is traceable from ground at the armature of relay 709, through the winding and make-before-break contacts of relay 712, conductor 761, back contact and inner lower armature of relay 722, outer upper armature and back contact of relay 724, conductor 731, back contact and innermost lower armature of relay 719, to grounded battery. Relay 712 operates and locks to grounded battery at its upper armature and front contact. Relay 712, upon operating, connects at its middle lower armature and front contact, transmission line conductor 601 to transmission conductor 745, which extends over the armature and back contact of relay 744, over conductor 743 to ground at the make-before-break contact of relay 718. Included in conductor 743 is resistance 757 and the voltage drop that now exists across this resistance is of such value and of such polarity as to operate polarized relay 717, relay 717 being poled to respond to negative, or marking, polarity and polarized relay 716 being poled to respond to positive, or spacing, polarity. Relay 717, upon operating, closes an obvious operating path for cut-through relay 718. Relay 718 operates and at its innermost upper armature and front contact connects transmission conductor 743 to toll line conductor 715. The negative potential from rectifier 614 is now impressed on toll line conductor 715 which extends through a circuit traceable over the armature of back contact of relay 806, through the uppermost windings, in series, of relays 801 and 802, resistance 815, retardation coil 816, resistance 817, through the winding of relay 808, conductor 836, innermost upper armature and back contact of relay 814, conductor 841, armature and back contact of relay 844 to ground. Relay 808 operates and thereby closes at its armature and contact a circuit traceable from ground battery 812, resistance 811 and 810, conductor 828, armature and contact of relay 808, resistance 830, through the winding of relay 809, conductors 831 and 832, marking contact and armature of relay 801 to ground. Relay 809 operates and closes at its armature and contact an operating circuit for relay 803. Relay 803 operates and (1) transfers its outer left-hand armature and from its back contact to its front contact thereby completing the artificial line side of the apex circuit, the line side extending as hereinbefore traced through the winding of relay 808; and (2) closes at its inner left-hand armature and contact an obvious operating circuit for relay 814.

Relay 814 operates and (1) extends at its outermost upper armature and front contact, the transmission conductor 825 over toll line conductor 833; (2) completes at its middle upper armature and contact the alternating current circuit for maintaining relay 809 operated during the transmission of signals, that is, during the time that relay 801 is following the signals, said circuit being traceable from grounded battery 812, resistances 811 and 810, conductor 828, middle upper armature and contact of relay 814, condenser 835, resistance 834, resistance 830, through the winding of relay 809, conductors 831 and 832, marking contact and armature of relay 801 to ground; (3) connects conductor 836 over its innermost upper armature and front contact to conductor 837, armature and marking contact of relay 818 to ground. The negative potential shown at the marking contact and armature of relay 824 and impressed over conductor 825 is now impressed on toll line conductor 833 in a circuit traceable over the armature and back contact of relay 318, retardation coil 317, through the uppermost windings, in series, of relays 316 and 306, retardation coil 315, through the winding of relay 314, left-hand armature and back contact of relay 313, innermost right-hand armature and back contact of relay 303, to ground at connection 319. Relay 314 operates and connects grounded battery 321 to a circuit extending through resistances 322 and 355, conductors 384 and 367, armature and contact of relay 314, conductor 366, resistance 365, through the winding of relay 327, conductor 328, to ground at the marking contact and armature of relay 316. Relay 327 operates and closes at its armature and contact an operating circuit for relay 313. Relay 313 operates and thereby (1) transfers at its left-hand armature and contact, toll line conductor 833 to ground at the armature and contact of send relay 308; and (2) closes at its outer right-hand armature and front contact as circuit extending from grounded battery 340, outer right-hand armature and front contact of relay 313, conductor 341, back contact and right-hand armature of relay 305, conductor

337 to call lamp 339. Call lamp 339 lights which indicates to the operator at the switchboard that a call is awaiting. The operator inserts a cord circuit, such as cord circuit 402, into jack 301 to complete the establishment of the connection as hereinbefore described.

Combined System

It is understood that Figs. 1 and 2 of system X may be combined with Figs. 8, 3 and 4 of system Y and that Figs. 6 and 7 of system Y may be combined with Figs. 3 and 4 of system X in order to provide two additional 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 between Figs. 7 and 8 receives from one end the polar signals from the armature and contacts of each of the send relays 623 and 626 and from the other end "medium current" and "high current" signals transmitted from the respective contacts of send relay 818. Similarly, the section shown extending between Figs. 8 and 3 of system Y receives from one end polar signals from the armature of send relay 824 and from the other end "medium current" and "high current" signals transmitted from the contacts respectively of relay 308.

