Dec. 31, 1968 A. MACOVSKI 3,419,676

LINE SCAN PRINTER

Filed July 20, 1965

Fig. 1

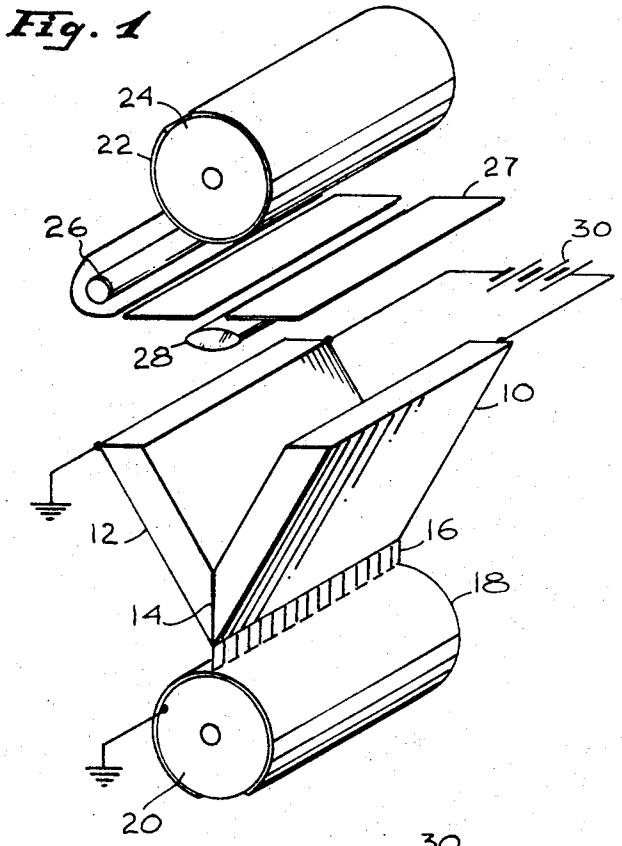
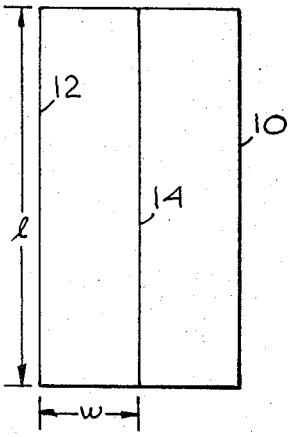


Fig. 2



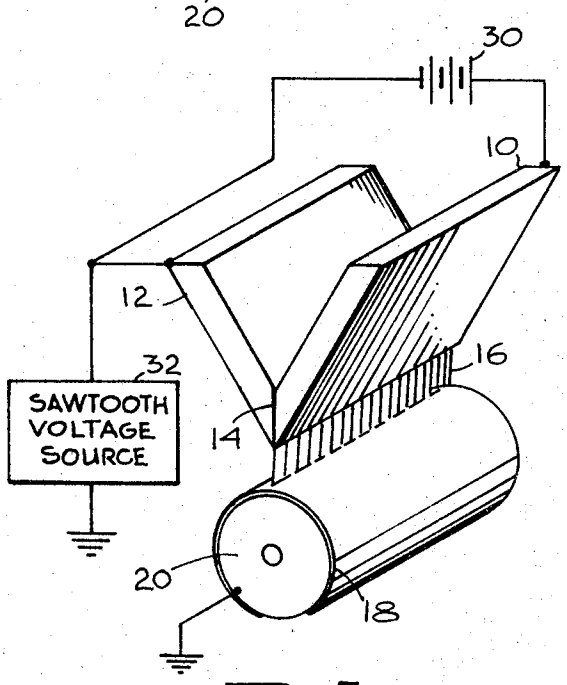
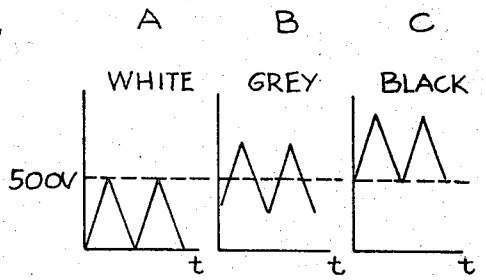


Fig. 3

Fig. 4



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LINE SCAN PRINTER

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ABSTRACT OF THE DISCLOSURE

An electrostatic transducer comprises a strip of photoconductive material having one end abutting one end of a strip of resistive material. A stylus has one end connected to the abutting ends and the other end in contact with paper. A ground plate is on the other side of the paper. A power supply is connected across the other ends of the photoconductive and resistive material. The other end of the photoconductive material is also grounded. When the photoconductive material is fully illuminated no charge is deposited on the paper. As the illumination decreases there is a corresponding increase in charge deposited.

This invention relates to apparatus for converting a lightimage into an electrostatic charge image and more particularly to improvements therein.

An object of this invention is the provision of an improved and novel light-to-electrostatic image transducer.

Yet another object of this invention is the provision of a simple and improved light-to-electrostatic image transducer.

Still another object of this invention is the provision of a light-to-electrostatic image transducer capable of reproducing grey scale image tones.

