March 21, 1944. R. V. L. HARTLEY 2,344,612

ELECTRIC SIGNALING

Filed June 27, 1942 3 Sheets-Sheet 1

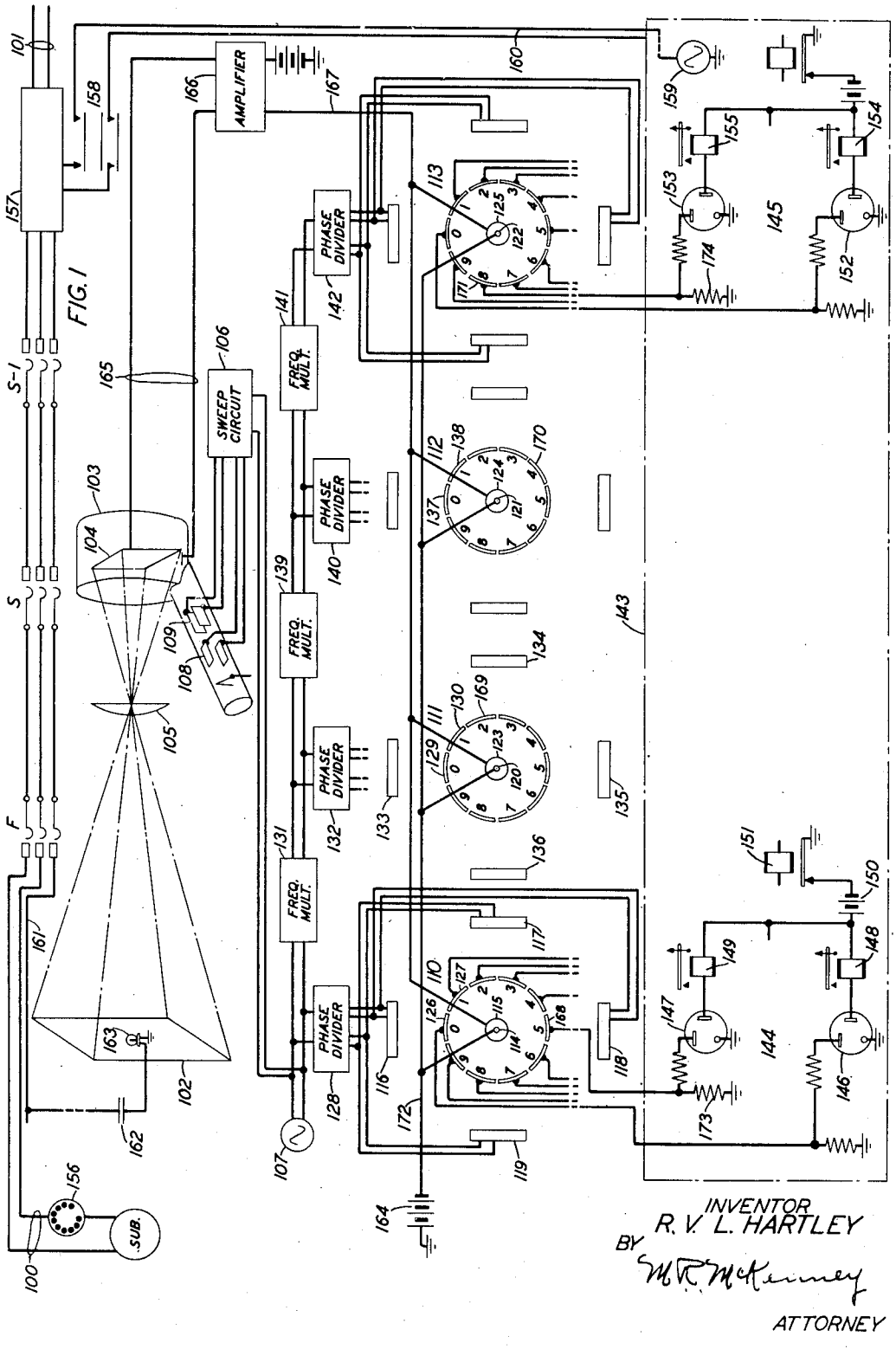

FIG. 1

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ELECTRIC SIGNALING

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FIG. 4