What is claimed is:

1. A telegraphic system comprising a main office, a source of ringing current at said office, a switching center, a main channel interconnecting said main office and said switching center, a plurality of outlying stations, a call signaling device at each of said outlying stations, transmission and reception apparatus for permutation codes at each of said outlying stations, a motor start element for each of said apparatus, other channels, normally deenergized, respectively connecting said outlying stations to said switching center, means at said switching center responsive to one or more sequential connections of said source to said main channel for actuating a call signaling device at any one, and one only, of said outlying stations selectively, and means in said switching center responsive to the operation of a motor start element at one of said stations for preventing any idle one of said other channels from becoming energized when one of said other channels is energized.

2. A telegraphic system comprising a main office, a source of calling signals at said office, a switching center, a main channel interconnecting said main office and said switching center, a plurality of outlying stations, a call signaling device at each of said outlying stations, motor driven transmission and receiving apparatus for permutation codes at each of said outlying stations, a motor start element for each of said apparatus, other channels, normally deenergized, respectively connecting said outlying stations to said switching center, means at said switching center responsive to one or more sequential connections of said source to said main channel for actuating a call signaling device at any one, and one only at a time, of said outlying stations selectively, and a source of permutation code signals effective, when one of said other channels is energized and operatively connected through said switching center to said main channel, to send said permutation code signals to the transmission and reception apparatus at any one of the other outlying stations at which a motor start element becomes operated at the time said one of said other channels is energized and operatively connected through said switching center to said main channel.

3. A telegraphic system comprising a main office, a source of ringing current at said main office, a switching center, a source of ringing current at said switching center, a main channel interconnecting said main office and said switching center, a plurality of outlying stations, a call signaling device at each of said outlying stations, other channels respectively connecting said outlying stations to said switching center, means at said switching center responsive to one or more sequential connections of said source to said main channel for actuating a call signaling device at any one, and one only at a time, of said outlying stations selectively, a plurality of groups of devices corresponding in number to said plurality of outlying stations, and means at said switching center for operating said groups of devices sequentially in response to and in accordance with said sequential connections to the first-mentioned source, other means responsive to the operation of each of said groups of devices for releasing the immediately preceding one of said groups whereby one group only remains operated at the termination of said sequential connections to the first-mentioned source to connect the second-mentioned source at regular intervals for an indefinite time to the call signaling device at the corresponding one of said outlying stations.

4. A telegraphic system comprising a main office, a switching center, a multisection main channel interconnecting said main office and said switching center, a plurality of stations, a call signaling device at each of said stations, a plurality of other channels respectively connecting said stations to said switching center, and a repeater terminating said main channel at said main office, a repeater interconnecting adjacent sections of said main channel, a source of selective calling signals at said main station, a source of selective ringing current at each of said repeaters, a source of ringing current at said switching center, and means at each of said repeaters for repeating one or more definite numbers of calling signals as transmitted from the first-mentioned source, and means at said switching center controlled by any one of the definite number of calling signals for repeating an indefinite number of signals from said source of continuous ringing current to operate a call signaling device at any one, and one only at a time, of said plurality of stations.

5. A telegraphic system comprising a main telegraphic trunk transmission circuit, an automatically operated switching center at which said circuit terminates, a plurality of telegraphic stations equipped with transmission and reception apparatus, a call signaling device at each of said stations, individual line circuits for connecting each of said stations through said switching center to said trunk circuit and means controllable over said trunk circuit from a point remote from said switching center for actuating said call signaling device at one, and only one, of said stations selectively, said means comprising a plurality of relay groups operated sequentially to automatically effect a connection between one, and one only, of said individual line circuits to said trunk transmission circuit and other group of relays ar-

ranged to operate sequentially to automatically operate the call signaling device at the station connected to said one, and one only, of individual line circuits, said last-mentioned group of relays being also adapted when said one, and one only, of individual line circuits is connected to said trunk transmission circuit, to automatically cause permutation code signals to be transmitted to the transmission and reception apparatus at an idle one of said telegraphic stations when a party at said one telegraphic station attempts to establish a connection between associated individual line circuits and said trunk transmission circuit at the time another of said individual line circuits is established in a connection with said telegraphic trunk transmission circuit.

