Aug. 3, 1937. F. S. KINKEAD 2,088,750

ANSWER BACK DEVICE FOR MACHINE SWITCHING PRINTING TELEGRAPH EXCHANGE SYSTEMS

Filed Jan. 18, 1936 5 Sheets-Sheet 1

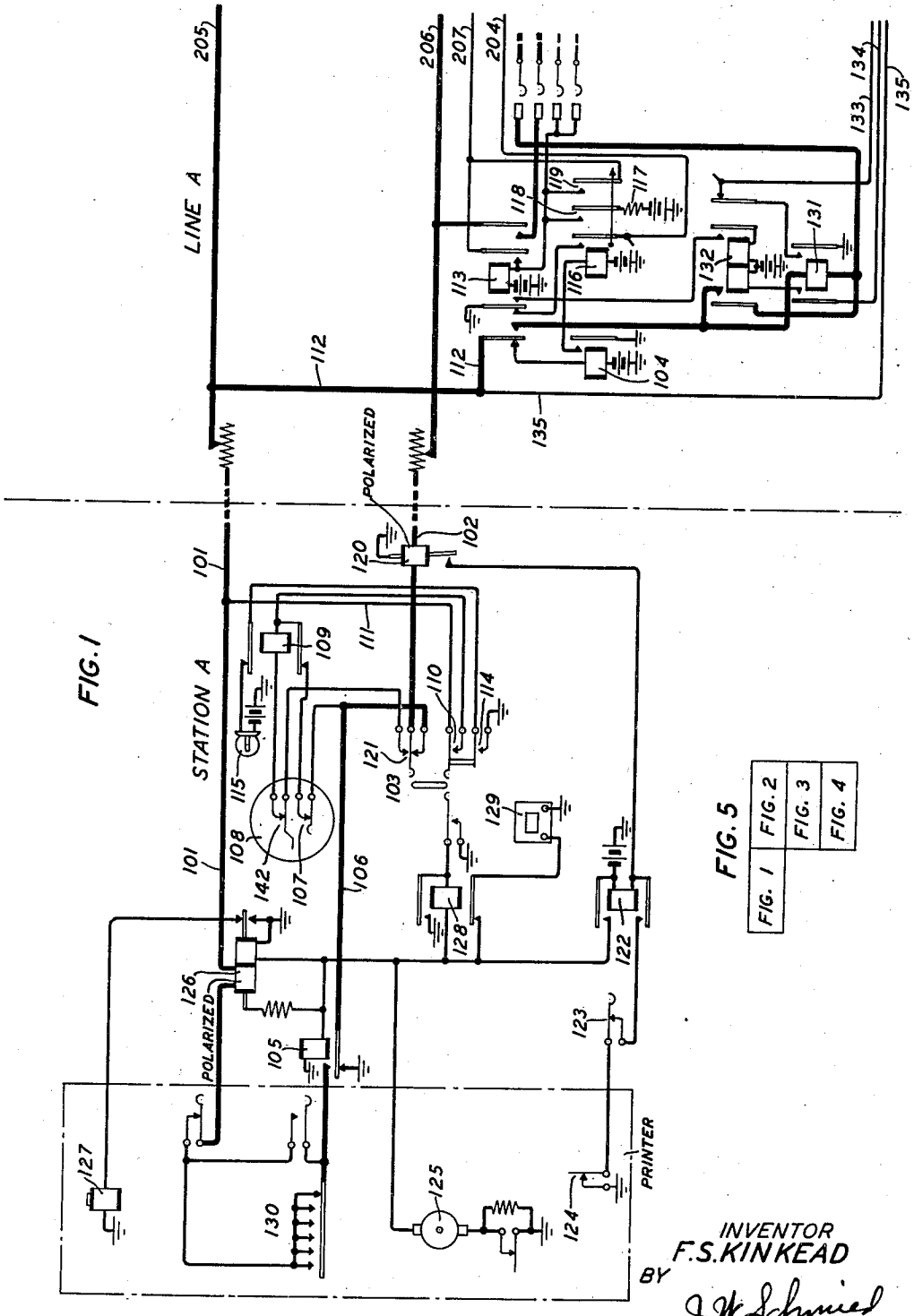

FIG. 1

FIG. 5

FIG. 1	FIG. 2	
	FIG. 3	
	FIG. 4	

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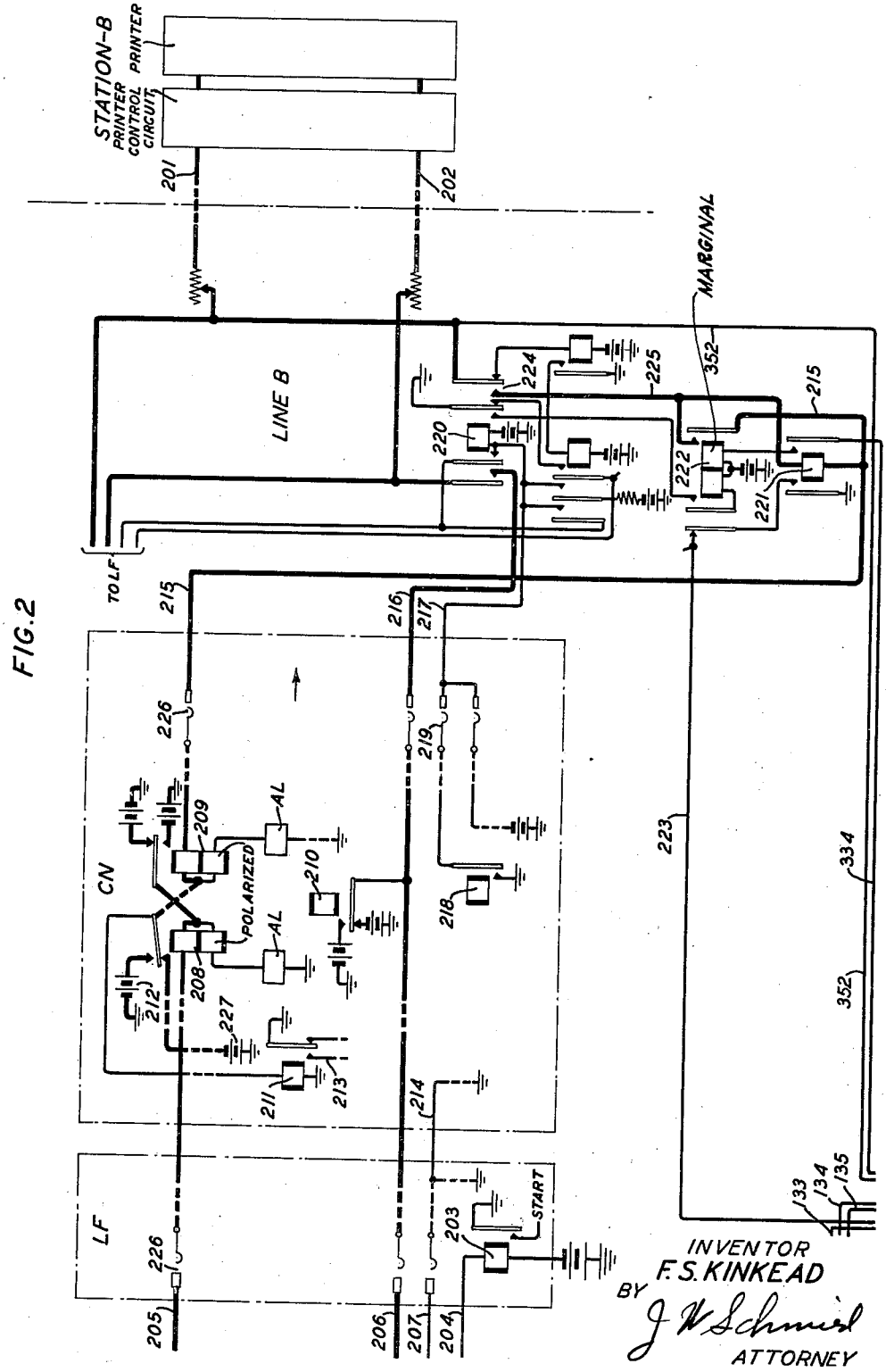
Filed Jan. 18, 1936 5 Sheets-Sheet 2