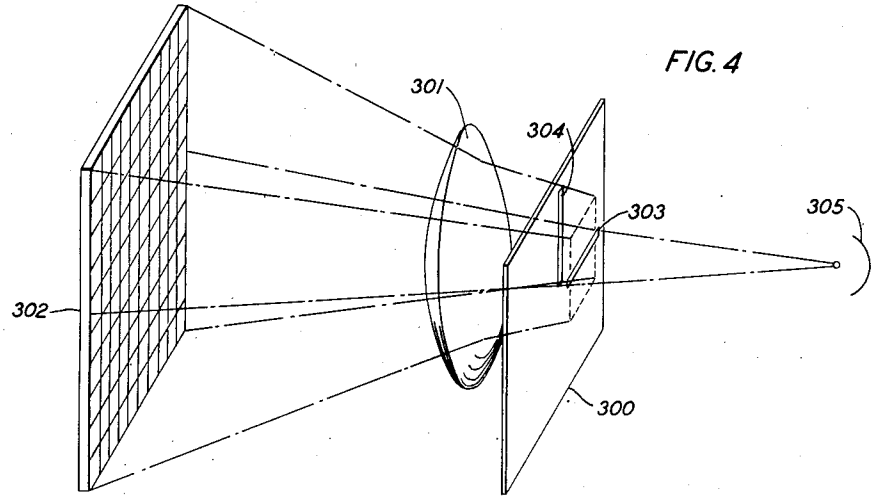
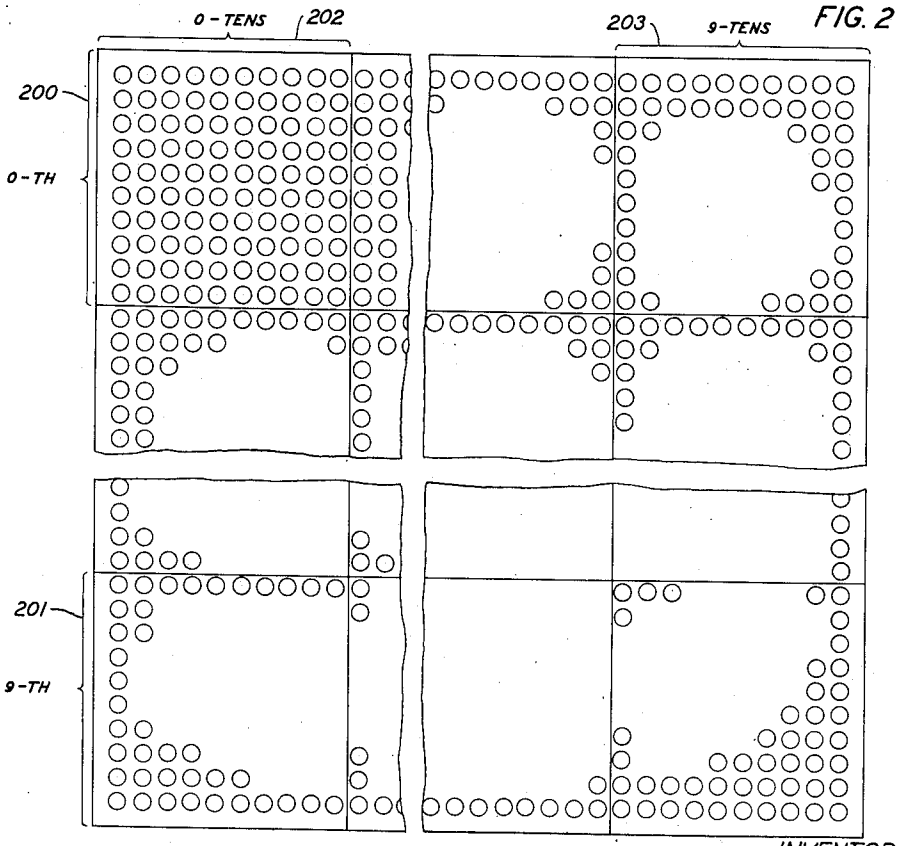


FIG. 2



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ELECTRIC SIGNALING

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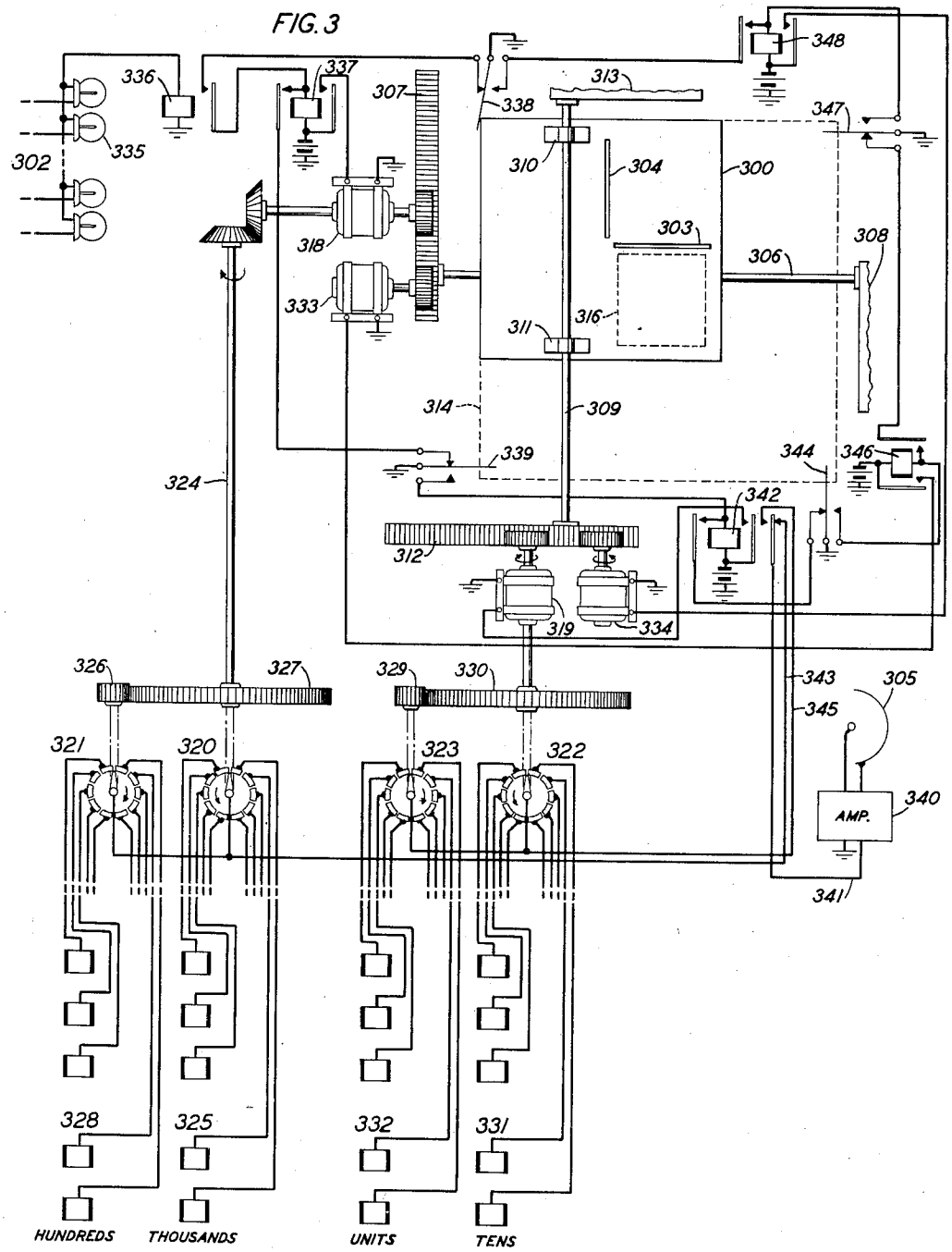
FIG. 3



