Feb. 15, 1944. W. H. MARTIN 2,341,934

ELECTRIC SIGNALING

Filed June 27, 1942 4 Sheets-Sheet 1

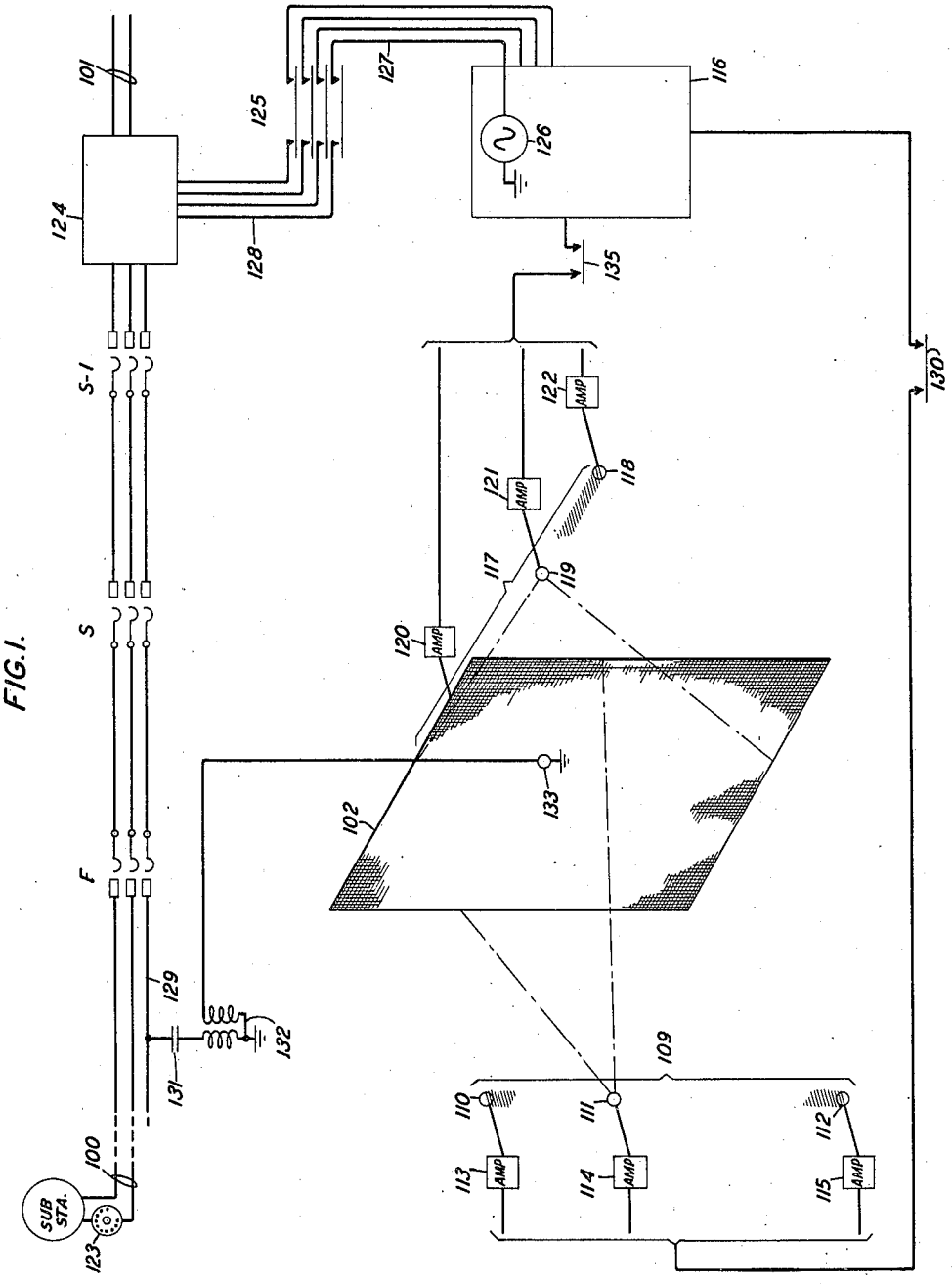


FIG. 1.