FIG. 2



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ANSWER BACK DEVICE FOR MACHINE SWITCHING PRINTING TELEGRAPH EXCHANGE SYSTEMS

Filed Jan. 18, 1936 5 Sheets-Sheet 3

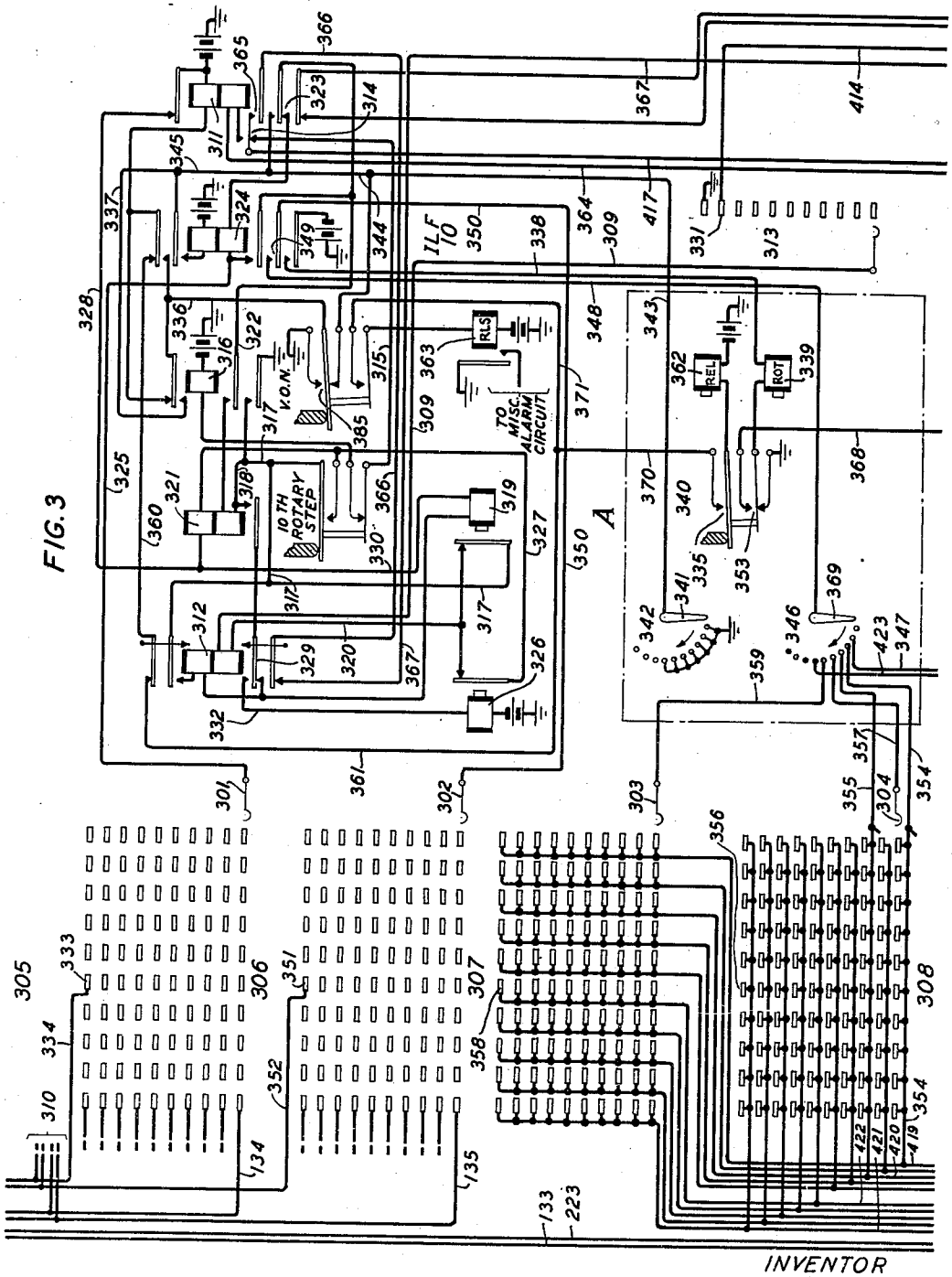

FIG. 3

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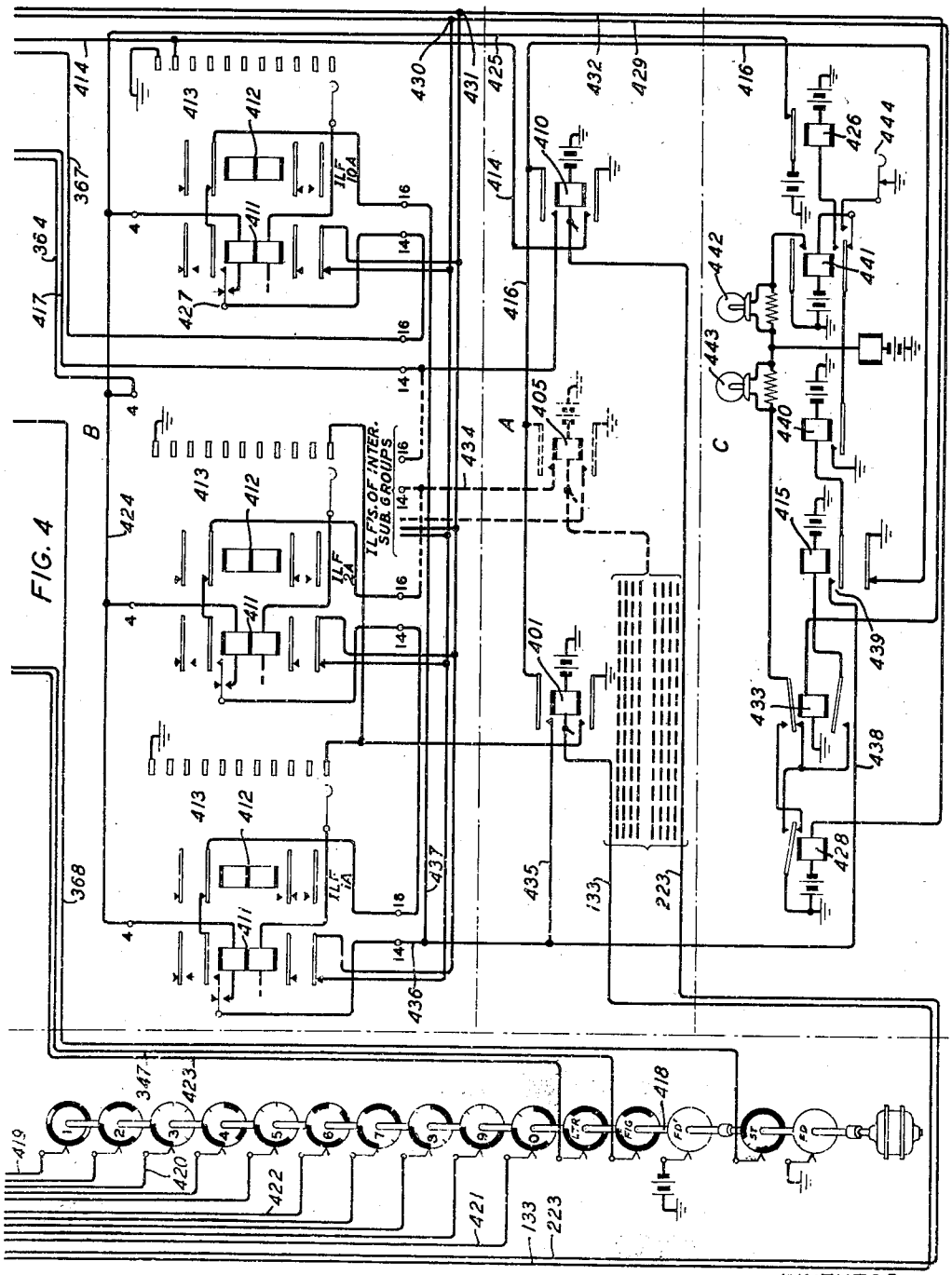
Filed Jan. 18, 1936 5 Sheets-Sheet 4



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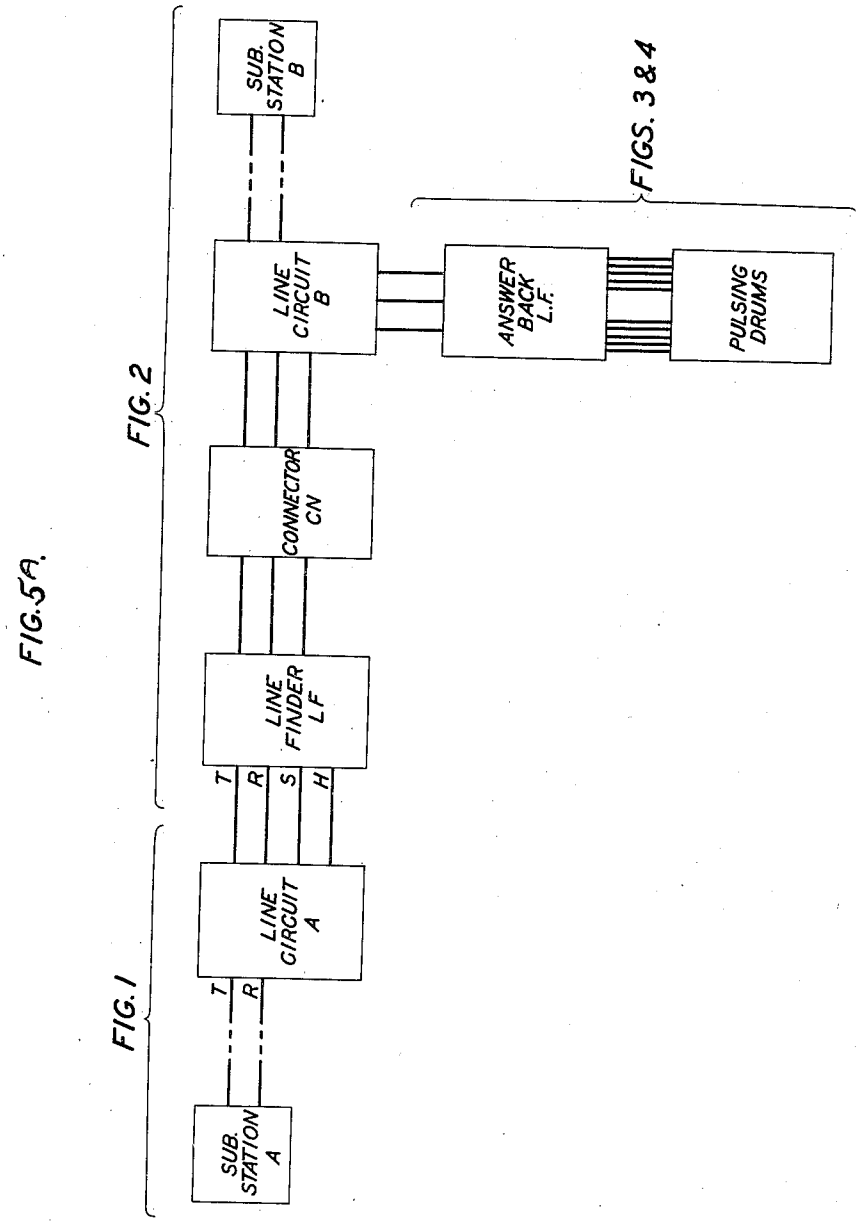
Filed Jan. 18, 1936 5 Sheets-Sheet 5



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Patented Aug. 3, 1937 2,088,750

UNITED STATES PATENT OFFICE

2,088,750

ANSWER-BACK DEVICE FOR MACHINE SWITCHING PRINTING TELEGRAPH EXCHANGE SYSTEMS

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Application January 18, 1936, Serial No. 59,679

9 Claims. (Cl. 178—4.1)

This invention relates to printing telegraph systems and more particularly to answer-back devices employed in connection therewith.

An object of this invention is to automatically transmit from a central switching point to a calling station predetermined signals corresponding to a signal code identifying a called station.

Another object is to inform a calling subscriber in a machine switching printing telegraph exchange system of the identity of the station which is after selection connected to the calling subscriber's line.

Another object is to apprise a calling subscriber that connection has been established to the correct called station.