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Patented Mar. 21, 1944

2,344,612

UNITED STATES PATENT OFFICE

2,344,612

ELECTRIC SIGNALING

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Application June 27, 1942, Serial No. 448,735

7 Claims. (Cl. 179—27)

This invention relates to electric signaling, particularly when employed in connection with the operation of automatic telephone systems.

An object of the invention is to facilitate the identification of lines, trunks, or other electric circuits or devices.

A more specific object is to reduce the amount of equipment needed for identifying the lines of a large group by providing a field of lamps representing the lines and utilizing a simple scanning process to determine the designation of any desired line from the position of the corresponding lamp in the field.

Another object of the invention is to identify the lines of a group by the use of an electron beam for scanning a field of lamps or similar elements representative of the lines of the group.

These objects are realized in a system for identifying the individual lines of a large group, such as the lines in a telephone system, by means of a field or array of signal lamps which are individual respectively to the lines of the group and which are arranged in decimal order in coordinate rows, together with means for scanning the array of signal lamps to determine the location of a lighted lamp therein. More specifically the field of lighted lamps is scanned by a scanning beam in a definite order relative to the decimal arrangement of the lamps in the field; and at the same time the beams of a plurality of switching devices, representing respectively the several digital places of the designations, are driven through a succession of switching positions to select the different values of the digits in the corresponding digital places. The rates at which these switching beams are driven through their switching positions are related to the movement of the scanning beam over the field of lamps such that they occupy at any instant the positions representing the digital place values of the designation of the line corresponding to the particular lamp being scanned at that instant by the scanning beam If the lamp being scanned is in a lighted condition, the electron switching beams become effective at that instant and cause the operation of associated registers to register the several digits of the corresponding line designation.

Another feature of the invention is an identification system in which the field of signal lamps is scanned by a movable screen to determine the relative position of a lighted lamp in the field. More specifically, the lamps are arranged in horizontal and vertical rows in an order bearing a definite relation to the designations of the lines they represent, and a screen having light-transmitting openings therein is advanced across the field of lamps in successive movements to determine first the horizontal position of any particular lighted lamp and then the vertical position thereof. Switching devices moving in synchronous relation with the scanning screen serve to select circuits for the operation of registers in accordance with each successive position of the screen, and light-sensitive means controlled by the screen and cooperating with said switching devices serves to effect the operation of said registers over the selected circuits when the position of any lighted lamp in the field is located by said screen.

Other features of the invention will be described more fully in the following detailed specification.

In the drawings accompanying the specification:

Fig. 1 is a conventional diagram of an automatic telephone system arranged for calling line identification;

Fig. 2 illustrates the field or panel of lamps representing the subscriber's lines in an office and serving to identify the lines by their numbers;

Fig. 3 discloses an alternative form of the line identifying mechanism; and

Fig. 4 illustrates the scanning system in which the mechanism of Fig. 3 is used.

The present invention is particularly useful in systems that require the preparation of tickets for the purpose of assessing a calling telephone subscriber for conversations held with other subscribers. Since these tickets are prepared automatically, it is necessary to determine the number of the calling line automatically in order that the charge may be assessed against the proper party. However, the invention may be used in any type of system where it is desirable to determine automatically the identity of a line, trunk, circuit, or other device. For example, it is often desirable to display the number of a calling party before an operator to whom the line has been extended, thereby eliminating the necessity for the operator to make an oral request or to perform a number-checking operation.

Referring to Fig. 1 of the drawings, the automatic telephone system illustrated herein comprises a large group of lines, usually ten thousand, which appear in the telephone central office

in non-numerical switches such as finder switches. The line 100 illustrated in the drawing appears in the bank of line finder switch F which in turn is associated with a first selector switch S. The selector S may have direct access to outgoing trunks or, as shown, it may have access through a succeeding selector switch S—1 to these outgoing trunks, such as the trunk 101, extending to distant offices.

The designation or identity of each line that establishes a toll call over one of the outgoing trunks 101 is obtained by scanning a field of signaling lamps mounted in a panel 102. This field of signal lamps includes a lamp for each of the ten thousand lines in the office, and each lamp represents the number of the associated line. The lamps are arranged in decimal order in coordinate horizontal and vertical rows, there being 100 hundred horizontal rows and one hundred vertical rows, each row in both directions containing one hundred lamps.

