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LIGHT RESPONSIVE SWITCHING MATRIX

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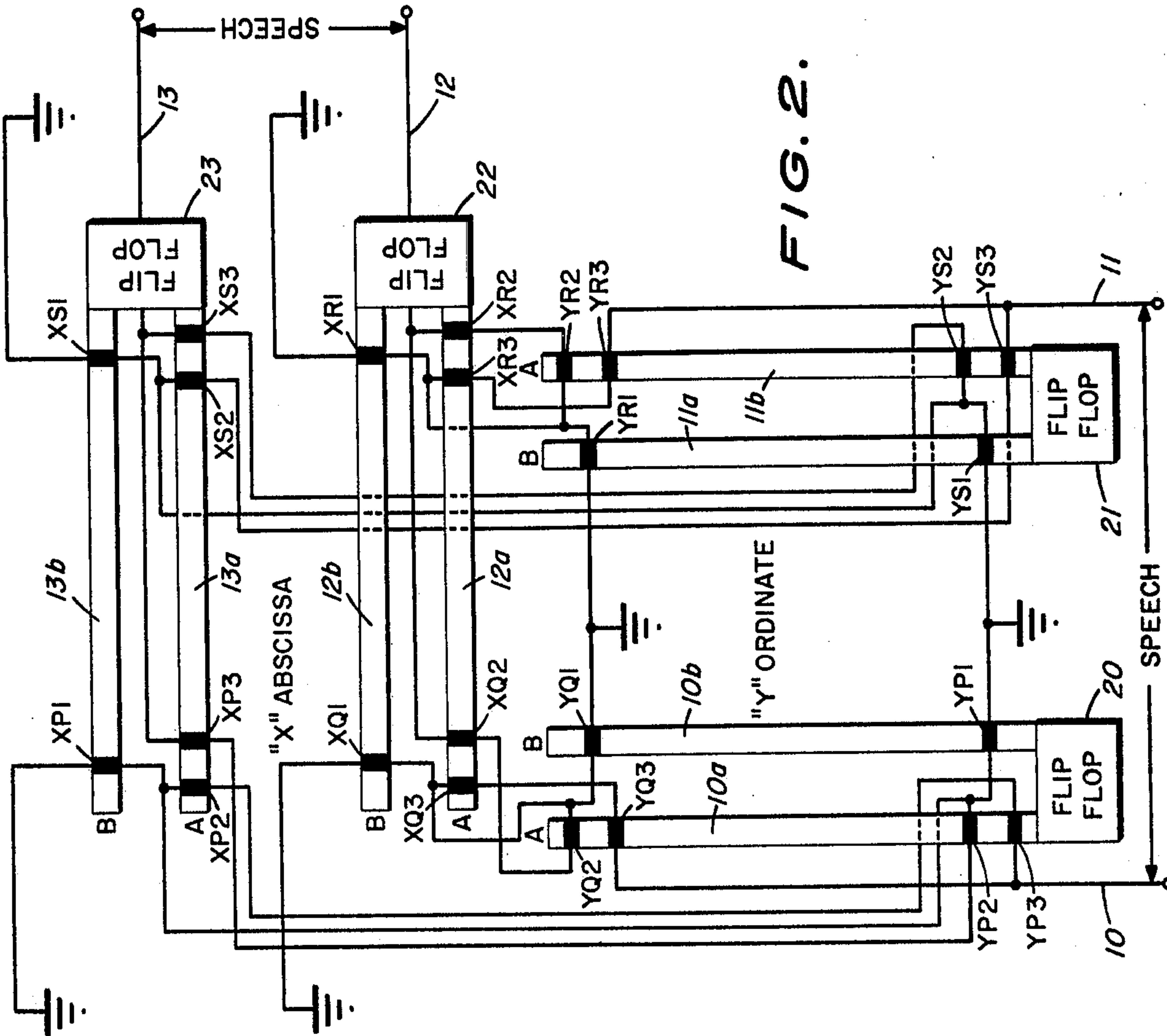


FIG. 2.