INVENTOR
W. H. MARTIN
BY W. R. McKamey
ATTORNEY

Feb. 15, 1944. W. H. MARTIN 2,341,934

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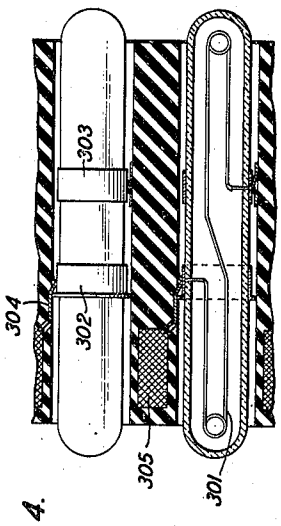


FIG. 4.

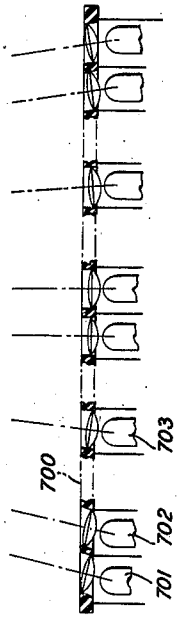


FIG. 7.

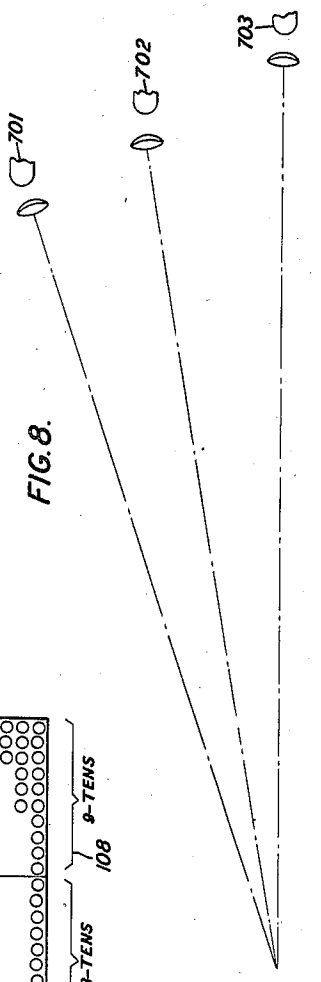


FIG. 8.

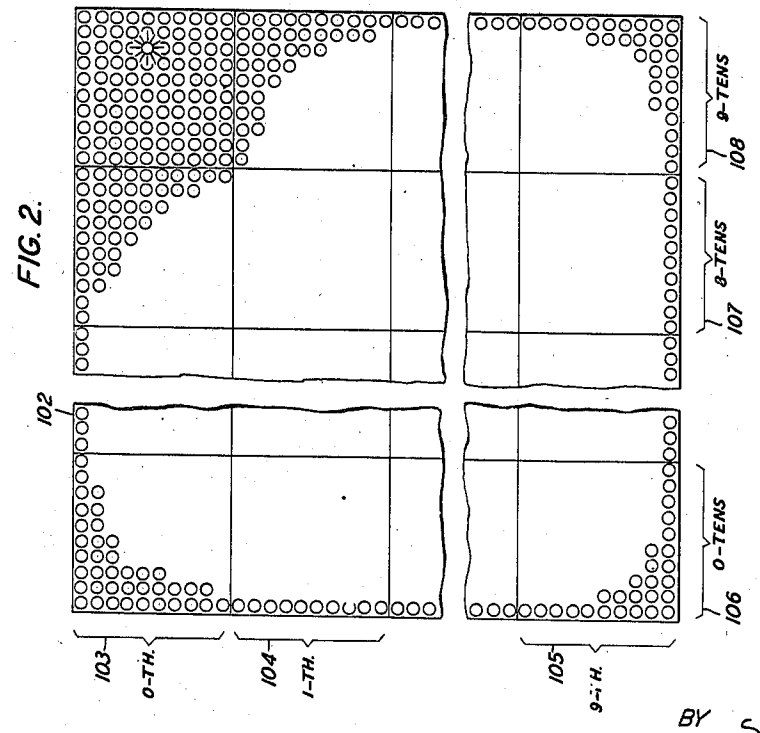


FIG. 2.