Answer-back devices appear to be divided into two classes, namely, those that may be located at the subscriber's station and are usually made a part of the printer, and those that are located at the central office. U. S. Patent 1,909,838 granted to C. C. Lane on May 16, 1933, discloses a type of device that forms a part of the printer at the subscriber's station, and U. S. Patent 1,936,200 granted to G. A. Locke and C. C. Lane on November 21, 1933, represents a type that is located at the central office.

The present invention belongs to that group of answering devices which are employed as part of the apparatus at the central office. This apparatus may be used with a manually operated switchboard or automatic switching exchange. Preferably, it is adapted to a teletypewriter exchange system employing automatically operated line finder and hunting connector switches of the step-by-step type. Such a system is disclosed in U. S. Patent 1,958,930 granted to F. J. Singer on May 15, 1934. The answer-back device in this invention is designed to transmit signals identifying the called station as soon as a connection between a calling and a called teletypewriter station has been completed and the printer motor at the called station has started. A special type of line finder switch for each group of one hundred subscribers' lines is provided in addition to the line finder switches required for the establishment of connections between subscribers' lines. This special line finder switch comprises four banks of one hundred contact terminals each. Cooperating with the special line finder switch is a single-movement rotary switch having two contact banks and serving as a timing switch for establishing in a predetermined sequence, circuits whereover groups of code signals corresponding to the called station's number are transmitted to the line connection established between two subscriber or teletypewriter stations. The code signals are transmitted by a series of discs fixedly mounted on a continuously rotating shaft and respectively arranged in engaging relation with a series of brushes which effect, during each revolution of the shaft, a predetermined series of openings and closings of each of the timing switch circuits. The special line finder switch extends through its bank of terminals the circuits completed in a predetermined sequence by the timing switch. The single-movement rotary switch is individual to the special line finder switch and the disc set is common to all the special line finder switches that may be employed in the system. If the frequency of calls requires it, additional special line finders and their associated timing selectors may be added to serve the same one hundred subscriber lines.

Other objects and features will be found in the following detailed description and accompanying drawings, in which Figs. 1 to 4, inclusive, when placed together as indicated in Figs. 5 and 5A, illustrate circuits and apparatus for automatically sending back to the calling subscriber the code number of the selected called subscriber.

Fig. 1 shows a teletype printer subscriber station A, together with its associated line equipment at the central office and includes all the necessary equipment for receiving and sending printed messages.

Fig. 2 shows a line finder and connector switch circuit of the usual type indicated in squares LF and CN, respectively. The latter is shown connected to the central office end of a called subscriber line, as indicated at line B, and is capable of being extended to the called subscriber printer station B over conductors **201** and **202**.

In Fig. 3 there is represented in schematic form a complete circuit diagram of an identification line finder of the step-by-step type used for finding a called station line circuit when that station has just been put in connection for sending and receiving messages. Said line finder, together with a selecting switch of Fig. 3A, serves to identify the number of the called station to the calling subscriber.

Fig. 4 shows a common signal distributor for all identification line finders in the office. Likewise, there is indicated at Fig. 4A, group relays **401**, **405** and **410** for starting the nearest line finder, there being one for each of ten sub-groups of ten subscriber lines. Identification line finders ILF1, ILF1A and ILF10A similar to the one shown in Fig. 3, are indicated in Fig. 4B in order

to bring out the manner in which these line finders are started. The circuit and apparatus shown in Fig. 4C represents supervisory and alarm equipment usually provided with line finders of this type.

In Fig. 1 of the drawings, there is shown the apparatus and circuit connections for a typical printing telegraph station, such as STA. A, it being understood that other stations, such as indicated as STA. B of Fig. 2, are similarly equipped. Station A is connected with the central office by means of tip conductor **101** and ring conductor **102**, and STA. B is similarly connected over tip conductor **201** and ring conductor **202**. At the central office, the line conductors **101** and **102** of station A, which is shown herein as the calling station, are connected to the line finder switch bank **226** of Fig. 2. Other stations in the system are similarly connected by means of conductor pairs to other terminals in said bank. The line finder switch indicated as LF of Fig. 2 is of the step-by-step type described in U. S. Patent 815,176 granted to A. E. Keith et al. on March 13, 1906. The subscriber station lines may be arranged in one or more groups of one hundred lines each, and each group may be arranged in ten subgroups of ten lines each. The connector switch designated as CN in Fig. 2 is shown for the purpose of indicating how a calling subscriber, such as STA. A, may by automatic means be connected to another station, such as the called STA. B. If it is desired to trace in detail the establishment of such a connection, reference may be had to U. S. Patent 1,958,930 granted to F. J. Singer on May 15, 1934.

The features of this invention more particularly reside in the equipment shown in Figs. 3 and 4 and are effective only after the calling station A has completed dialing the called station B and the printer motor at the called station has started. Under these conditions, the line equipment for station B in Fig. 2 causes what is termed an identifying line finder shown at ILF**10** in Fig. 3 to find and connect with the line B equipment of Fig. 2, said finders being similar in most respects to that disclosed and described in the patent to Singer mentioned above. Line finder bank **305** serves to stop the switch on a terminal corresponding to the number of the called line B, all in a manner commonly the part of the usual line finder operation. Therefore, the three brushes **302**, **303** and **304** contacting with the line finder banks **306**, **307** and **308** automatically serve to identify the called subscriber station B in a manner later to be described.

Operation of the system

A detailed description will now be given of the manner in which a signal code corresponding to the called station B is automatically transmitted back to the calling subscriber station A.

Calling subscriber A in Fig. 1, prepares to dial subscriber B by first operating key **103** to the right, thus closing an operating circuit for relay **104**, extending from ground at back contact and armature relay **105**, conductor **106**, contact **107** on dial **108**, lower back contact and armature relay **109**, closed contact **110** of key **103**, conductor **111**, tip conductor **101**, conductor **112**, left armature and back contact of relay **113**, through winding of start relay **104** to grounded battery. Ground is connected at contact **114** of key **103** to operate lamp **115** for the purpose of supervising the call.

Start relay **104** operates and closes an obvious circuit for operating relay **116** which in turn closes a circuit for operating a line finder subgroup relay **203** of Fig. 2, traced from battery through winding relay **203**, conductor **204**, right innermost contact of relay **116** to ground at inner left armature and back contact relay **113**. Further description of the operation of line finder LF of Fig. 2 may be found in the Singer patent hereinbefore referred to. For the purposes of this description, it may be assumed that line finder LF is accordingly started and eventually the brushes connect with line conductors **205**, **206** and **207**, shown in Fig. 2. Relays **131** and **132** shown at the bottom of line A equipment serve to cause an identification line finder to find this line under conditions where this line is called by another line but said relays are not effective on originating calls.