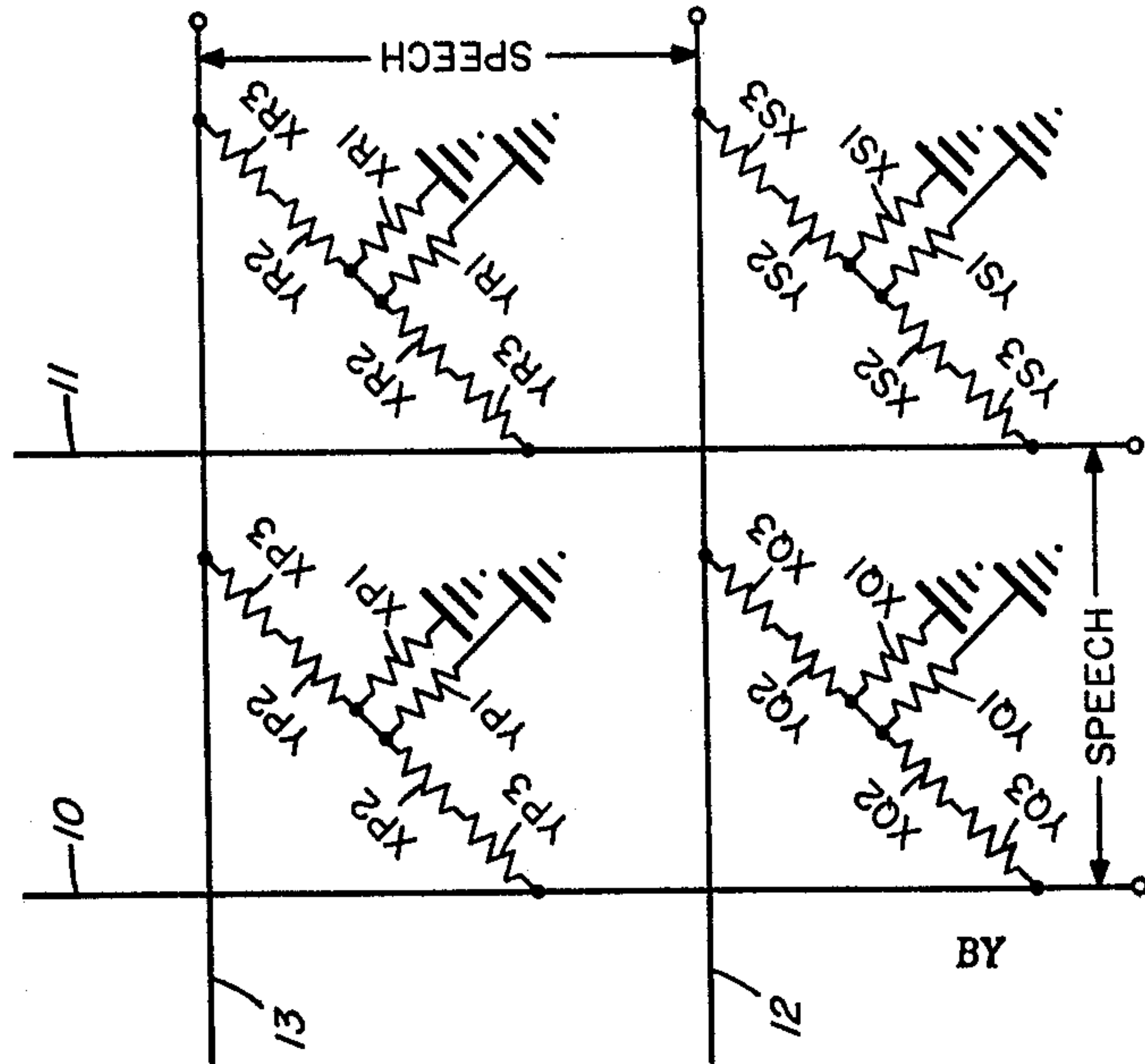


FIG. 1.

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LIGHT RESPONSIVE SWITCHING MATRIX
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12 Claims

The present invention relates in general to photoconductor devices and more particularly to a light controlled cross-point switching matrix for use in connection with telephone communication systems.

The switching matrix is generally well known in the electronic art, and has been applied to many different uses in the various special fields thereof. One such use for the switching matrix is in the communication field, and especially in connection with telephone communication systems in the form of a speech cross-point matrix, which effects selective interconnection of line circuits. Mechanical cross-point switching to effect interconnection of line circuits in telephone systems has experienced continuing development and recent efforts have been directed to a speech cross-point matrix responsive to light-controlled photoconductor elements. In such a matrix, the orthogonal lines of the matrix are interconnected at the junctions thereof by photoresponsive resistors whose resistance is controlled by individual light sources at each cross-point of the matrix so as to make possible the completion of a path from one selected input line along the abscissa of the matrix to a single ordinate line at the output thereof. While these arrangements have proven satisfactory, the need for plural individual light sources at each of the cross-points of the matrix in addition to the manufacturing problems resulting from this requirement has made this construction both uneconomical and complicated to manufacture.

