Oct. 7, 1969 A. MACOVSKI 3,471,861

LIGHT-ADDRESSED MATRIX PRINTER

Filed Sept. 7, 1965 2 Sheets-Sheet 1

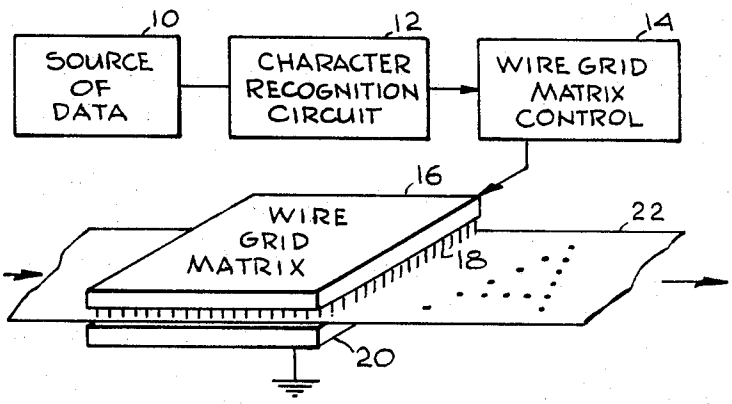


Fig. 1

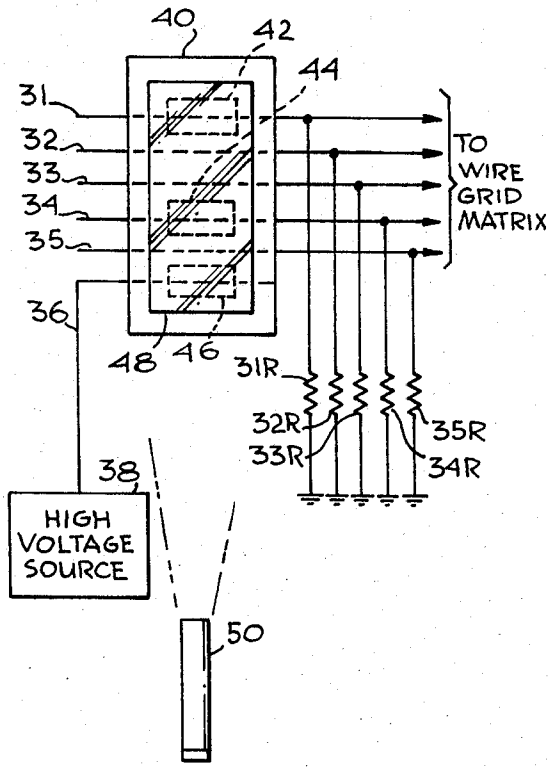


Fig. 2

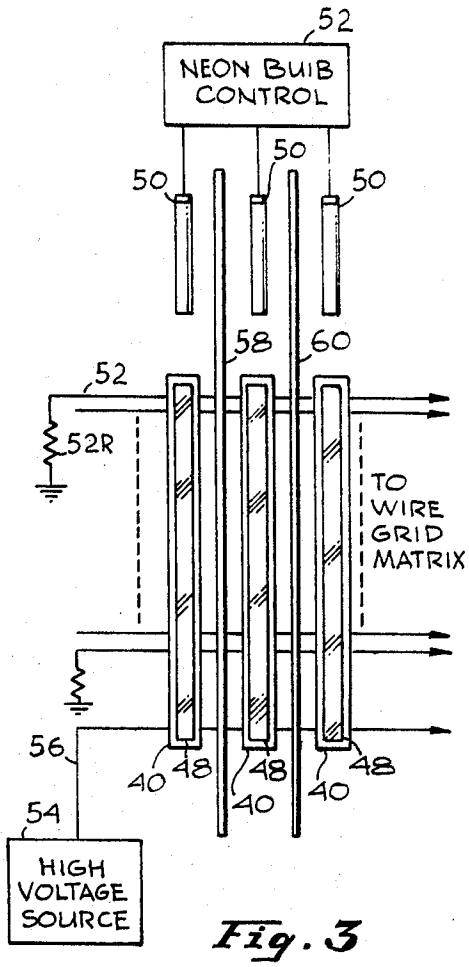


Fig. 3

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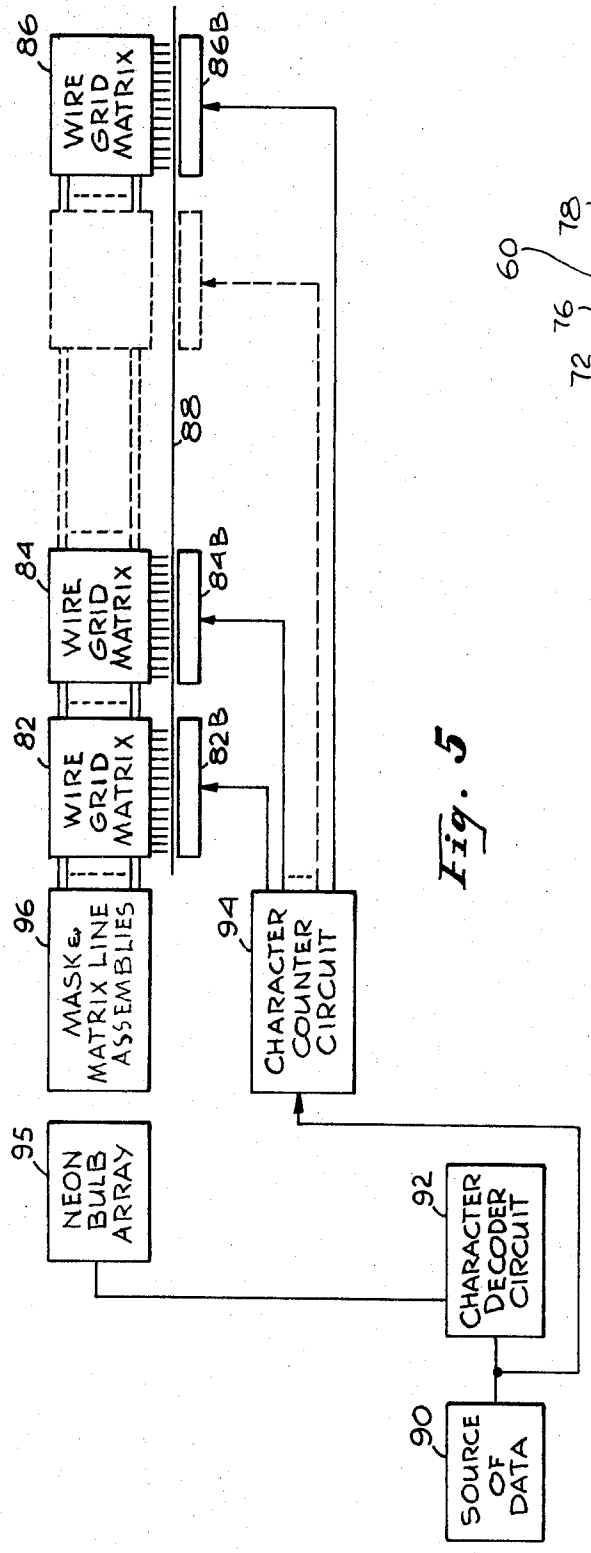


Fig. 5

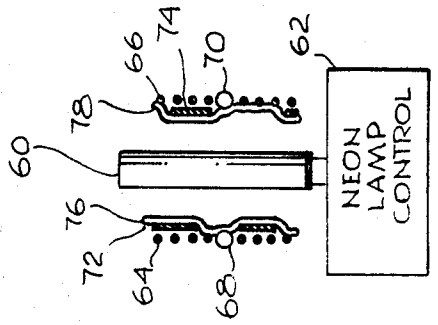


Fig. 4

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LIGHT-ADDRESSED MATRIX PRINTER

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ABSTRACT OF THE DISCLOSURE

In a wire grid printer of the type wherein wires are terminated in a matrix opposite to a ground plane, and voltage is selectively applied to the wires in the matrix to obtain a discharge between those wires and the ground plane for the purpose of electrostatic writing, there is provided a unique arrangement for addressing these wires with high voltage comprising bringing these wires to a region where an insulating mass having a hole or holes therein can be applied to one side of these wires. The holes are positioned to expose those wires which when energized with high voltage cause electrostatic charge deposition in the form of a desired character. Photoconductive material is deposited through the mask holes and over the mask to extend to a high voltage wire whereby the space between the high voltage wire and the exposed wires is bridged by the photoconductive material. Then when it is desired to energize these wires, light is shined upon the photoconductive material to reduce its resistance whereby the voltage applied to these wires from the high voltage wire exceeds the threshold for electrostatic charge deposition.