INVENTOR
W. H. MARTIN

BY

ATTORNEY

Feb. 15, 1944. W. H. MARTIN 2,341,934

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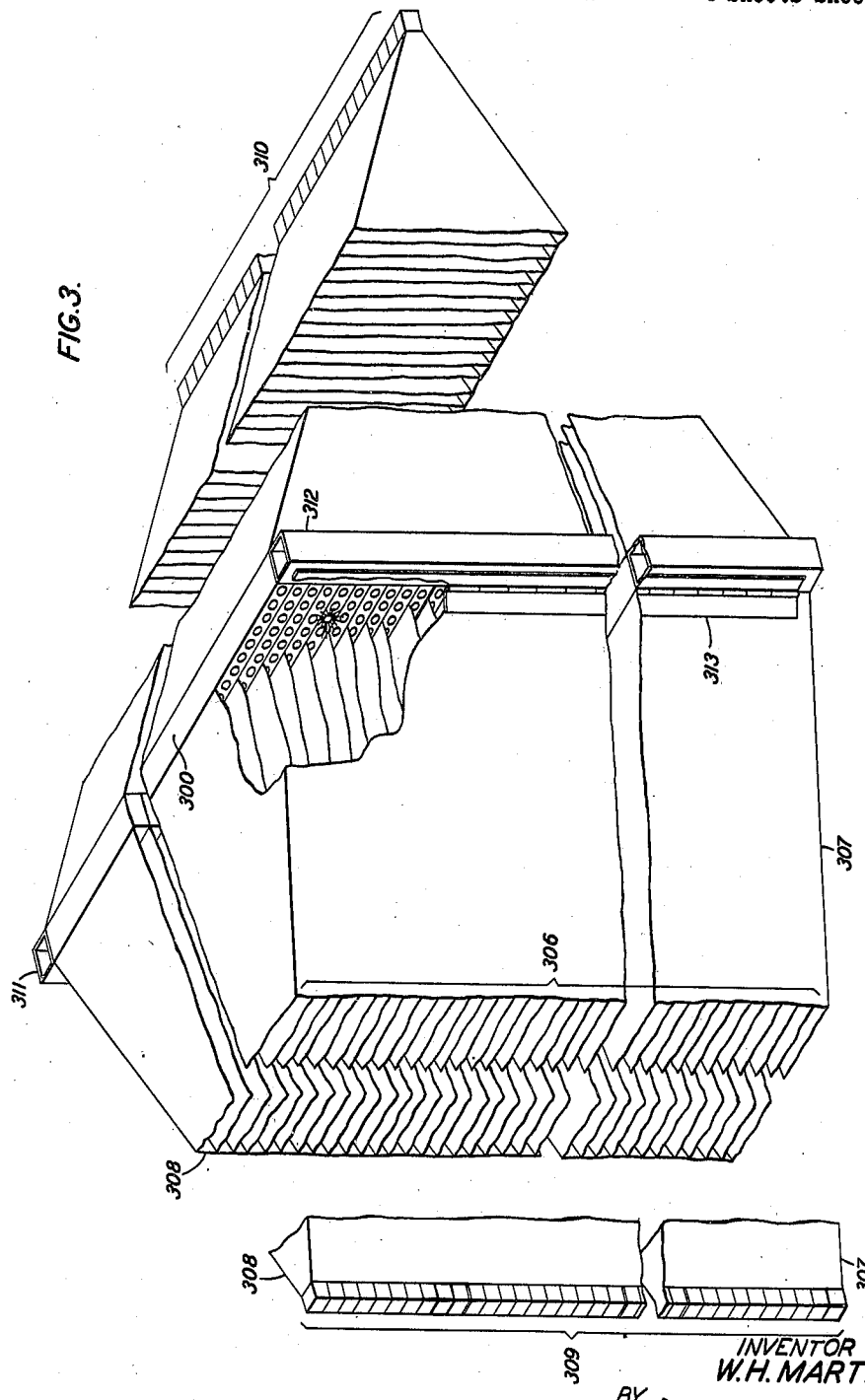
FIG. 3.