A sleeve test circuit is closed upon the brushes contacting with their respective terminals, traced from grounded battery through winding cut-off relay **113** in parallel with grounded battery through resistance **117** and contact **118** on relay **116**, thence through contact **119** on relay **116** to conductor **207** and ground, first in the line finder circuit and later in the connector circuit. Cut-off relay **113** operates in this network and locks direct to conductor **207** at its own right inner contact. A line finder having been started and the line found, it is the function of relay **113** to open the circuit for the line or starting relay **104** to prevent further starting of line finders, all as more particularly described in patents previously mentioned.

Hunting connector

In the idle condition of the connector CN of Fig. 2, relay **209** is energized by current normally flowing through its lower winding and its armature is, therefore, held against its back contact. Relay **208** is energized by current normally flowing through its lower winding and its armature is thereby held against its front contact. Negative grounded battery **227** is, however, not connected as indicated by the dotted lines until after the connector has been dialed to the called line.

When the associated line finder finds a line extending to subscriber station A and the cut-through relay, not shown, in the finder circuit operates, the tip conductor **205** is extended through the finder LF and into the connector circuit through upper winding of polarized relay **208**, armature and back contact relay **209** to grounded positive battery. The ring conductor **206** is likewise extended to the line finder and into the connector circuit through the armature and back contact relay **210** to negative battery. As previously traced, line conductors **205** and **206** at this time extend over conductors **101** and **102**, respectively, and are joined together through relay **109**, dial contact **142**, and contact **121** of dial key **103** of calling subscriber A. The closure of this circuit causes relay **208** to move its armature to its back contact, thereby operating pulse relay **211** over a path extending from positive battery **212** and armature relay **208** through winding relay **211** to ground. Ground thus connected to front contact **213** of pulse relay **211**, as is well known in the operation of step-by-step switching mechanisms, operates a slow release relay for maintaining ground back over conductor **214** to sleeeve **207** for holding the connection and places the connector switch

in condition to step vertically and horizontally each time relay 211 releases and reoperates in response to the operation of the subscriber dial. The closure of this circuit also operates relay 109 at station A, thereby causing lamp 115 to be extinguished, indicating to the subscriber that the circuit is cut through and ready for dialing.

Dialing

At each interruption of the dial 108 corresponding to the code number of the called station B, pulse relay 211 releases due to the de-energization of the upper winding of relay 208, whereby the relay armature is actuated to its associated front contact. As before stated, negative grounded battery 227 is not connected at this time. For further details of the manner in which the connector switch responds to these impulses and the manner in which the cut-through relay, not shown, functions, reference should be had to patents hereinbefore mentioned. After dialing is completed, the cut-through relay operates if the called line is idle and causes the polarity on both the calling and called lines to be momentarily reversed.

Starting of motor at station A

Reversal of polarity momentarily on the calling line causes polarized relay 120 at station A to operate and close an obvious operating circuit for the motor start relay 122, which in turn operates and locks through its lower contact to ground through emergency stop key 123 and motor control contact 124 on the station printer. Relay 122, at its upper contact, closes a circuit for starting printer motor 125 in parallel with four other circuit paths to ground, one for operating relay 105 to permit the closure of the loop circuit through the station transmitter as soon as dialing key 103 is released; the second for operating pulsing polarized relay 126 through its right-hand winding to prevent operation of printer magnet 127 except when a circuit is closed through its left winding; a third path through the lower contact on relay 128 for operating buzzer 129 to inform the subscriber that motor 125 has started; and a fourth path for operating relay 128 to shut off buzzer 129 when the subscriber restores key 103 and momentarily throws it to the left to stop the buzzer signal. The release of key 103 disconnects the dial 108 and lamp 115 from the line and closes the loop circuit through the transmitter 130 and the left winding of relay 126. Current through the left winding of relay 126 overpowers the effect of current in the right winding, causing it to close a circuit at its top contact to the printer magnet 127 for maintaining it in an operated condition subject to transmitter 130 or to reversal of line battery from the called end of the connection.

Starting of motor at station B

When the connector circuit connects with the called line B, a relay, such as 218, immediately operates and connects ground to brush 219, which may then be further traced over conductor 217 and through the line cut-off relay 220 winding to battery. Operation of relay 220 extends the tip and ring conductors 215 and 216 through to the called subscriber station B, with the winding of relay 221 included in the tip conductor 215. As a part of the cut-through operation of the connector previously referred to, a momentary reversal of battery is connected to the called line which causes the motor at station B to start up in identically the same manner as described for the calling station A. That is, a polarized relay at station B corresponding to relay 120 at station A operates and prepares station B for transmitting and receiving messages in the same manner as described above for station A. The non-locking key corresponding to key 103, however, is in its normal position and the attendant at station B in response to the operation of the buzzer corresponding to buzzer 129 merely operates the key momentarily to the left to stop the buzzer.

Starting identification line finder

When the connector switch of Fig. 2 makes connection with line B, as above described, the loop to the called station B included relay 221 of an identifying circuit, but this relay did not operate until after the attendant at station B operated the key for stopping the buzzer. Relay 221 did not operate on the momentary reversal from the connector because at that time the tip conductor 201 was open at lower front contact of relay corresponding to relay 105 of station A. Relay 221 operates after a relay similar to relay 120 has locked a relay similar to relay 122 to thereby operate a relay similar to relay 105 after relay 210 has been restored to normal. When the attendant at calling station A receives an answer-back signal, he may assume that the attendant at station B is ready to exchange messages with him.

The operation of relay 221 does two things; at its right contact it prepares a battery path through the right winding relay 222 for stopping an identification line finder on the terminal corresponding to the called line; at its left contact it connects ground to left outer armature and back contact relay 222 which is further traced over conductor 223 and through winding of subgroup relay 410 of Fig. 4A to battery. This relay is common to a subgroup of ten subscriber lines terminating in the tenth level of switch banks 305 and 306 associated with identification line finder ILF10 of Fig. 3. The line circuit of station B for the purpose of this illustration is thus arbitrarily assumed to be in the tenth level, while station A line circuit is shown connected over leads 133, 134 and 135 and terminating in the first level. Other stations in the system are respectively connected by means of conductor pairs to the other terminal sets in the same line finder switch banks and each line conductor pair is multipled as indicated at 310 to various levels of other line finder banks in accordance with the well-known slip multiple method disclosed in U. S. Patent 1,161,655 granted to C. L. Goodrum on November 23, 1915.

Subgroup relay 410 functions after the usual manner of this form of advance start wire operation to start an idle line finder to hunting for the calling line which, in this case, is a subscriber line that has just been called by another station. Other subgroup relays 401 to 409, inclusive, are represented by relay 401 in the first subgroup and relay 405 in intermediate subgroups, each corresponding to a particular group of ten lines. It will be obvious that a detailed description of the operation of the advance start wire circuit is not pertinent to the understanding of this invention, although it may be had by referring to the Goodrum patent, supra. In Fig. 4B, however, there are shown relays 411, 412 and commutator 413, representing a portion of other identification line finders ILF1A, ILF2A and

ILF10A involved in the start wire circuit and corresponding to relays 311, 312 and commutator 313 of the line finder shown in Fig. 3. A detailed description of the functions of this start wire may be found in the patent to Singer previously referred to in which ILF1A and ILF10A represent a second finder in the subgroups 1 and 10, respectively.