Referring for the moment to Fig. 2, which illustrates the lamp formation more clearly, the hundred horizontal rows are divided into ten equal groups, one for each thousand lines. For example, the horizontal group of lamps 200 represents the No. 0 thousands group of lines, the horizontal group of lamps 201 represents the No. 9 thousands group of lines, and the eight intermediate groups of lamps not shown in the drawings represent the corresponding thousands groups. Each one of these thousands groups contains ten horizontal rows of one hundred lamps representing respectively the ten hundreds groups in the thousand. In like manner the field of lamps is divided into ten vertical groups representing the ten tens groups of all hundreds groups. For example, vertical groups 202 and 203 represent respectively the No. 0 and No. 9 tens groups. Each of these tens groups contains ten vertical rows of lamps representing respectively the ten units designations.

Returning to Fig. 1, the lamp field 102 is scanned by means of a scanning device 103 to determine the location therein of any lighted lamp. To this end an image of the lamp field 102 is focussed on the screen 104 of the scanning device by any suitable lens 105, and an electron beam is caused to play over the screen 104 under the control of a sweep circuit 106. The sweep circuit 106 is energized by a suitable source of alternating current 107 and, by means of the control plates 108, 109, causes the electron beam to scan the image screen 104 in any desired pattern. It may be assumed, for example, that the electron beam is caused to traverse the virtual image of the lamp field 102 beginning with the first lamp in the No. 0 tens group, in the No. 0 hundreds group of the No. 0 thousand and passing over the horizontal one hundred-lamp rows in succession and in the same order until the last lamp in the No. 9 tens group of the No. 9 hundreds of the No. 9 thousand is reached. The scanning device 103, the lens system therefor, and the controlling sweep circuit 106 may be of any well-known type.

The position at any instant of the electron beam on the image screen 104 in terms of the designation digits of the line represented by the lamp in the corresponding position in the panel 102 is determined by a set of rotary electron beam switching tubes 110, 111, 112 and 113, there being one of these tubes for each digital place in the designations of the lines. The tube 110, which determines the values of the thousands digits, contains a central cathode 114, a control grid 115 and a series of ten circumferentially placed anodes, one for each of the ten different values of the digit. The energizing coils 116, 117, 118 and 119 located in quadrature around the tube 110 serve to produce a rotating field causing the beam from the central cathode 114 to sweep over the circumferential anodes at a speed depending upon the frequency of the energizing source. Similarly, the tubes 111, 112 and 113, which determine respectively the values of the hundreds, tens and units digits, contain central cathodes 120, 121, 122, control grids 123, 124, 125, and circumferentially located anodes, the same as tube 110, representing the ten different values of the corresponding digits. The tubes 111, 112 and 113 also have the quadrature coils for producing the rotating field that causes the associated beams to sweep over the anodes. For a better understanding of the structure and operation of a tube of this character reference is made to the patent to Skellett, No. 2,217,774 of October 15, 1940.

The switching beam of the thousands tube 110 is driven in synchronism with the scanning beam. That is to say, the beam of tube 110 makes one complete rotation over the ten anode positions while the scanning beam is performing a complete scanning cycle of the screen 104. More specifically, the beam of the thousands tube 110 is in engagement with the No. 0 anode 126 during the interval that the scanning beam is scanning the image of the No. 0 thousands group of lamps; the beam is in engagement with the No. 1 anode 127 during the interval that the scanning beam is scanning the image of the No. 1 thousands group of lamps; and the same synchronous relation prevails throughout the remainder of the scanning cycle. This relation between the scanning beam and the rotating beam of the thousands tube 110 is obtained by energizing the quadrature coils 116, 117, 118 and 119 with current taken directly from the source 107 and having, therefore, the same frequency. The phase divider 128 serves the well-known purpose of supplying the quadrature coils with current of two different phases for producing the necessary rotating magnetic field.

The switching beam of the hundreds tube 111 is also driven in synchronism with the scanning beam but at a rate that is ten times as fast as that of the thousands beam 110. In other words, the beam of tube 111 makes one complete revolution through its ten anode positions during the interval that the beam of tube 110 is in engagement with each one of its ten anodes. The synchronous relation between the beam of tube 111 and the scanning beam may be better understood from an examination of Fig. 2. Assuming that the scanning beam has just commenced a new cycle, it proceeds to scan over each of the ten horizontal hundreds rows of the No. 0 thousand group in succession. During the interval the scanning beam is traversing the No. 0 hundreds row in the thousand, the beam of tube 111 is dwelling on the No. 0 anode 129; while the scanning beam is passing over the next or No. 1 hundreds row the beam of tube 111 is in engagement with the next anode 130; and so on for each of the remaining eight hundreds rows. After the scanning beam has completed the scanning of the ten hundreds of the No. 0 thousand, it proceeds likewise to scan the corresponding ten hundreds of the No. 1 thousand, and the beam of tube 111 correspondingly repeats its cycle. And the same relation continues for the remaining thousands groups. The synchronous relation between the

tube 111 and the scanning device 103 is obtained by driving the tube 111 from the same source 107; and the one-to-ten speed ratio between tubes 110 and 111 is obtained by introducing a frequency multiplier 131 which increases by ten times the frequency of the wave derived from the source 107. The output circuit of the frequency multiplier 131 is applied to the phase divider 132, and the energy from the divider 132 is applied to the quadrature coils 133, 134, 135 and 136 to rotate the beam of tube 111 at the desired speed.