INVENTOR
W. H. MARTIN

BY M. T. McFarney

ATTORNEY

Feb. 15, 1944. W. H. MARTIN 2,341,934

ELECTRIC SIGNALING

Filed June 27, 1942 4 Sheets-Sheet 4

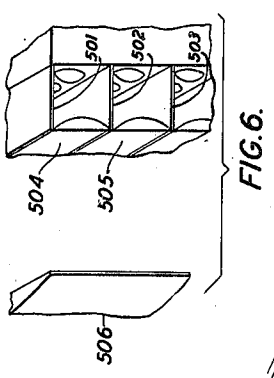



FIG. 6.




FIG. 5.

INVENTOR
W. H. MARTIN

BY W. V. C. McKenney

ATTORNEY

Patented Feb. 15, 1944 2,341,934

# UNITED STATES PATENT OFFICE

2,341,934

## ELECTRIC SIGNALING

William H. Martin, Summit, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application June 27, 1942, Serial No. 448,733

8 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.

A more specific object is to simplify the identification of the lines of a large group by detecting the location of a lighted lamp in a field arranged to correspond with the designations of the lines in the group.

A further object of the invention is a novel arrangement of the lamps in a panel so that each lamp emits light from both sides thereof to effect the desired identification.

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 of signal lamps which are individual respectively to the lines of the group and which are arranged in an array of coordinate horizontal and vertical rows. More specifically, the horizontal rows of lamps of one side of the array are separated by horizontal shields that direct the light from the lamps in each of the several horizontal rows onto a series of light-sensitive devices which are individual respecspectively to said horizontal rows. On the other side of the lamp array the vertical rows are similarly separated by shields provided for directing the light from all of the lamps in each of the several vertical rows onto a series of light-sensitive devices which are individual respectively to said vertical rows. The set of light-sensitive devices corresponding to the horizontal rows of lamps serves to detect the thousands and hundreds digits of the line designations, and the other set of light-sensitive devices, which correspond to the vertical rows, serves to detect the tens and units digits of these designations. Thus when any lamp in the field is lighted corresponding to a desired line, the light therefrom on one side of the array shines on the light-sensitive device individual to the corresponding horizontal row, and the light shining therefrom on the other side of the array impinges on the light-sensitive device individual to the corresponding vertical row. The energy developed by the excited light-sensitive device is utilized to register or indicate the number of the line concerned.

A feature of the invention is an identifying system of this character in which the light directing shields are replaced by lenses on both sides of the lamp field, the lenses on one side of the field serving to focus the light from the horizontal rows on corresponding light cells and the lenses on the other side serving to focus the light from the vertical rows on corresponding light cells.

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

In the drawings accompanying the specification:

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

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

Fig. 3 discloses the identification lamp panel provided with means for directing the light emitted by the lamps therein;

Fig. 4 is a detail showing the position of the lamps in the identification panel;

Fig. 5 is an alternative construction in which lenses are used for directing the light;

Fig. 6 is an enlarged detail of the construction shown in Fig. 5;

Fig. 7 is a modification of the lens structure used in Fig. 5; and

Fig. 8 is a conventional diagram of the lens system of Fig. 7.

The present invention is particularly useful in systems that require the preparation of tickets for the purpose of assessing a calling telephone subscriber for each conversation held with other subscribers. Since these tickets are prepared automatically, it is necessary to determine the number of the calling line 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 the drawings, the automatic telephone system illustrated in Fig. 1 comprises a large group of lines, usually ten thousand, which appear in the central office in non-numerical switches such as finder switches. The line 100 illustrated in the drawings, appears in the bank of line finder switch F, which is associated with a first selector switch S. The selector switch S may have direct access to outgoing trunks, or, as shown, it may have access through a succeed-

ing selector S—1 to trunks outgoing to distant offices, such as the trunk 101.

A field 102 including ten thousand signal lamps, one for each line in the office, is provided for obtaining the designation or identity of each line that establishes a telephone connection over one of the outgoing trunks 101. The lamps in the field 102 have numbers corresponding to the numbering of the associated lines, and they are arranged in decimal order in coordinate horizontal and vertical rows. There are one hundred horizontal rows and one hundred vertical rows, and each row in both directions contains one hundred lamps. This formation is illustrated more clearly in Fig. 2. The hundred horizontal rows are divided into ten equal groups, one for each thousand lines. For example, the horizontal group of lamps 103 represents the number "0" thousands group of lines, the horizontal group of lamps 104 represents the number "1" thousands group of lines, the horizontal group 105 represents the number "9" thousands group of lines, and similarly for the remaining groups which have been omitted in the drawings. Each of these thousands groups contains ten horizontal rows of one hundred lamps representing the ten hundreds groups in the thousand. In like manner the field of lamps 102 is divided into ten vertical groups representing the ten tens groups of all hundreds groups. For example, vertical groups 106, 107 and 108 represent respectively the No. 0, No. 8 and No. 9 tens groups. Each of these tens groups contains ten vertical rows of lamps representing respectively the ten units designations.