6. A telegraphic system comprising a main office, a switching center, a single wire telegraphic half duplex operated trunk transmission circuit interconnecting said main office and said switching center, and having a polar sending differential receiving operation, a source of selectively operated call signals at said main office, a plurality of telegraphic stations, transmission and reception apparatus for permutation codes at each of said stations, a line connecting each of said stations to said switching center, a starting element at each of said stations for operatively connecting the transmission and reception apparatus to said trunk transmission circuit, a call signaling device at each of said stations, a repeater at said main office, means in said repeater for repeating call signals from said selectively operated source, means in said switching center responsive to said repeating means for operating a call signaling device at one, and one only, of said stations, other means in said repeater for cooperating with said transmission and reception apparatus at each of said stations for providing, during transmission, signals consisting of voltage reversals in one direction and voltage and zero voltage in the other direction, and other means at said switching center for transmitting permutation code signals to said transmission and reception apparatus at each of those stations whereat a call is attempted when said trunk transmission circuit is engaged in an operative connection with a line extending to another of said stations.

7. A telegraphic system comprising a main office, a switching center, a single wire telegraphic half duplex operated trunk transmission circuit of the multisection type, interconnecting said main office and said switching center and using polar sending differential receiving, a source of selectively operated call signals at said main office, a plurality of telegraphic stations, a line connecting each of said stations to said switching center, a starting element at each of said stations for operatively connecting the transmission and reception apparatus to said trunk transmission circuit, a source of calling signals at said main office, a call signaling device at each of said stations, a repeater at said main office, a repeater interconnecting adjacent sections of said trunk transmission circuit, and means in each of said repeaters for repeating calling signals originating in said selectively operated source, and other means in each of said repeaters for providing during transmission of signals between adjacent sections, voltage reversals in one direction and voltage and zero voltage in the other direction.

8. A telegraphic system comprising a main telegraphic impulse transmission trunk, a switching center at which said trunk terminates, a plurality of telegraphic stations equipped with transmission and reception apparatus for permutation codes, individual line circuits for connecting each of said stations to said switching center, and means controllable over said trunk from a point remote from said switching center for actuating a call signaling device at one, and only one, of said stations selectively, said means comprising elements for transmitting over said trunk appropriate ringing current conditions and other elements at said switching center responsive thereto in combination with means at each of said telegraphic stations for indicating a busy condition of said trunk whenever said trunk is in use.

9. A telegraphic system comprising a main telegraphic impulse transmission trunk, a switching center at which said trunk terminates, a plurality of telegraphic stations equipped with transmission and reception apparatus for permutation codes, individual line circuit for connecting each of said stations to said switching center, and means controllable over said trunk from a point remote from said switching center for actuating a call signaling device at one, and only one, of said stations selectively, said means comprising elements for transmitting over said trunk appropriate ringing current conditions and other elements at said switching center responsive thereto in combination with means at each of said telegraphic stations operable in response to actuation of a call establishing element to record a busy signal upon said reception apparatus.

10. A telegraphic system comprising a main telegraphic impulse transmission trunk, a switching center at which said trunk terminates, a plurality of telegraphic stations equipped with transmission and reception apparatus for permutation codes, individual line circuits for connecting each of said stations to said switching center, and means controllable over said trunk from a point remote from said switching center for actuating a call signalling device at one, and only one, of said stations selectively, said means comprising elements for transmitting over said trunk appropriate ringing current conditions and other elements at said switching center responsive thereto in combination with means operable by connection of any one of said telegraphic stations to said trunk to lock the other stations from access thereto during the continuation of said connection.

11. A communication system comprising a main station, a source of periodically varying current at said main station, a switching center, a main telegraph channel interconnecting said main station with said switching center, a plurality of outlying stations, a call signaling device at each outlying station, a telegraphic line connecting each outlying station to said switching center, means for calling one of said outlying stations comprising means at the switching center responsive to successive applications of said source to said main channel to actuate one of said call signaling devices selectively and exclusively of others thereof in accordance with the number of applications of said varying current to said channel, and means operable to include in said line at the station of the actuated signaling device a telegraphic contact and telegraphic receiving instrument.

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