Assuming identification line finder ILF10 of Fig. 3 is idle when subgroup relay 410 operates, ground on the bottom armature is connected over conductor 414 to the tenth terminal of commutator 313 of this particular line finder, and likewise to commutator 413 of a second line finder ILF10A associated with the same subgroup relay 410. This will serve to stop the finder switch on the tenth level as will later be described. At its upper contact, relay 410 closes a circuit for starting the switch to step to the tenth level. This circuit may be traced from ground on bottom contact relay 415 of Fig. 4C over conductor 416 and top contact relay 410, thence over conductor 417, through contact 314 on relay 311 of Fig. 3, conductor 315 and bottom contact on tenth rotary step springs to battery through winding relay 316.

Stepping of identification line finder

The operation of relay 316 at its outer lower armature and contact connects ground to conductors 317 and 318 for controlling the line finder ILF10. Ground connected to lead 317 prepares a circuit for stepping the finder on the level in which the terminals of the called line are located. This path may be traced through a normally made contact on the line finder vertical magnet 319, conductor 320 and through the lower winding of relay 312, conductor 309 to the brush bearing on commutator bank 313. Ground connected to lead 318 prepares a path for stopping the line finder on the terminal corresponding to called station line B and is further traced through lower winding relay 321 lower inner contact relay 316, conductor 322, back contact 323 on relay 311, lower winding relay 324, conductor 325 to brush 301 which stops the finder switch when the brush finds battery on the terminal 333. This battery through the right winding relay 222 is placed on terminal 333 over lead 334 by the operation of relay 221 at its right armature and contact.

Ground connected to lead 317 also serves to start the line finder to stepping vertically by operating relay 321. This path is traced from ground on lead 317 through a break contact on vertical magnet 319 and on rotary magnet 326, conductor 327 and through upper winding relay 321 to battery over conductor 328 and top break contact relay 311. Relay 321 at its make contact connects ground that was traced to lead 318 from bottom contact on relay 316, to armature 329 of relay 312 and further traced over its back contact, through winding of vertical magnet 319 and conductors 330 and 328 to battery at top contact relay 311. The vertical magnet 319 upon operating steps the brush arms of the switch up one level and then due to opening the contact on magnet 319 and breaking the operating ground for the top winding relay 321, previously traced, relay 321 releases, which in turn at its lower armature removes ground from the vertical magnet 319. The magnet releases and again closes the associated break contact to again operate relay 321 and in turn the vertical magnet. In this manner the switch continues to step vertically until the brush of commutator 313 comes in contact with the terminal 331 which is grounded by relay 410 as traced previously. Upon connecting with this terminal the contact on magnet 319 opens as before but relay 321 does not release because of the presence of ground at commutator terminal 331 which may then be further traced over brush and conductor 309, lowing winding relay 312, conductor 320 thence over contact on rotary magnet 326, conductor 327, through top winding relay 321 to battery on lead 328 at top back contact relay 311. In this manner further stepping of the magnet 319 ceases and due to current flowing through the lower winding of relay 312, the latter operates after a very short time interval and at armature 329 transfers the stepping circuit to the rotary magnet 326 over conductor 332. Said time interval is provided by the slowness of relay 312 to operate and prevents any probability of snagging the brushes.

Relay 321 remaining operated during this transfer of the operating path from the vertical magnet 319 to the rotary magnet 326 at once causes the rotary magnet to be energized and the switch to take one rotary step, whereupon commutator brush breaks its contact with terminal 331 and allows relay 321 to release to open the ground that is energizing the rotary magnet 326. Said magnet releases, which again closes the operating path for the top winding relay 321 and in turn closing ground to the rotary magnet 326. Thus the switch continues to step from left to right until the brush 301, which is now contacting with the top row of terminals in the bank 305, makes contact with terminal 333. Then instead of relay 321 releasing as before, it remains operated over a circuit from ground on lead 318 traced through lower winding relay 321, bottom inner contact and armature relay 316, conductor 322, contact 323 on relay 311, lower winding relay 324, thence over lead 325 and brush 301 to battery on terminal 333, as previously traced through right winding relay 222 in station B line circuit. The current thus flowing is sufficient to operate relay 324 but is not sufficient to operate relay 222.

Relay 324 in operating, at its top inner armature and contact, first closes a holding circuit for itself over lead 337 and upper front contact relay 316, conductor 336, and contact 335 to ground. Relay 324 at its outer upper armature and front contact closes a circuit for operating relay 311 and at its outer upper armature and back contact opens the circuit of the release magnets as will later be described. Relay 324 at its lower innermost contact and armature completes a path which shunts out the previously traced path through contact 323 on relay 311 and lower winding relay 324, thereby reducing the circuit resistance and permitting relay 222 of Fig. 2 to operate and remove ground for starting other line finders.

Going back to the closure of a circuit on relay 324 for operating relay 311, this path is traced from ground on top spring of line finder V. O. N. springs over conductor 336, outer upper armature and front contact of relay 324, direct to battery through top winding relay 311. Relay 311 operating at its upper armature and contact opens the battery supply for vertical magnet 319 and for upper winding relay 321. Relay 321, however, continues to hold on its lower winding until relay 316 releases. Relay 311 in operating at contact 314 opens the circuit to relay 316 previously traced over conductor 315 causing it and relay 321 to release. Release of relay 316

opens at its upper front contact a holding circuit for relay **324** but the latter does not release due to brush **341** of the rotary selector of Fig. 3A having taken one step into the grounded bank **342** as will later be described. A holding circuit for relay **324** may, therefore, be traced from ground in bank **342** over brush **341**, conductors **343**, **344** and **345** to inner upper armature and front contact relay **324**, through top winding relay **324** to battery. In this manner relay **324** remains operated until the signal interrupter of Fig. 4 has completed sending back the necessary signals for identifying the called station line B as will later be described.

The principal function of relay **311** operating as described above is to extend at contact **365** the start wire circuit to the next idle available line finder circuit so that other called lines may be identified during the sending back of signals on the first call previously traced. For example, a second line in subgroup **10** being called at this time would again operate relay **410** which at its upper contact would connect ground on conductor **416** to conductor **417**, thence through contact **365** on relay **311**, conductor **366**, bottom contact relay **312**, conductor **367** to armature **427** on relay **411** of the next finder ILF10A if it were idle, or to the next finder circuit that is idle.