The lamps in the panel 102 are arranged to emit their light from both sides of the panel and to shine selectively on light-responsive devices such as photoelectric cells. Referring again to Fig. 1, a group 109 of one hundred photoelectric cells is disposed in a vertical array on one side of the lamp panel 102. These one hundred cells, 110, 111 and 112 are individual respectively to the hundred horizontal rows of lamps in the panel 102, and light-directing means hereinafter described serves to direct the light emitted by any light in any horizontal row to the corresponding photoelectric cell. For example, if cell 110 represents the No. 0 hundreds row in the No. 0 thousands group 103 (Fig. 2), the light emitted by any one of the hundred lamps in that row shines on the cell 110 and on no other. The individual circuits from the cells 109 extend through corresponding amplifiers 113, 114, 115 and thence through a connector 130 to the registering and identifying mechanism 116. In a similar manner a group 117 of one hundred photoelectric cells is provided on the opposite side of the lamp panel 102. These cells, however, are arranged horizontally and are individual respectively to the one hundred vertical rows of lamps in the panel. For example, the cell 118 is individual to the No. 9 units row in the No. 9 tens group of lamps 108, and cell 119 is individual to a particular units row in another one of the tens groups. And the remaining cells in the group are likewise individual to corresponding vertical rows of lamps. Similarly light-directing means are provided on this side of the panel to direct the light from each of the hundred vertical rows of lamps selectively to the corresponding photoelectric cell. The output circuits from the cells 117 extend through amplifiers 120, 121, 122 through a connector 135 to the registering and identifying mechanism 116.

Before discussing the detailed structure of the lamp panel 102, a brief description will be given of the operation involved in the process of identifying a subscriber's line. Assume to this end that the subscriber of line 100 desires 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 S. The switches S and S—1 respond successively to the subscriber's dial 123 to extend his line to an idle trunk 101 outgoing in the desired direction. At any suitable time during the extension of the connection of the subscriber's line to the trunk 101 an idle registering and identifying mechanism 116 is associated with the connection. The connection of the mechanism 116 with the controlling circuits 124 of the trunk 101 is effected by a suitable connecting device 125. As the subscriber continues to dial the remaining digits of the wanted designation, these digits may be registered in the mechanism 116 where they are later used to control the operation of 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 116 is ready to receive the identification of the calling line 100, it establishes connection with the identifying lamp panel 102 through the connectors 130 and 135. Also a circuit is closed from the source of energy 126 over conductor 127 through the connector 125, conductor 128, thence over the sleeve connection through switches S—1, S and F to the sleeve conductor 129 of the subscriber's line 100. The circuit is completed from conductor 129 through condenser 131 and the primary winding of transformer 132. The voltage induced in the secondary winding of the transformer 132 lights the panel lamp 133 which is individual to the line 100 and occupies the numerical position on the panel corresponding to the number of the line. Light from the lamp 133 shines selectively on the photoelectric cell 111 on one side of the panel and selectively on the photoelectric cell 119 on the opposite side. Since cell 111 is individual to a horizontal row of one hundred lamps it represents the thousands and hundreds digits of the line number of the line 100. Likewise the cell 119, being individual to the particular vertical row of one hundred lamps containing the lamp 133, represents the tens and units digits of the line 100. The electrical energy produced by the light shining on cells 111 and 119 is amplified by the amplifiers 114 and 121 respectively and is transmitted through connectors 130 and 135 to the mechanism 116. Any suitable translating means in the mechanism 116 serves to translate the currents flowing in these circuits and to operate digit registers which register the digits of the designation of line 100. Thereafter the registered information may be transferred to the controlling circuits 124 where it serves to operate a ticket printer to print the number of the calling subscriber's line together with the other information about the call.