There has also been proposed a matrix utilizing a composite arrangement of photoconductors and electroluminescent elements designed to operate much in the order of the photoconductor matrix utilizing individual light sources; however, this construction is also complicated and expensive so manufacture and presents problems with regard to maintenance and repair in addition to difficulties encountered in efficient operation of the device.

It is therefore an object of the instant invention to provide a light controlled speech cross-point matrix which overcomes or otherwise completely eliminates the above-mentioned difficulties inherent in known devices of a similar nature.

It is another object of the instant invention to provide a light controlled speech cross-point matrix which is of simple and economic construction and which provides for efficient and accurate operation.

It is still another object of the instant invention to provide a light controlled speech cross-point matrix which may be easily and economically maintained for efficient and accurate use under adverse operating conditions.

In accordance with the instant invention, each of the orthogonal lines representing the abscissa and ordinate of the cross-point matrix are provided with a pair of glass light conducting tubes, upon each of which is deposited a series of photoconductive rings capable of changing resistance when exposed to light. The rings on the glass light conducting tubes are then interconnected in the same manner as the photoconductive resistances utilized in the known light conducting cross-point matrix so that upon selective illumination of the proper tubes representing a pair of orthogonal lines of the matrix a complete path, which may be a speech path, is provided from the input to the output thereof. The result is a construction which may be easily and inexpensively

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manufactured and easily maintained for efficient and accurate operation.

These and other objects, features and advantages of the instant invention will become more apparent from the following detailed description of the invention when taken in conjunction with the accompanying drawing, which illustrates one embodiment of the instant invention, and wherein:

FIGURE 1 is a diagrammatic representation of a portion of a light controlled cross-point matrix of known configuration; and

FIGURE 2 is a plan view, partly schematic, of the construction in accordance with the present invention of the partial cross-point matrix illustrated in FIGURE 1.

Looking more closely to the drawing, wherein like reference numerals have been used throughout the views to designate corresponding parts and particularly to FIGURE 1, a portion of a cross-point matrix illustrated therein includes ordinate lines 10 and 11 extending in the Y direction and abscissa lines 12 and 13 orthogonal thereto extending in the X direction. The lines 10, 11, 12 and 13 may form switching lines for electrical control or electrical scanning, or in the preferred embodiment may form speech transmission lines for connecting selective line circuits in a telephone communication system.

The lines 10 and 11 are electrically insulated from the lines 12 and 13 at their cross points, as is common in the standard matrix configuration, with selectively controlled resistance paths provided between selective conductors at each of the cross-points to effect controlled interconnection of one of the ordinate lines with one of the abscissa lines. This resistive path in the light controlled cross-point matrix consists, for example, of photoconductive resistances YP3, XP2, YP2 and XP3 connected in series between the orthogonal conductors forming an individual cross point. The center point between the photoconductive resistors XP2 and YP2 is connected to ground through a parallel combination of photoconductive resistors YP1 and XP1. The photoconductive resistors are of the known type having high and low impedance states in their non-illuminated and illuminated conditions, respectively.

In accordance with a known matrix construction, at least a pair of light sources, and usually three light sources, must be provided at each coordinate or cross-point of the matrix to provide for full enabling or interconnection between an ordinate line and an abscissa line. That is, with a light source provided for association with the photoconductive resistances YP2 and YP3, a half enabling of the cross-point is effected. A complete enabling of the cross-point then requires a light source to be provided in conjunction with the photoconductive resistances XP2 and XP3. In the known construction, individual light sources are also provided in conjunction with the photoconductive resistances YP1 and XP1 which light sources are operated reciprocally with those associated with the serially connected resistances to provide for positive on and off conditions at the cross-points.

It should be apparent that the requirement in the known construction for provision of multiple light sources at each cross-point of the matrix results in a very complicated construction which is expensive to manufacture due to the number of components and the type of control required. As a result, in an attempt to materially reduce the cost of manufacture of such a matrix, it is proposed in accordance with the invention that light sources be provided common to each of the ordinate and abscissa lines in the matrix having an extremely simple construction so that the otherwise high cost of manufacture is avoided while retaining the efficient and accurate operation associated with and required of this type of device.