Movement of rotary selector and transmission of identification signals

The operation of relay **324** at its bottom contact connects battery to conductor **338** thence through rotary magnet **339** to ground on bottom contact of selector off-normal springs **340**. The rotary magnet **339** operates and the rotary selector switch of Fig. 3A takes one step and causes off-normal springs **340** to operate. The circuit including rotary magnet **339** is thereby extended over conductor **368** to cam ST on signal interrupter as shown in Fig. 4 and thence to ground at feed cam FD during the time the live segment on cam ST is passing under its brush. Since the signal interrupter is rotating continuously it will be observed that one live segment passes under its brush once every revolution of the interrupter and in this manner the rotary selector in Fig. 3A will be stepped one step ahead for every revolution of the interrupter. It will, therefore, be apparent that the selector brushes **341** and **369** remain on each terminal of the selector banks **342** and **346**, respectively for the duration of one revolution of the signal interrupter.

Transmission of impulses corresponding to code number of called station

When rotary selector of Fig. 3A is stepped off-normal, brush **369** comes to rest on the first terminal which in this case is blank and has no function in sending back signals because the length of time it remains on this terminal is variable depending on the position of the live segment on cam ST when the selector takes its first step. When cam ST passes under brush connected to conductor **368** the selector will step to the second terminal and from now will remain on each terminal one full revolution of the interrupter. The second terminal in bank **346** is connected to the conductor **347** which contacts with cam marked "FIG" on signal interrupter of Fig. 4. The cutting of this cam gives out a signal which when it is received at the calling station A printer causes the receiver to shift to the upper case position ready for printing figures. The circuit over which the signal reaches the calling station A is traced from positive battery on feed cam FD', over cam shaft **418**, live segments on cam FIG, thence over conductor **347** to brush **369** of Fig. 3, conductor **348**, contact **349** on operated relay **324**, conductor **350** and selector brush **302** to terminal **351** on which the line finder is resting, thence over conductor **352**, contact **224** on cut-off relay **220** of Fig. 2, portion of tip conductor **225**, and right front contact on operated relay **222**, tip conductor **215**, terminal and brush **226** of regular connector switch, top winding relay **209** to positive grounded battery **212** on back contact relay **208**. Positive battery interruptions over the circuit thus traced, therefore, causes the operation and release of relay **209** which at its top armature and contacts repeat the signal into the called subscriber's loop over the conductors **205** and **206** all in a manner commonly found in telegraph repeater systems. This operation may be explained by pointing out that the current in the lower winding of relay **209** tends to hold the armature to its front contact but the line current in the upper winding thereof is twice as great and the relay therefore is held to its back contact to cause current to flow in the calling station line A. The positive battery applied to the repeater by the signal interrupter shunts out the current in the upper winding of relay **209** to cause it to repeat open or no current signals to the calling station A.

When signal interrupter of Fig. 4 enters the period of its next revolution the segment on cam ST closes ground momentarily to the conductor **368** which is further traced through contact **353** on selector springs **340**, through winding rotary magnet **339**, conductor **338**, and battery through bottom contact and armature on relay **324**. Thus the selector is caused to step to the third terminal where it remains until signal interrupter shaft **418** makes another revolution. During this period selector brush **369** contacts with a terminal in bank **346** which connects to conductor **354** for supplying a code positive battery interruption traced from cam FD, through signal interrupter shaft **418** cam **1**, conductors **419** and **354**, brush **369** and thence over same path as traced in previous paragraph. This positive battery signal is received on the calling subscriber station A printer as the number 1 and identifies the particular thousand in which the called line is located.

When signal interrupter starts its next revolution the selector is caused to step to the fourth terminal as above described where it remains during the remaining portion of this revolution. At this time the number 3 is printed at the calling station printer due to code positive battery interruptions traced from cam FD, through signal interrupter shaft **418**, cam **3**, conductors **420** and **355** to brush **369** and thence over a path previously traced. This positive battery ground signal identifies the particular hundred in which the called line is located. On the next or fifth terminal of the selector, the number 0 is transmitted by code positive battery interruptions traced from cam FD, through signal interrupter shaft **418**, cam **0**, conductor **421**, terminal **356** in finder bank **308**, brush **304**, conductor **357** to terminal in bank **346** of rotary selector, brush **369** and thence over same path as previously traced. This positive battery signal identifies the particular group of ten in which the line is located. Similarly on the sixth terminal of the

selector the number 6 is printed. The positive battery interruptions in this case through cam 6 may be traced over conductor 422, terminal 358 in selector bank 307, finder brush 303, conductor 359 to the sixth terminal in selector bank 346, brush 369 to the path previously traced. This positive battery signal identifies the particular unit of the line number being called by station A.

When the signal interrupter starts its next revolution the selector is caused to step to the seventh terminal. During the period ground interruptions are transmitted to subscriber station A printer through repeater relays 209 and 208 of connector circuit CN indicated in Fig. 2 and serve to restore the printer to the lower case position ready to receive and transmit the message. The path for these ground interruptions is traced from ground at feed cam FD, through signal interrupter shaft 418, cam LTR to conductor 423 and associated terminal in selector bank 346, thence through brush 369 and over the same path previously traced for other signals. In this manner the number of the called line B is automatically recorded on the printer of the calling line A.

Release of identification line finder

During the period in which the answer-back signals are being sent to the calling station, the identification line finder ILF10 is being held by ground at switch bank 342 over a path as previously described. When therefore the circuit of the selector switch rotary magnet 339 is closed to step the switch to the eighth terminal, brush 341 in bank 342 in this position of the selector no longer is connected with ground so that relay 324 releases thereby closing a circuit for operating the release magnets of both the identification line finder and the associated rotary selector. This circuit may be traced from ground at top contact 335 of line finder V. O. N. springs, conductor 336, upper armature and back contact relay 316; to battery through upper winding relay 311 for holding the latter relay during the release period; and to battery through upper armature and back contact relay 324, conductor 360, upper armature and back contact relay 312, and conductor 361, thence over the two release magnet paths in parallel. The selector release magnet path is traced from conductor 361, over lead 370, upper contact and spring of selector off-normal springs 340, and the finder release magnet path is traced from conductor 361, over lead 371, and lower contact and lower spring on finder V. O. N. springs. In this manner both of said switches are caused to restore to normal. The removal of ground from lead 336 at contact 335 of the V. O. N. springs when the switch comes to normal, opens the circuit for the release magnets and for relay 311. The latter relay normally releases and makes said line finder available to serve a succeeding call. If, however, some other identification line finder is being started at this particular moment, ground will be present on lead 417 thus maintaining relay 311 in an operated condition through its lower winding and conductors 364, 424 and 425 to battery at back contact and armature of relay 426 at the bottom of Fig. 4. As soon, however, as the start wire is not being energized relay 311 will release and the finder will be ready to serve another call. The connection between STA. A and STA. B of Figs. 1 and 2 in the meantime remains and continues to function to transmit the subscribers' messages in the usual manner.