The mechanism 116 corresponds in its purposes and operation and, if desirable, may also correspond in large measure with the structure of the register-sender and identifying mechanisms fully disclosed and described in Gooderham Patent 2,300,829, of November 3, 1942, and in the application of Gooderham, Serial No. 448,782, filed June 27, 1942. The registers on which the thou-

sands, hundreds, tens and units digits of the calling line number are registered may be the well-known relay registers which are so universally used in register senders of the automatic telephone art. The amplified currents flowing over the thousands and hundreds leads from the cells 109 operate the corresponding thousands and hundreds relay registers in the mechanism 116; and, similarly, the currents flowing over the tens and units leads from the cells 117 operate the tens and units relay registers in said mechanism. Reference, therefore, is made to the patent and to the application above noted for a full understanding of the manner in which the mechanism 116 is seized in response to the dialing by the calling subscriber and connected to the ticketing trunk 101 through the connector 125, of the manner in which the digits of the called line are registered in mechanism 116, of the manner in which the tone current is sent from source 126 over the sleeve of the connection to cause the identifying circuits to identify the particular line calling and to register the digits of the number of this line in the mechanism 116, and of the manner in which these identification systems operate in any other respect that may be helpful to an understanding of the application of the present invention.

Referring now to Figs. 3 and 4, a description will be given of the detailed construction of the signal lamp panel. This device comprises a vertical panel 300 of suitable thickness and provided with one hundred horizontal and one hundred vertical rows of holes or cells extending through the panel and corresponding to the decimal array of lamps in the field 102 above discussed. Each one of these ten thousand cells contains a double lamp which is capable of emitting its light on both sides of the panel 300. These lamps are illustrated in the enlarged detail of Fig. 4. Each lamp contains a filament 301 which terminates in the external contact rings 302 and 303. When the lamp is in place the rings 302 and 303 engage stationary contacts located in the panel 300 which serve to conduct current to the lamp filament. It will be noted that the contact ring 302 has a shoulder which engages the associated fixed terminal 304 to fix the position of the lamp symmetrically within the cell. The conductors for each horizontal row of lamps are grouped in a cable 305 which is brought out to the exterior of the panel 300 in any suitable manner.

It may be noted at this point that the signal lamps may be of the ordinary types having incandescent filaments or they may be of the gaseous discharge type. The latter would probably be preferable where it is desired to increase the speed of identification and to reduce correspondingly the time necessary for holding the common field of lamps 102 for the identification of each calling line.

The left or front side of the panel 300 is provided with a series of horizontal shields or separator plates 306 dividing the field of lamps into one hundred separate horizontal rows. These separating plates are enclosed by side plates 307 and 308 and are tapered as illustrated to form a series of one hundred horizontal light chambers. At the apex of the series of horizontal chambers is located the series of one hundred photoelectric cells 309. Thus the light from any one of the hundred lamps in a particular horizontal row in the panel 300 is confined to the associated light chamber and is directed to the apex thereof where it impinges on the single photoelectric cell individual to that horizontal row of lamps. To enhance the efficiency of the light-directing chambers the interior surfaces may be covered with any suitable material to induce the maximum degree of reflection. In a corresponding manner the opposite side of the panel 300 is provided with one hundred vertical light-directing chambers, and at the apex of these chambers there are located the corresponding one hundred photoelectric cells 310. Thus the light from any one of the lamps in any vertical row in the panel 300 is confined to its vertical light-directing chamber and is caused to impinge upon the particular photoelectric cell which is individual to that vertical row.

The panel 300 is mounted in any suitable manner between the tubular standards 311 and 312, and the chamber structures on both sides of the panel may be hinged to these standards. For example, the chamber structure on the left side of the panel 300 is provided with the hinge 313 which permits the entire chamber assembly to be turned away from the panel, thus facilitating the replacement and repair of the lamps. If desired the chamber structure on the other side of the panel may be hinged in similar manner.