This invention relates to printers of the type which employ a wire grid matrix as a printing transducer, and more particularly to an improvement in the control arrangement for wire grid matrix printers.

A wire grid matrix printer or a dot matrix printer normally comprises an array of wires, the points of which are spaced opposite a back bar. The paper which is to be written upon is inserted between the points of the wires and the back bar. In order to write with this arrangement, a voltage is applied to each one of the wires which are disposed in the form of a desired character. When this voltage exceeds a predetermined threshold value, a voltage discharge occurs which deposits a charge on the paper. In this manner, an electrostatic charge pattern is deposited on the paper. The paper is then moved to a developing position where it is developed with the usual and well-known triboelectric toning powders.

Various arrangements for selecting the wires to which a voltage is applied have been employed. Since the voltage which must be applied to effectuate the discharge between wire points and back bar is substantial, the usual selection and/or switching systems which are employed are quite expensive. Such switching systems may include a diode for each line which is biased to be conductive or non-conductive as required. Alternatively, silicon control rectifiers have been employed which are selectively rendered conductive.

An object of this invention is the provision of a simplified arrangement for addressing the wires of the wire grid printer.

Another object of this invention is the provision of a unique and inexpensive arrangement for addressing the wires of a wire grid printer.

Yet another object of the present invention is the provision of a novel wire grid selection and printing system.

These and other objects of the invention are achieved in an arrangement wherein there is placed, over the addressing wires which are connected to the wire grid matrix. Each of these masks is made of insulating material and has openings for the purpose of exposing those wires which when energized will cause the wire grid matrix to print the desired character. In addition to all the address wires of the wire grid matrix, there is provided a high voltage supply wire.

Each mask and the voltage supply wire is then covered over with photoconductive material whereby the photoconductive material will pass through the holes in each mask and come in contact with the underlying address wire. The voltage applying wire is also connected to the photoconductive material. A high voltage is applied thereto. A light source, such as a neon bulb, is placed adjacent each photo-conductive material coated mask. Then, in order to have a desired character written, the one of the light sources is illuminated which is adjacent to the mask openings which expose wires which when energized produce the desired character. The resistance of the photoconductive material is rapidly reduced in response to being illuminated, to a value such that the voltage from the wire connected to the voltage source is applied to the several address wires by reason of connection made with the photoconductive material through the holes in the mask. Those wires which are thus energized energize the wires of the wire grid matrix depositing an electrostatic charge pattern on the paper which can be subsequently developed.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself both as to its organization and method of operation, as well as additional objects and advantages thereof will best be understood from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is a schematic representation of a wire grid matrix and its associated required control system;

FIGURE 2 is an illustration of an arrangement for addressing the wire of the matrix, in accordance with this invention;

FIGURE 3 illustrates how a plurality of characters may be written employing an arrangement in accordance with this invention;

FIGURE 4 shows a unique arrangement for addressing the wires of a wire grid matrix in accordance with this invention; and

FIGURE 5 is a schematic representation of a wire grid line printer employing addressing techniques in accordance with this invention.

Referring now to FIGURE 1, there is shown a schematic representation of a simplified arrangement for a wire grid matrix. A source of data **10** supplies electrical signals representatives of characters desired to be printed to a character recognition circuit **12**. The recognition signal of the circuit **12** is applied to a wire grid matrix control **14**. This comprises an arrangement whereby voltage is applied to selected ones of the wires of the wire grid matrix **16** which correspond to the dot pattern outline of the recognized character. The voltages are applied between the wires **18** of the wire grid matrix and a back bar **20**. Paper **22**, which passes between the wires **18** and the back bar **20**, receives electrostatic charge deposition from the end of each of the energized wires. Thus the electrostatic dot pattern image is formed and the paper is moved to bring the electrostatic image to a developing station, not shown. The developing of the image is done in accordance with well-known xerographic techniques.

It will be appreciated that the wire grid matrix control arrangement **14**, whereby selected wires have a high voltage applied thereto in accordance with the character which is recognized, is a complex and costly structure. In accordance with this invention, the arrangement is considerably simplified.