The switching beam of the tens tube 112 is also driven in synchronism with the scanning device but at a frequency which is ten times the frequency of the tube 111. Since the speed ratio of the tubes 111 and 112 is one to ten, it will be seen from Fig. 2 that the beam of tube 112 makes one complete revolution while the scanning beam is passing over a row of one hundred lamp images in any given thousand. The hundreds row being divided into ten tens groups 202, 203, etc., it follows that the beam of tube 112 is engaging the No. 0 anode 137 while the scanning beam is passing over the ten positions in the No. 0 tens group 202, that the beam of tube 112 engages the No. 1 anode 138 while the scanning beam is passing over the No. 1 tens group, and similarly for the remaining tens groups in any hundreds row in any thousands group. The requisite speed for the beam of tube 112 is obtained by the frequency multiplier 139, which supplies a wave of the increased frequency to the phase divider 140, which in turn supplies its energy to the quadrature coils of the tube 112.

Finally the switching beam of the units tube 113 is driven at ten times the speed of tube 112 by current supplied through the frequency multiplier 141 and phase divider 142 to the quadrature coils of the tube 113. Thus the synchronous relation between the tube 113 and the scanning device 103 is such that the beam of tube 113 passes from one anode to the next each time the scanning beam moves from one lamp image to the next. More specifically, as the scanning beam passes over the ten successive image positions in any group of tens in any hundreds row the beam of the tube 113 passes synchronously over its ten anodes.

The purpose of the four switching tubes 110, 111, 112 and 113 is to operate a register mechanism 143 to register therein the thousands, hundreds, tens and units digits of the particular line corresponding to a lighted lamp in the field 102. Accordingly, the mechanism 143 is equipped with four digit registers, two of which, the thousands and units registers 144 and 145, are illustrated. The register 144 comprises a series of ten discharge tubes 146, 147 and associated relays 148, 149. The starting anodes of the tubes 146, 147 are connected respectively through high resistance elements to the ten positional anodes of the rotary beam tube 110, and these anodes of the rotary beam tube are also connected through elements of relatively low resistance to ground. The cathodes of the tubes 146, 147 are grounded, and the main anodes of these tubes are connected respectively through the windings of the register relays 148, 149 to a common anode battery 150 and thence through a control relay 151 to ground. Similarly the ten tubes 152, 153 of the register 145 are connected to the anodes of the rotary beam tube 113 and to the register relays 154, 155. And the same is true of the hundreds and tens registers not shown in the drawing.

A description will now be given of the operations involved in the process of identifying a subscriber's line. Assume for this purpose that the subscriber of line 100 wishes to make a toll call for which a ticket should be prepared to record the nature of the call and the charge therefor. When the subscriber initiates the call, the line finder F finds his line and extends it to the usual pulsing mechanism associated with the selector switch S. The switch S and the switch S—1 respond successively to the subscriber's dial 156 to extend his line to an idle trunk 101 outgoing in the desired direction. At any suitable time after the extension of the connection of the subscriber's line to the trunk 101 an idle registering mechanism 143 is associated with the connection. The connection of the mechanism 143 with the controlling circuit of the trunk 101 is effected by a suitable connecting device 158. As the subscriber continues to dial the remaining digits of the wanted designation, these digits may be registered in the mechanism 143 where they are later used to control the operation of the switches in the offices beyond and also to furnish the necessary information for printing the designation of the called subscriber's line.

As soon as the mechanism 143 is ready to receive the identification of the calling line 100 it establishes connection with the identifying equipment, which includes the lamp panel 102, the scanning device 103 and the rotary beam tubes 110, 111, 112 and 113. This connection is established through any suitable connecting device that may be provided for that purpose. Also a circuit is closed from the source of energy 159 over conductor 160, connector 158 thence over the sleeve conductor through the switches S—1, S and F to the sleeve conductor 161 of the subscriber's line 100. The circuit is completed from conductor 161 through a condenser 162 to the lamp 163, which is individual to the line 100 and occupies the numerical position in the panel 102 corresponding to the number of the line. An image of the lighted lamp 163 is focussed by the lens system 105 in its proper elemental position on the image screen 104 of the device 103. It will be assumed for the purpose of illustration that the number of the line 100 is "5248."

The scanning device and rotary beam switching tubes may be operating continuously or they may be started in any suitable manner under control of the register mechanism 143. While the scanning beam is passing over the quiescent areas of the image screen 104 only virtual beams may be permitted to exist in the switching tubes 110, 111, 112 and 113. This effect is obtained by selecting the voltage of battery 164 such that it is normally insufficient to cause the creation of an electron beam between the central cathodes of the rotary tubes and the outer anodes. Therefore, as the scanning beam passes over unenergized areas of the screen 104 representing the unlighted lamps in the field 102 the magnetic fields around the switching tubes 110, 111, 112 and 113 rotate in their synchronous relations with the scanning beam, but no real beams exist within these switching tubes. As soon, however, as the scanning beam reaches the energized image area representing the lighted lamp 163, a voltage is produced in the output circuit 165 of the device 103. This voltage is amplified by a suitable amplifier 166, and a positive potential is applied over conductor 167 to the control grids 115, 123, 124 and 125 of the switching tubes. This positive potential is sufficient to permit the tubes to discharge, thus transforming the virtual beams

into real beams of electrons. At the particular instant when the switching beams become real their positions are such that the beam of tube 110 impinges on the No. 5 anode 168, the beam of tube 111 engages the No. 2 anode 169, the beam of tube 112 engages the No. 4 anode 170, and the beam of tube 113 encounters the No. 8 anode 171.