The panel structure shown in Fig. 5 is substantially the same as the one in Fig. 3, except that lenses are used instead of the light chambers for directing the light from the signal lamps to the photoelectric cells. The panel 500 contains one hundred horizontal and one hundred vertical rows of holes or cells in which the double lamps are disposed to emit their light from both sides of the panel. On the left-hand side of the lamp panel 500 horizontal shields or spacers are arranged to separate the successive adjacent horizontal rows of lamps. Three of these shields, 501, 502 and 503, are illustrated in the enlarged view shown in Fig. 6. The light from the lamps in the horizontal rows is confined to the spaces between the associated shields and is focussed along horizontal lines by means of cylindrical lenses disposed horizontally between the shields. For example, the light from all of the lamps in the horizontal row enclosed by the shields 501 and 502 is collected by the horizontal cylindrical lens 504 and focussed along a horizontal line in front of the panel. Similarly, the light from any of the lamps in the next horizontal row is collected by the cylindrical lens 505 and is focussed along a horizontal line which is parallel to the focal line of the preceding row, and the same is true of all of the other horizontal rows of lamps in the field. In order that the light from any horizontal row may be brought to a point near the associated photoelectric cell a large cylindrical lens 506 is disposed adjacent the horizontal lens and at a suitable distance determined by the focal dimensions of the lenses. The lens 506 is arranged with its curved surface at right angles to the corresponding surfaces of the individual horizontal lenses, and the result is that the parallel focal lines of light caused by the successive horizontal lenses are focussed on a vertical series of points in the vicinity of which the series of one hundred photoelectric cells 507 are arranged. Thus the light from each horizontal row of lamps in the panel 500 is selectively brought to focus, by the individual lens of the row and the common lens 506, near the photoelectric cell individual to that particular row.

On the other side of the lamp panel 500 the shields and the individual cylindrical lenses are

arranged vertically corresponding with the vertical rows of lamps, and the common cylindrical lens **508** is arranged at right angles to the individual lenses. Thus the light from the several vertical rows of lamps is focussed selectively at the corresponding photoelectric cells of the series **509**.

In the modification illustrated in Fig. 7 the cylindrical lenses of Fig. 5 are dispensed with and strips of spherical lenses are provided instead. These strips, such as the strip **700**, may be molded en bloc, and one of them is provided for each of the horizontal rows of lamps on one side of the panel **500** and one for each of the vertical rows of lamps on the other side of the panel. The planes of the successive lenses in the strip are arranged at varying angles as illustrated so that the light from each of the lamps **701**, **702**, **703**, etc., is brought to focus, as shown in Fig. 8, on the cell which is individual to the row of lamps.

It will be understood that the illustrations in the drawings are to a large extent conventional and that no attempt has been made to portray the particular dimensions for the various parts to secure best results. The best dimensions and other design factors may of course be chosen without departing from the scope of the invention.

What is claimed is:

1. The combination in a telephone system including a group of telephone lines, said lines having designations including a plurality of character places, the characters of each place varying in value from line to line, of means for identifying any desired one of said lines in response to a characteristic electrical condition thereon comprising a plurality of signal lamps individual respectively to said lines, said signal lamps being arrayed in a definite order with respect to the values of the characters of said designations, a plurality of light-responsive devices, means for illuminating the particular one of said signal lamps corresponding to a desired one of said lines and for directing a beam of light from said lamp to a particular one of said light-responsive devices to energize the same, and means responsive to the energized light-responsive device for identifying the designation characters of said desired line.

2. The combination in a signaling system including a group of lines, said lines having designations including a plurality of character places which vary from line to line, of means for identifying any desired one of said lines by determining its designation comprising a plurality of signal lamps individual respectively to said lines, said lamps being arranged in horizontal and vertical rows in a definite order with respect to the values of the characters of said designations, means for illuminating the particular one of said signal lamps corresponding to a desired one of said lines, a plurality of light-responsive devices individual respectively to the horizontal rows of lamps, means for guiding the light from any lamp in each horizontal row to the individual light-responsive device, a second plurality of light-responsive devices individual respectively to the vertical rows of lamps, means for guiding the light from any lamp in each vertical row to the individual light-responsive device, and means controlled by said light-responsive devices when energized by light shining thereon for determining the designation of the line corresponding to the illuminated lamp.