A simplified showing of an embodiment of this invention may be seen in FIGURE 2. Assume that the five wires respectively **31**, **32**, **33**, **34** and **35** represent the thirty-five writing wires usually found in a wire grid matrix. Each of the writing wires **31** through **35** is connected through a resistor respectively **31R** through **35R** to ground. Another wire **36** connects to a high voltage source **38**. An insulating mask **40** is used to cover all of the wires **31** through **35**. This mask has openings therein, represented by the dotted rectangles **42**, **44**, **46**. Each one of these openings exposes the wire through the mask. An opening is always provided for the wire **36** which is connected to the high voltage source **38**. The placement of the other openings **42**, **44** as well as the number thereof, are determined by the particular character desired to be printed and the ones of the wire grid matrix wires which must be energized in order to print that particular character. Thus, as seen in FIGURE 2, the wires **31** and **34** are the wires to be energized to print a particular character, which here could be the two dots of a colon.

The portion of the mask **40** which is laid over the wires is then covered with photoconductive material **48** in a manner so that the wires which are exposed through the mask openings, and only those wires, are covered or contacted by the photoconductive material. The value of the resistors respectively **31R** through **35R** is selected to be approximately the geometric mean between the dark and the illuminated resistance of the photoconductor so that their resistance value is low compared to the dark resistance and high relative to the illuminated resistance. A value of 100K ohms is typical. Thus, each resistor forms, with the photoconductive material, a voltage divider which greatly attenuates the voltage at each undesired wire without significantly affecting the voltage at each desired wire.

Now, if light from a light source such as the neon bulb **50**, is allowed to illuminate the photoconductive material, the resistance of the photoconductive material which when unilluminated is high, when illuminated drops to a value such that the wires **31** and **34** are effectively connected to the wire **36** through the now, low resistance path, made up of the illuminated photoconductive material. Thus, the high voltage from the source **38** is now substantially directly applied to the wires **31** and **34** whereby the voltage at the ends of these wires exceeds the threshold required to deposit an electrostatic charge and such charge is deposited.

FIGURE 3 shows an arrangement whereby a plurality of the masks **40** with the covering photoconductive material **48**, are applied adjacent to one another, to the wires **50** which terminate in the wires of the wire grid matrix. Each one of the masks **40** has the holes therein placed so that a different character will be written by the wire grid matrix. High voltage from the source **54** is connected to a high voltage wire **56**. This wire is connected to the wires **52** by means of a low resistance path through the photoconductive material, whenever that material is illuminated by a selected one of the neon bulbs **50**. Only one resistance **52R** is required for each wire **52**. The one of the wires which is selected to be illuminated is determined by a neon bulb control circuit **52**. This can be any simplified wire selection system, since low voltage neons may be used for illumination. If required, in order to prevent illumination by a neon bulb of more than one strip of photoconductive material, separating partitions respectively **58**, **60** may be employed to block the light of a neon bulb from illuminating an adjacent strip of photoconductive material **48**.

FIG. 4 illustrates another physical arrangement of a lamp, wires, masking material and photoconductive material which may lend itself to a simpler and more compact configuration than the one shown in FIGURE 3. Not shown, but required, is a resistor connected between each writing wire and ground. Here, the lamp **60** which is connected to a neon lamp control **62**, is placed between the wires which are on both sides thereof. These wires, represented by reference numerals **64** and **66**, which connect to the wires terminating in wire grid matrix, are placed on both sides of the lamp and in their center, or at one side, whichever is more convenient, there are placed the high voltage wires respectively **68**, **70**. A mask respectively **72**, **74** is required for each set of wires, with openings therein to permit the photoconductive material respectively **76**, **78** to connect the high voltage wires respectively **68**, **70** to those of the sets of wires **64**, **66** which are exposed by the openings in the masks respectively **72**, **74**. The operation of the apparatus shown in FIGURE 4 is the same as that which has been described for FIGURES 2 and 3. The arrangement shown in FIGURE 4 may be used for illuminating the wires from a single wire grid matrix which are split in half and disposed on both sides of the lamp.

FIGURE 5 is a simplified block schematic diagram which illustrates how the embodiment of the invention may be employed to provide a line printer or an arrangement for printing a line of type one character at a time. This requires the provision of a wire grid matrix **82**, **84**, **86**, for each character desired to be printed on a line. A back bar respectively **82***b*, **84***b*, **86***b* is provided for each wire grid matrix. The paper **88** upon which writing is to occur passes between the wire grid matrices and the back bars in a direction into the plane of the drawing.