If desirable the beams of the switching tubes may be continuously real but of insufficient intensity to be effective except when the device 103 is scanning a sensitized image area. This effect may be obtained in the obvious manner by adjusting the bias on the control grids 115, 123, 124, 125, such that the beams are of low intensity until the device 103 finds the lighted lamp. And it will be understood that the invention contemplates the use of either a virtual beam replaced by a real beam when the lighted lamp is found or a real beam of low intensity replaced by one of high intensity when the lighted lamp is found.

When the switching tube 110 becomes effective as above described, a circuit is closed from the negative pole of battery 164, conductor 172, cathode 114 across the cathode beam to the anode 168 thence through resistor 173 to ground. Current flowing in the resistor 173 sets up a voltage across the control gap of tube 147. Thereupon the tube 147 ionizes, and a circuit is closed from ground through the contact of relay 151, battery 150, winding of register relay 149 through the main discharge gap of the tube 147 to ground. Register 149 operates in this circuit to register the thousands digit "5" of the line 100. At the same instant similar circuits are closed across the electron beams of tubes 111 and 112 to cause the operation of corresponding registers to register the hundreds digit "2" and the tens digit "4" of the calling line. Also at the same instant a circuit is closed from battery 164, conductor 172, cathode 122 of the units tube 113, anode 171 through the resistor 174 to ground. The voltage developed across the resistor 174 operates the tube 153, causing in turn the operation of register relay 155 to register the units digit "8" of the calling line 100. Thus the complete number of the calling line is detected and registered during the brief interval that the beam of the device 103 is resting on the image of the lighted lamp 163. An instant later the scanning beam passes to the next elemental image area which is unenergized, and the beams of the tubes 110, 111, 112 and 113 revert to their virtual status and are ineffective to cause the operation of other registers.

After the number of the line has been registered in the mechanism 143, it is used in any suitable manner for causing the operation of a printer to print the number on the ticket which is being prepared for the call. This printer may be located in the controlling circuits 157 of the trunk 101, in which case the registered information in the mechanism 143 is transferred through the connector 158. After all necessary operations have been performed, the register mechanism 143 and the identifying mechanism are restored to their normal condition ready for subsequent use.

For more detailed information concerning the operation of identification systems reference may be had to the application of J. W. Gooderham, Serial No. 448,782, filed June 27, 1942.

The frequency multipliers 131, 139 and 141 serve the purpose, as explained hereinbefore, of increasing the frequency by desired amounts. Many such devices are available in the art, and any suitable one of these may be used. For example, reference is made to the multiplier shown in Burton 1,917,921 of July 11, 1933. Similarly the phase dividers 128, 132, 140 and 142 used herein may be any of the numerous devices of the prior art which are suitable for the present purpose. One such device is shown in detail in Fortescue 1,565,434 of December 15, 1925.

In the alternative form of identifying mechanism illustrated in Figs. 3 and 4 a movable screen 300 is used for scanning the lamp field 302. The screen 300 is moved first in a vertical direction and then in a horizontal direction to scan an image of the field 302 which is focussed on the screen by a lens system 301. The screen 300 is provided with horizontal and vertical slots 303 and 304 respectively, which permit light to pass to light-sensitive element 305 when the screen reaches the horizontal and vertical positions corresponding to a lighted lamp in the field 302. Mechanism associated with the screen 300 and movable in synchronism therewith serves to determine the decimal values of the digits of the line represented by the lighted lamp. This mechanism is illustrated in detail in Fig. 3.

Referring now particularly to Fig. 3, the movable screen 300 is supported by a horizontal shaft 306 to which it is attached for slidable movement thereon. The shaft 306 is secured at one end to a rack 307 which serves to translate the shaft in a vertical direction. For this purpose the opposite end of the shaft 306 is designed to slide freely in the guide member 308. The screen 300 is also attached to the vertical shaft 309 by means of guides 310 and 311 which permit the screen to slide freely on the shaft in a vertical direction. Like the shaft 306, the shaft 309 is secured at one end to a rack 312 and at the other end is arranged to slide in the guide member 313.

The normal position of the screen 300 is, as shown in the drawings, in the upper left corner of the area indicated by the dotted square 314. In this position the horizontal slot 303 rests just above the image area 316 of the lamp field 302, and the vertical slot 304 lies just to the left of the area 316. The screen 300 is first driven downwardly along the shaft 309 by means of a motor 318 which operates on the rack 307. In its downward movement the screen 300 causes the slot 303 to scan the horizontal lines of the image area 316. When the screen reaches its position in the lower left corner of the area 314 the slot 303 assumes a position below the image area 316, and the slot 304 is now opposite the image area and to the left thereof. The next step is to advance the screen 300 horizontally along the shaft 306 until it reaches a position in the lower right corner of the area 314. This is accomplished by operating the motor 319 which engages the rack 312. During the horizontal movement of the screen 300 the vertical slot 304 scans the vertical lines of the image area 316.

The vertical and horizontal scanning movements of the screen 300 are measured by digit switches 320, 321, 322 and 323. The brush of the switch 320 is connected directly to shaft 324, which in turn is geared directly to the driving motor 318. Therefore, the brush of switch 320 moves over its ten position contacts in synchronism with the movement of the screen 300 from its upper to its lowermost position. These ten stationary contacts of the switch 320 correspond to the ten different values of the thousands digit of the lines, and they are connected correspond-

ingly to the relays of the thousands register 325. The switch 321, which corresponds to the hundreds digit, is connected to the shaft 324 by gears 326 and 327 having a ratio such that the brush of switch 321 moves ten times as fast as the brush of switch 320. Thus the switch 321 moves in synchronism with the slot 303 over the ten hundreds horizontal rows of each thousand. The ten stationary contacts of the hundreds switch 321 are connected to the relays of the hundreds register 328. In a similar manner the motor 319 is directly connected to the brush of the tens digit switch 322 which moves over its ten positions during the horizontal movement of the slot 304 over the image area 316. Also the brush of the units switch 323 is driven through gears 329 and 330 at ten times the speed of switch 322 whereby the switch 323 is in synchronism with the vertical slot 304 as it passes over the units positions of each group of tens. The stationary contacts of the switches 322 and 323 are connected respectively to the relays of the tens and units registers 331 and 332.