3. The combination in a signaling system including a group of electrical circuits, said circuits having discriminating designations including a plurality of digital places, the digits of each place varying in value from one circuit to another, of means for identifying any desired one of said circuits comprising a plurality of signal lamps individual respectively to said circuits, said signal lamps being arrayed in a panel and in a definite order with respect to the values of the digits of said designations, the lamps in said array serving to emit light from both sides of said panel, means for illuminating the particular one of said lamps corresponding to a desired one of said circuits, a light-responsive device, means for causing the light shining from the illuminated lamp on one side of said panel to impinge upon said light-responsive device, a second light-responsive device, means for causing the light shining from said lamp on the other side of said panel to impinge upon said second light-responsive device, and means controlled by said light-responsive devices when energized for identifying the designation of the circuit corresponding to the illuminated lamp.

4. The combination in a signaling system including a group of telephone circuits, said circuits having designations including a plurality of digital places, the digits of each place varying in numerical value from one circuit to another, of means for identifying any desired one of said circuits comprising a plurality of signal lamps individual respectively to said circuits, said signal lamps being arrayed in a field and arranged in numerical groups corresponding to the designations of said circuits, means for lighting the particular one of said signal lamps corresponding to a desired one of said circuits, a plurality of light-sensitive devices individual respectively to said numerical groups of lines, light shields for directing the light from any illuminated lamp in a numerical group to the light-sensitive device individual to such numerical group, and means controlled by said light-sensitive devices for identifying the designation of the circuit corresponding to the illuminated lamp.

5. The combination in a signaling system of a plurality of lines having designations including a plurality of digital places of means for identifying any desired one of said lines comprising a plurality of signal lamps individual respectively to said lines, said lamps being arrayed in a panel in horizontal and vertical rows and arranged to emit their light from both sides of the panel, means for illuminating the particular lamp corresponding to any desired one of said lines, a plurality of light-sensitive devices individual respectively to the horizontal rows of lamps on one side of the panel, a plurality of light shields separating the horizontal rows of lamps on said one side of the panel and forming a series of chambers into which the light from all lamps in the corresponding horizontal rows shines, said chambers serving to direct the light from the lamps in the successive horizontal rows selectively to the corresponding light-sensitive devices, a plurality of light-sensitive devices individual respectively to the vertical rows of lamps on the other side of said panel, a plurality of light shields separating the successive vertical rows of lamps on said other side of the panel and forming a series of light chambers into which the light from all lamps in the successive vertical rows shines, said chambers serving to direct the light from the lamps in the successive vertical rows selectively to the corresponding light-sensitive devices, and means controlled by said light-

sensitive devices for determining the designation of the line corresponding to the lighted lamp in the panel.

6. The combination in a signaling system including a group of lines, said lines having designations including a plurality of digital places of means for identifying any desired one of said lines comprising a plurality of signal lamps individual respectively to said lines, said signal lamps being arrayed in a definite order with respect to the values of the digits of said designations, means for illuminating the particular one of said signal lamps corresponding to a desired one of said lines, a plurality of light-responsive devices, lenses for focussing the light from said signal lamps selectively on said light-responsive devices, and means controlled by said light-responsive devices for identifying the designation of the line corresponding to a lighted lamp.

7. The combination in a signaling system including a group of lines, said lines having designations including a plurality of digital places of means for identifying any desired one of said lines comprising a plurality of signal lamps individual respectively to said line, said signal lamps being arranged in rows in a definite order with respect to the values of the digits of said designations, means for illuminating the particular one of said signal lamps corresponding to a desired one of said lines, a plurality of light-sensitive devices individual respectively to said rows of signal lamps, lenses for selectively focussing the light from all lamps in each of said rows on the corresponding light-sensitive device, and means controlled by said light-sensitive devices for identifying the designation of the line corresponding to a lighted lamp.

8. The combination in a signaling system including a group of lines, said lines having designations including a plurality of digital places, of means for identifying any desired one of said lines comprising a plurality of signal lamps individual respectively to said lines, said signal lamps being arranged in rows in a definite order with respect to the values of the digits of said designations, means for illuminating the particular one of said signal lamps corresponding to a desired one of said lines, a plurality of light-sensitive devices individual respectively to said rows of signal lamps, lenses individual respectively to said rows of lamps each serving to direct the light from all lamps in the associated row to a focal line, a common lens for directing the light from all of said focal lines to the respective light-sensitive devices, and means controlled by said light-sensitive devices for identifying the designation of the line corresponding to a lighted lamp.

WILLIAM H. MARTIN.