Referring to FIGURE 2 of the drawing, the construction in accordance with one embodiment of the instant invention simulating the partial matrix configuration of FIGURE 1 is illustrated. While it is apparent that a working cross point matrix would provide a greater number of ordinate and abscissa lines than illustrated forming a multitude of cross points, the simplified configuration of FIGURE 1 has been chosen for representing the construction of the instant invention in order to present a clear description and uncomplicated illustration of the features of the present invention. As this detailed description proceeds, it will be apparent that a mere duplication of the illustrated elements following the described principles of the invention will result in a full working matrix of the desired size.

In accordance with the present invention, each of the lines of the matrix is provided with a pair of light conductive glass tubes which form a semi-common light source for each of the cross-points along that line. For example, the light conducting glass tubes 10a and 10b in FIGURE 2 provide the light source for each of the YP photoconductive resistances connected to line 10 in FIGURE 1; the light conducting tubes 11a and 11b form the light source for each of the Y coordinate photoconductive resistors associated with the line 11; and, in a like manner, the photoconductive tubes 12a and 12b and the photoconductive tubes 13a and 13b form the light sources for the X coordinate photoconductive resistances associated with the line 12 and 13 respectively.

The photoconductive resistances interconnecting the cross-points of the matrix are provided on the light conducting tubes in the form of rings of photoconductive material with one tube of the pair associated with each line, for example, tube 10a carrying the series connected resistances and the second tube of the pair for example, tube 10b carrying the parallel or shunting resistor which effects positive disabling of the connection. Thus, all of the Y coordinate photoconductive resistors associated with a coordinate line of the matrix at each cross-point with which that line is involved is formed as a ring of photoconductive material on one particular pair of light conducting tubes.

The effective result of the combination in accordance with the present invention, which will become clear from the following description of the operation of the invention, is that illumination, of all the Y coordinate resistors along a particular ordinate line of the matrix and illumination of all of the X coordinate resistors along a particular abscissa line of the matrix will effect a half enabling of all cross-points along these lines with the exception of the particular cross-points formed by both of these particular ordinate lines, i.e., figuratively speaking, the point on the matrix at which the light sources cross.

The light conducting tubes are illuminated by individual light sources controlled by a separate light flip-flop 20, 21, 22 and 23 provided for each of the pairs of the tubes associated with lines 10, 11, 12 and 13. As is apparent from the description of FIGURE 1, it is necessary that the series resistances at each cross-point be illuminated alternately with the shunt resistances so as to provide a positive on and off condition. This alternate illumination is effected through use of the flipflops controlling the individual light sources for each one of the complementary tubes of a given pair. Since one of the tubes of each pair carries only the series resistances, and the other tube carries only the shunt resistances, alternate illuminations of the tubes of each pair by the light flip-flops will provide the necessary on and off operation of each cross-point.

For purposes of illustrating the operation of the present invention, it is assumed that a speech path is desired through line 10 to line 13 of the matrix illustrated in FIGURE 1. For this purpose it will be necessary to switch the photoconductive resistances YP3, XP2, YP2 and XP3 to their low impedance state so as to provide a current path from the line 10 to the line 13 at the cross-point of the

lines. This reduction in impedance of the series resistors is effected through illumination thereof by way of the light conducting tubes 10a and 13a in FIGURE 2.

Initially, each of the light flip-flops 20, 21, 22 and 23 will be in the reset state so that the second light conducting tube of each pair carrying the shunt resistances will be illuminated reducing the shunt impedances to their low impedance state. Thus, in FIGURE 2, the point of connection between the photoconductive ring YP2 on light conducting tube 10a and photoconductive ring XP2 on photoconductive tube 13a is connected to the photoconductive ring YP1 on light conducting tube 10b, which ring is in turn connected to ground. In a like manner, this same point of connection between the photoconductive rings XP2 and YP2 is connected to photoconductive ring XP1 on light conducting tube 13b, which ring is in turn connected to ground. Illumination of the tubes 10b and 13b provide the shunt path through the photoconductive rings YP1 and XP1 to ground from the center point of the serially connected resistors.