Data from a source of data **90**, which may be magnetic tape or other information storage media, provides the data signals serially and edited as to line format to a decoder recognition circuit **92**. This data is also applied to a character counter circuit **94**, which advances in count for each character until a line of characters has been printed. Signals indicative of the fact that the character counter should be reset to its initial count position or some other position may be applied to the character counter circuit. The character counter circuit, as it advances sequentially to each count state, may serve to successively ground each one of the back bars **82***b*, **84***b*, **86***b*.

The character decoding circuit **92**, which can be any of the well-known arrangements for energizing a single circuit out of many circuits in accordance with the character code, causes the illumination of an associated one of the neon bulbs in a neon bulb array **94**. The neon bulb array is positioned adjacent to a mask and matrix line assembly **96** which comprises a plurality of the photoconductor-mark-resistor arrangements shown in FIGURE 2 or FIGURE 4 herein. The neon bulb which is illuminated causes the application of voltage to the wires, in the manner previously described, whereby the energized wires in a wire grid matrix are those which will print a dot pattern of the recognized character.

At this time, it should be noted that all of the wires in the wire grid matrices **82**, **84**, **86** are connected in parallel and extend from the mask and matrix line assembly **96**. Accordingly, all of the wires of a matrix required to write a character are excited simultaneously. However, writing or charge deposition will only be done by the matrix having its back bar energized by the character counter circuit **94**.

In operation, as each character from the source of data is recognized by the character decoding circuit, a single one of the bulbs in the neon bulb array is illuminated. This will result in the decoded character being duplicated by the wires selected in all of the wire grid matrices. However, writing thereof will occur only at the location in a line which the character actually occupies, as determined by the character counter circuit **94**. At the end of each line, the paper **88** is advanced so that a new line of characters may be written. As the paper continues to advance it will pass through the conventional development region for development in accordance with well-known xerographic techniques.

There has accordingly been shown and described hereinabove a novel, useful and unique arrangement for selecting and exciting the wires of a wire grid matrix employed for electrostatic writing.

What is claimed is:

1. An improved line printer comprising for each character to be printed in a line a wire matrix, the wires of all of said wire matrices terminating in a writing plane, a separate back bar spaced opposite each one of said wire matrices at said writing plane, a plurality of wires, each of said wires connecting in parallel a correspondingly located wire in all of said wire matrices, for each character to be printed, a plurality of masks of insulating material, each said mask being applied over said plurality of wires at separate locations therealong, each said mask having openings therethrough for exposing those wires which when excited will enable said wire matrices to print a predetermined character, a source of energizing voltage including a high voltage terminal and a ground terminal, a separate resistor connecting each of said plurality of wires to said ground terminal, a lead extending from said high voltage terminal to said plurality of wires, means for applying a layer of photoconductive material over each of said masks to extend through the openings therethrough to the exposed wires and also to said lead, a plurality of lamps, there being one lamp interposed between at least two layers of photoconductive material covering masks, means for energizing a lamp in accordance with a character desired to be printed, and means for connecting the one of said plurality of back bars to said ground terminal which is located opposite a wire matrix at the location at which it is desired to print said character.

2. Apparatus as recited in claim 1 wherein said means for connecting one of said plurality of back bars to said source of energizing potential comprises a cyclic counter having a count output for each back bar, means connecting each said count output to each said back bar, and means for advancing the count of said counter to space it in a count state corresponding to the location of a back bar in a line desired for writing a character.

3. In a wire grid matrix printer of a type adapted to produce an electrostatic image of a dot pattern of a plurality of characters by the selective application of writing voltages to the writing wires of said wire grid matrix, an

improved wire energization system for each character to be written comprising:

a mask made of an insulating material for covering all of the writing wires of said wire grid, said mask having openings therethrough over those writing wires which when energized provide an electrostatic image of a character desired to be printed, and

means for applying an energizing voltage to said uncovered writing wires comprising:

a high voltage lead,

a ground terminal,

a separate resistance means connected between each writing wire and said ground terminal,

a unitary piece of photoconductive material extending from said high voltage lead over said mask and through the openings therein to contact each of said uncovered writing wires,

a light bulb,

said writing wires being positioned on both sides of said light bulb and said photoconductive material being between said light bulb and said writing wires, and

means for illuminating said photoconductive material when it is desired to reduce the resistance value thereof whereby said high voltage lead is simultaneously connected through said illuminated photoconductive material to all of said uncovered writing wires to enable them to write said predetermined character.

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178—30; 250—209; 346—33