The screen 300 is restored from its operated position in the lower right corner of the square 314 to its normal position by moving it first in a vertical direction to the upper right corner of square 314 and then in a horizontal direction to its normal position as illustrated in Fig. 3 of the drawings. The vertical restoring movement of the screen is performed by a motor 333 which acts on the rack 307, and the horizontal restoring movement is performed by a motor 334 acting on the rack 312.

The detailed operation of the scanning system shown in Fig. 3 will now be described. Assume that a circuit is closed for lighting the lamp 335 in the field 302. The energizing circuit of the lamp 335 also includes the winding of the relay 336 which operates and closes a circuit from battery through the winding of relay 337, contact of relay 336 to ground through the contacts 338 in their normal position. Relay 337 operates and locks in a circuit from battery through its winding and contact to ground through the contacts 339 in their normal position. Relay 337 also closes an obvious circuit for the motor 318 which operates to drive the screen 300 in its downward scanning movement and also to rotate the thousands and hundreds digit switches 320 and 321. As soon as the screen 300 leaves its normal position, the contacts 338 shift to their off-normal position and open the operating circuit of relay 337. During the downward movement of the screen 300 the light slot 303 encounters the image of the lighted lamp 335, and light passes through the slot to the photoelectric cell 305. The energy thus produced by the cell 305 is amplified by an amplifier 340, and current flows in the output circuit of the amplifier over conductor 341 through the outer armature and back contact of relay 342, conductor 343 to the brushes of switches 320 and 321 and over the segments on which these brushes are standing to the corresponding relays of the respective thousands and hundreds registers 325 and 328. As soon as the slot 303 passes by the image of the lighted lamp, the photoelectric cell 305 becomes ineffective, and current ceases to flow in the output circuit of the amplifier 340.

When the slot 303 has passed over the entire image area 316, the screen 300 engages the contact springs 339 and shifts them from their normal to their operated position. Relay 337 now releases and opens the driving circuit of the motor 318. In the off-normal position of the contacts 338 an obvious operating circuit is closed for relay 342, which operates and locks to the contacts 344 in their normal position. Relay 342 closes a circuit for motor 319, which now drives the screen 300 in a horizontal direction and rotates the brushes of the switches 322 and 323. During its initial movement, screen 300 disengages the contacts 339 permitting them to restore to their normal position thus opening the operating circuit of relay 342. As the screen 300 moves horizontally the light slot 304 encounters the image of the lighted lamp 335, and light passes through the slot to energize the photoelectric cell 305. The current flowing in the ouput of the amplifier 340 now passes over conductor 341 through the front contact of relay 342, conductor 345 brushes of the switches 322 and 323 to the corresponding relays in the tens and units registers 331 and 332.

After the vertical slot 304 has completed the scanning of the image area 316, the screen 300 engages the contacts 344 and shifts them from their normal to their operated position. Contacts 344 open the locking circuit of relay 342, which releases and opens the driving circuit of the motor 319. Contacts 344 also close an obvious circuit for relay 346, which operates and locks to the contacts 347 in their normal position. Relay 346 closes an obvious circuit for motor 333, and the motor acts upon the rack 307 to drive the screen 300 in a vertical direction to the upper right corner of the square 314. During the initial movement of the screen 300 it disengages the contacts 344, permitting them to restore to their normal position to open the operating circuit of relay 346. When the screen 300 is fully restored in the vertical direction, it engages contacts 347 to open the locking circuit of relay 346, which in turn opens the operating circuit of the motor 333. The screen 300 and the rack 307 have now been restored to their normal position in the vertical direction, and the thousands and hundreds switches 320 and 321 have been restored to their normal positions. The contacts 347 when operated by the screen 300 also closes an energizing circuit for relay 348, which locks to the operated contacts 338. Relay 348 closes an obvious circuit for motor 334, and the motor drives the screen 300 horizontally to the left. On the first movement of the screen 300 in its horizontal direction contacts 347 restore and open the energizing circuit of relay 348. Finally when the screen 300 reaches its normal position, it restores the contacts 338 to open the locking circuit of relay 348 and the energizing circuit of the motor 334. Thus the screen 300 has been restored to its normal position in the horizontal direction, and the tens and units registers 322 and 323 are now in their normal positions.

The operated relays of the registers 325, 328, 331 and 332 may be locked in any well-known manner and may serve as above explained to cause the printing of a ticket to identify the number of the calling line.