Alarm and all finder busy

Referring to Fig. 4C of Sheet 4, this circuit arrangement provides for giving an alarm in the event that all finders are busy. This is accomplished by a normally closed circuit traced from battery through relay 428, conductor 429 to junction 430, thence through a normally made contact on bottom of finder relay 311 and in parallel with similar contacts on other finder relays such as represented by relay 411, back to junction 431, conductor 432 to ground through the winding of relay 433. Both relays 428 and 433 therefore remain normally operated as shown in the drawings. If all finders are busy relays 428 and 433 will release to operate relay 415 to thereby open the primary ground on the start circuit. If the trouble ground still persists, the operation of relay 415 at its bottom contact removes ground from the conductor 416 that connects to the start wire circuit through the upper make contacts on relays 401 to 410 inclusive. This permits a finder relay 311 or 411 to release as soon as a finder circuit completes its function of sending answer-back signals and thereby permits the start wire circuit to function again in its normal way by reoperating relays 428 and 433. If, however, a trouble ground is present anywhere on the start wire conductors 416, 417, 434, 435, 436, 437 or extension of same through contacts on relays 311 and 411 all finders will be started erroneously then said ground should be traceable eventually over lead 438, contact 439 on relay 415 to battery through winding relay 440. The latter relay operating under these conditions would operate relay 441 and in turn relay 426. Relay 441 would also light trouble lamp 442 while operation of relay 426 would remove battery from the holding windings of all finder relays 311 and 411. This permits said relays to restore and the relays 428 and 433 to reoperate and release relays 440 and 426 but relay 441 will remain locked to light lamp 442 until released by momentary operation of key 444. If the trouble ground should clear of itself in the meantime, relays 415 and 426 will have already been released to permit the start wire to again function. In the event a trouble battery is present anywhere on start wire conductors attaching to junction point 430, relay 428 would be made to release while relay 433 remains operated. Under this condition lamp 443 lights to inform the attendant of this condition.

What is claimed is:

1. A printing telegraph system comprising a plurality of subscribers' stations, a central office, telegraph printer sets at said subscribers' stations, means at each of said stations for initiating a connection between the printer set at the calling subscriber's station and a printer set at any one of the other of said subscribers' stations, automatically operated means at said central office for completing in response to the operation of said initiating means, said connection, an identifying line-finder and a rotary stepping switch both responsive to the establishment of said connection between the calling and the called subscriber's stations, an impulse transmitter for transmitting combinations of groups of current impulses respectively corresponding to the code numbers of said stations, circuit means selectively operative in response to the operation of said identifying line-finder and said rotary stepping switch for causing to be repeated to the calling subscriber's station the combination of

groups of current impulses corresponding to the code number of the connected called subscriber's station.

2. A telegraph circuit, according to claim 1, wherein the line finder switch is an idle one of a group, any one of which, if idle, is accessible, upon the establishment of said connection, for selecting and then causing to be repeated to the calling subscriber's printer set groups of current impulses corresponding to the code number of the connected called subscriber's printer set.

3. A telegraph circuit, according to claim 1, wherein the line finder switch comprises four banks of contacts, one whereby the switch is maintained in an operated position while the groups of current impulses corresponding to the complete code number of the connected called subscriber's printer set are being transmitted to the connected calling subscriber's printer set; another whereby the line extending to the connected calling subscriber's printer set is connected to the current impulse transmitter and over which the groups of current impulses respectively corresponding to the thousands and hundreds digit of the code number of the called subscriber's printer set are transmitted to the calling subscriber's printer set; another over which the group of current impulses corresponding to the tens digits of the code number of the called subscriber's printer set is transmitted to the calling subscriber's printer set; and another over which the group of current impulses corresponding to the units digit of the code number of the called subscriber's printer set is transmitted to the calling subscriber's printer set.

4. A telegraph circuit, according to claim 1, wherein the rotary stepping switch comprises two banks of contacts, one for effecting the timing of transmission of the current impulse groups corresponding to the several integers in the code number of the called subscriber's printer set, and the other for effecting when all the groups of current impulses corresponding to the complete code number of the called subscriber's printer set has been transmitted, the release of the auxiliary line finder switch and the rotary stepping switch.

5. A telegraph exchange system comprising a plurality of subscribers' stations, a central office, a circuit connecting each of said subscribers' stations to said central office, means at said central office for automatically interconnecting in response to a call from any one of said subscribers' stations, a plurality of said subscribers' stations for communicating purposes, other means at said central office for repeating back to a calling subscriber's station the code number corresponding to the connected called subscriber's station, said other means including an identifying circuit associated with the circuit of said called subscriber's station, a plurality of continuously operating signal transmitting devices for respectively transmitting different groups of current impulses, a non-numerical selecting device for preparing said interconnected subscriber's circuits for connection to said signal transmitting devices, a timing device for completing the connection of certain of said signal transmitting devices to said interconnected subscriber's circuits in a desired sequence to correspond to the code number of said connected called subscriber's station, and means responsive to the operation of the identifying circuit associated with said called connected station for effecting the joint operation of said selecting and said timing device.

6. A telegraph exchange system, according to claim 5, wherein the non-numerical selecting device is a line finder switch of the step-by-step type and said timing device is a switch of the single-movement rotary type.

7. A telegraph exchange system, according to claim 5, wherein said timing device comprises a circuit arrangement for restoring itself to normal after the last digit of the code number of the called subscriber's station is transmitted to said calling subscriber's line and for restoring to normal said non-numerical selecting device to permit direct communication between said calling subscriber's line and said connected called subscriber's line.

8. A telegraph exchange system comprising a plurality of subscribers' stations, a main station, printing telegraph equipment and a source of power therefor at each said subscriber's station, said source being normally disconnected from its associated equipment, a normally open line circuit connecting each of said subscribers' stations to said main station, switching means at each of said subscribers' stations for closing its associated line circuit, pulsing means at each of said subscribers' stations for transmitting an intermittent current over its associated line circuit, automatically operated means at said main station responsive first to said switching means and then to said pulsing means for interconnecting one of said subscribers' stations with any other of said subscribers' stations, means responsive to said automatically operated means for operatively connecting the power source of each of said subscribers' stations operatively interconnected, to its associated printing equipment, line finding apparatus responsive when the first mentioned automatically operative means effects the interconnection of one of said subscribers' stations and any other of said subscribers' stations, a continuously operating device common to said plurality of subscribers' stations for simultaneously generating groups of current impulses in various combinations, means for selecting the combination of impulses corresponding to the code number of said other of the subscribers' stations, means for transmitting said selected combinations of impulses to said one of the subscribers' stations whereby said one of the subscribers' stations is assured of an established connection to the desired subscriber's station, and means for restoring to normal the line finding apparatus operated in response to the establishment of said interconnection and said selecting means, as soon as a complete combination of groups of current impulses corresponding to the code number of said other subscriber's station has been transmitted to said one subscriber's station.

9. A telegraph exchange system, according to claim 8, wherein the line finding apparatus comprises a plurality of line finder switches, means for selecting an idle one of said line finder switches in response to the establishment of a connection between said one of subscribers' stations and said other of said subscribers' stations, and means for preparing another of said line finder switches for engagement by any other of said subscribers' stations during the time that the selected line finder switch is engaged.

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