For providing a conductive line from the line 10 to the line 13 in the matrix control circuitry of any conventional construction (not shown) effects enabling of the flip-flops 20 and 23 so as to switch illumination from the tube 10b to the tube 10a and from the tube 13b to the tube 13a. In this condition, the photoconductive rings YP2 and YP3 on the tube 10a and the photoconductive rings XP2 and XP3 on the light conducting tube 13a are illuminated so as to change them to their low impedance state providing a conducting path from the line 10 to the line 13 through resistors YP3, XP2, YP2 and XP3. At the same time the tubes 10b and 13b become dark, switching the shunt resistances XP1 and YP1 to their high impedance state.

With the illumination of light conducting tube 10a the photoconductive rings YQ3 and YQ2 thereon will also be reduced to their low impedance state; however, no connection is effected between the line 10 and the line 12 in the matrix since the cross-point formed by these lines is only half enabled, the resistances XQ2 and XQ3 remaining in their high impedance state. In addition, due to the reset condition of the light flip-flop 22 to provide illumination of the light conducting tube 12b, the shunt resistance XQ1 is reduced to its low impedance state providing a shunting of the cross-point to prevent enabling thereof.

In a like manner, the cross points all along lines 10 and 13 of the matrix will be half enabled with the exception of the cross-point formed by a combination of the two lines. In effect, it can be visualized that enabling of the proper flip-flops will effectively provide a light path along selective ordinate and abscissa lines of the matrix so as to enable the cross-point at the point of intersection of the light paths.

It should be apparent that in utilizing light conducting tubes as semi-common light sources for the coordinate lines of the matrix and providing the light sensitive resistances as coatings on the light conducting tubes so as to provide for simultaneous illumination of a series of common resistors provides a construction which may be economically manufactured and which is dependable and accurate in use and also retains the flexibility of control provided by known arrangements of a similar kind.

While I have shown and described one preferred embodiment in accordance with the instant invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to a person skilled in the art and I therefore do not wish to be limited to the details shown and described therein but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

I claim:

1. A cross-point switching matrix for use in telephone communication systems comprising:
a plurality of individual input means,

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a plurality of individual output means electrically isolated from said input means, and

radiation signal control means connecting each input means to all of said output means for selectively effecting electrical interconnection between a single input means and a single output means,

said radiation signal control means including an individual pair of light conducting tubes associated with each input means and each output means and photoconductive means deposited on said light conducting tubes interconnecting individual input means and output means.

2. The combination defined in claim 1 wherein said pairs of light conducting tubes each include a first tube carrying photoconductive means connected in series between individual input and output means and a second tube carrying photoconductive means shunting to ground said series connection between individual input and output means.

3. The combination defined in claim 2 further including light source means for alternately illuminating said first and second light conducting tubes of two selective pairs for switching between the input and output means associated therewith.

4. The combination defined in claim 3 wherein said light source means includes a pair of lamps and flip-flop means for alternately energizing said pair of lamps in response to external control.

5. The combination defined in claim 4 wherein said input means and said output means are in the form of intersecting conductive lines, said radiation signal control means providing electrical interconnection at a selective intersection between said conductive lines.

6. A device comprising at least one input line and a plurality of output lines in electrical isolation with said input line, individual light responsive means associated with each output line and with said input line including first and second photoconductive resistors connected in series interconnecting said output line with said input line for effecting electrical connection therebetween upon

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selective illumination thereof, first light means optically coupled to all of said first resistances and second light means optically coupled with respective ones of said second resistances, said first light means being in the form of a light conducting tube associated with a switchable light source.

7. The device of claim 6 wherein said first resistances are formed as photoconductive rings on said light conducting tube.

8. The device of claim 7 further including third photoconductive resistor means connected between the point of connection of each of said first and second resistances and ground, and third light responsive means optically coupled to said third resistance.

9. The device of claim 7 further including a plurality of input lines, said individual light responsive means interconnecting each output line with each input line.

10. The device of claim 8 wherein said second light means is in the form of at least one light conducting tube and a switchable light source associated with all of the second resistor connected to a common output line.

11. The device of claim 10, wherein said first and second light means each further include at least one lamp for illuminating said respective light conducting tubes and flip-flop means for selectively energizing said lamps in response to external control.

12. The device of claim 8, wherein said third light responsive means includes a light conducting tube and a switchable light source associated with all of the third resistors of light responsive means connected to a common input line.

References Cited

UNITED STATES PATENTS

3,360,657	12/1967	Schlesinger	-----	250—220	XR
3,310,681	3/1967	Hargens	-----	340—380	XR

DONALD J. YUSKO, Primary Examiner

U.S. Cl. X.R.

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