What is claimed is:

1. In a telephone system, in which designations are assigned to the lines of a group on a decimal basis, each designation having a plurality of digital places, the combination of a plurality of signal lamps individual respectively to the lines of said group, said lamps being arranged in decimal order in a field of coordinate rows, an electron device having a scanning beam and means for causing said beam to scan said field of lamps in a definite order, switching beam devices, one for

each digital place in said designations, each switching device having a beam position for each digit value of the corresponding place, means for driving the beams of said switching devices through the successive switching positions at such a rate with respect to the movement of said scanning beam that each switching beam occupies at any instant the switching position corresponding to the digit value of the signal lamp in said field which is being scanned at that instant by the scanning beam, a plurality of registers, one for each of said digital places, each register being capable of variable operation to register any one of the digit values of the corresponding place, means for lighting any one of the lamps in said field to identify the particular line corresponding thereto, and circuit means interconnecting said switching devices and the corresponding registers and responsive to the respective switching beams for operating said registers to register the designation of said particular line when the scanning beam scans the lighted signal lamp.

2. The combination in a signaling system, including a group of lines having designations assigned on a decimal basis, each designation having a plurality of digital places, of a plurality of signal lamps individual respectively to the lines of said group, said lamps being arranged in a field in decimal order, an electron device having a scanning beam and means for causing said beam to scan said field of lamps in a definite order, electron beam switching devices, one for each digital place in said designations, each switching device having a beam position for each digit value of the corresponding place, means for driving the beams of said switching devices in synchronous relation with said scanning beam, a plurality of registers, one for each of said digital places, each register being capable of variable operation to register any one of the digital values of the corresponding place, means for lighting any one of the lamps in said field, and circuit means interconnecting said switch devices and the corresponding registers and responsive to the respective switching beams for operating said registers to register the designation of the line corresponding to the lighted signal lamp.

3. The combination in a signaling system, including a group of lines having designations assigned on a decimal basis, each designation having a plurality of digital places, of a plurality of signal lamps individual respectively to the lines of said group, said lamps being arranged in a field in decimal order, an electron device having a scanning beam and means for causing said beam to scan said field of lamps in a definite order, electron beam switching devices, one for each digital place in said designations, each switching device having a beam position for each digit value of the corresponding place, means for driving the switching beams of said devices in synchronous relation with said scanning beam and at different relative speeds, the speed of each switching beam bearing a definite relation to the decimal values of the corresponding digital place, means for lighting any one of the lamps in said field to identify the particular line corresponding thereto, and means controlled by the beams of said switching devices and effective when said scanning beam scans the lighted lamp in said field for registering the designation of the line corresponding to said lamp.

4. The combination in a signaling system of a group of lines having designations, each designation having a plurality of digital places, a plurality of lamps individual respectively to the lines of said group and arranged in decimal order, an electron device having a scanning beam and means for causing said beam to scan said lamps in a definite order, switching tubes, one for each digital place of said designations, each tube having a series of positions representing the values of the digit in the corresponding place, means for causing a virtual beam to sweep over the successive positions of each switching tube in synchronous relation with the movement of said scanning beam, means for lighting any one of the lamps in said group to identify the particular line corresponding thereto, means responsive to said scanning beam and effective when it scans the lighted lamp for transforming the virtual beams of said switching tubes into real beams of electrons, and means controlled by the real beams of said switching tubes for establishing the designation of the line corresponding to the lighted lamp.

5. The combination in a signaling system of a group of lines having designations, each designation having a plurality of characters, a plurality of signal elements individual respectively to the lines of said group, said elements being arranged in a field, a beam scanning device having a screen, means for producing on the said screen an image of said field of signal elements, a source of voltage of a given frequency for driving the beam of said device at a given speed to scan its image field, a plurality of switching tubes, one for each of the characters of said designations, each of said switching tubes having a series of positions and means for producing a beam of energy, each of said tubes having a driving means for causing the associated beam to move from one position to the next, frequency multipliers for increasing the frequency of the voltage from said source to different values, circuit means for applying the output energy of said frequency multipliers to the driving means of the respective switching tubes, said driving means responsive to the energy of the different frequencies for causing the associated beams to occupy the successive positions at different speeds, means for rendering any one of said signals effective, and means controlled by said scanning device when its scanning beam scans the image of the effective signal element for rendering the energy beams of said switching tubes effective, and means responsive to the beams of said switching tubes for registering the designation of the line responsive to the effective signaling element.

6. In a signaling system, a group of lines having designations, each designation having a plurality of digital places, a plurality of signal lamps individual respectively to the lines of said group, said lamps being arranged in a definite order in a field of coordinate rows, a screen having light apertures therein, means for moving said screen to scan the lamps in said field, switches movable in synchronism with said screen, each of said switches having a series of positions representing the different values of the digit in the corresponding place in said designations, means for lighting the lamp corresponding to any one of said lines, light-sensitive means responsive to light shining through the aperture in said screen when said screen reaches the position corresponding to the lighted lamp in said field, and means controlled by said light-sensitive means and said switches in the positions which they occupy when light passes from the lighted lamp through said aperture for establishing the designation of the corresponding line.

7. In a signaling system, a group of lines having designations, each designation having a plurality of digital places, a plurality of signal lamps individual respectively to the lines of said group, said lamps being arranged in a definite order in a field of coordinate rows, a screen having horizontal and vertical light slots therein, means for moving said screen in both coordinate directions to scan said field of lamps with said light slots, a plurality of switching devices, one for each of the digital places of said designations, means for driving said switching devices in synchronism with the movement of said screen in its vertical and horizontal directions while scanning said field of lamps, each of said switching devices having a series of positions representing the values of the digit in the corresponding place, light-sensitive means responsive to light shining through the slots in said screen when said screen in its vertical and horizontal movements reaches the positions corresponding to a lighted lamp in said field, and means controlled by said light-sensitive means and said switching devices in the positions they occupy when said slots reach the position corresponding to a lighted lamp for establishing the designation of the line represented by such lighted lamp.

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