These and other objects of the invention are achieved in an arrangement wherein the light-to-electrostatic image transducer comprises a strip of photoconductive material which has one end butted against one end of a strip of resistive material. The materials are chosen so as to have substantially similar conductivities at some intermediate value of light, such as that which occurs in grey areas. The contact line of the two materials is placed in contact with a dielectric surface such as that of electrostatic printing paper. A voltage is applied between the non-abutting or other two ends of the two strips of material. The non-abutting end of the photoconductive strip is then grounded. When the photoconductive material is illuminated with light from copy which is to be reproduced, under full white light the photoconductive strip serves to connect the abutting end of the resistor substantially to ground since the photoconductor is at its lowest resistance value when it is totally illuminated. Thus, no charge is deposited on the paper. Under substantially no light conditions, the photoconductor has its highest resistance value and there is a potential existing at the abutting end of the resistor. There will be a charge deposition at this time since the potential applied across the photoconductor is also applied across the electrostatic printing paper. The amount of charge deposited between full illumination and no illumination of the photoconductor is determined by the extent of such ilumination,

since the photoconductor serves as a voltage divider whose value varies in accordance with the amount of light which is caused to be shined thereon. The photoconductive strip may be considered to be in parallel with the electrostatic writing paper and thus the higher the resistance value of the photoconductive strip, the more charge is applied to the electrostatic writing paper.

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 an isometric and schematic drawing of an embodiment of the invention;

FIGURE 2 is a top view of the embodiment of the invention;

FIGURE 3 is a schematic representation of another arrangement of the embodiment of the invention; and

FIGURE 4 are wave shapes shown to assist in an understanding of the operation of the embodiment of the invention shown in FIGURE 3.

Referring now to FIGURE 1, there may be seen an embodiment of the invention in schematic form. The light image to electrostatic image transducer actually comprises a strip of resistive material **10** at one end of which there has been abutted a strip of photoconductive material **12**. The ends which have been abutted form a junction **14**. As may be seen in FIGURE 2, the width w of the photoconductive material **12** is that of a picture element of the material to be copied and the length **1** is that of a line of the material to be copied. In order to obtain a recording which includes grey scale, the properties of the resistor and the photoconductive material are selected so that they have similar conductivities at some intermediate value of light such as that which occurs in the grey areas of the image or copy desired to be reproduced. While a selection of photoconductive materials such as cadmium sulfide and the like have resistivities which are fixed within the limits of full illumination and no illumination, the values of resistor materials can be easily controlled so that when the resistivity of the photoconductive material and the intermediate light value is obtained, it is a simple matter to obtain a strip of resistive material having this value.

While it is possible to deposit electrostatic charges on paper from the tip of one or the other or both of the abutted ends of the resistor and photoconductor, it is preferred to use a plurality of metal writing styli **16** instead. These extend outwardly from the function and are spaced along the junction. There is one stylus **16** for each picture element along a line of copy to be reproduced. The writing styli contacts the material to be written on, such as a sheet of electrostatic writing paper **18**. This may be mounted around the surface of a conductive drum **20**. The drum surface is grounded. One rotation of the drum produces the latent charge image.

Copy **22** which is to be reproduced is similarly mounted on the periphery of a drum **24** which is driven in synchronism with the drum **20**. The surface of the drum which is to be scanned is illuminated by a light source **26**. A mask **27** insures that light from only a line of picture

elements on the copy **22** reaches a lens **28**. The lens **28** focuses the light from the line of picture elements and is focused upon the photoconductive strip **12**.

A source of potential **30** is connected across the non-abutted ends of the photoconductive strip and the resistor strip. The ends of the photoconductive and resistive material to which the potential **30** is connected may have a conductive film deposited thereon. The photoconductive material end is also connected to ground. The value of the potential **30** for this source is selected such that when the photoconductive strip **12** is illuminated with light having an intensity corresponding to full white, the voltage threshold necessary to deposit a charge on the paper is not exceeded. For values of illumination less than full white, the threshold required for charge deposition will thereafter be exceeded.

The arrangement shown in FIGURE 1 is such that the photoconductive strip **12** serves as a voltage divider whose value at each picture element varies with the illumination which is caused to be shined thereon. The photoconductive strip is in parallel with the electrostatic paper from the junction **14** to ground. Accordingly, when it is illuminated with the full illumination strength the junction **14** is substantially connected to ground through the photoconductor and no charge is deposited on the electrostatic paper, since the potential at the writing tip **16** is insufficient for this purpose.

At minimal illumination of the photoconductor **12**, the potential applied across the paper **18** is at optimum and an optimum amount of charge will be deposited thereon. For values of light in between the minimum and maximum illumination of the photoconductive strip **12**, the potential applied across the electrostatic paper **18** and the amount of charge deposited varies directly with the amount of light. Accordingly, the embodiment of the invention show in FIGURE 1 is capable of reproducing grey scale as well as black and white images. The copy **22** is scanned in a single revolution of the drum **24** while the paper **18** has charge deposited upon it by the styli **16**, for each picture element, substantially simultaneously with the scanning. The paper **18** can then be removed and the charge image thereon developed and fixed in accordance with well known xerographic techniques.

FIGURE 3 is a schematic representation of another arrangement of the embodiment of the invention for reproducing grey scale using an "Electronic Screening" operation. Similar functioning apparatus is given the same reference numerals as in FIGURE 1. It is well known that the writing threshold on dielectric paper approximates 500 volts. That is, in order to deposit charge on the paper the voltage applied across the paper should be 500 volts or more. A saw tooth voltage source **32** is connected between the end of the photoconductor formerly connected to ground. The period of the saw tooth is made equal to the time it takes to scan a picture element on the copy. Alternatively expressed, it is the time required for the drum **24** to rotate to replace a line of picture elements being scanned with a successive line of picture elements. The wave forms respectively shown in FIGURES 4A, 4B and 4C correspond to the voltage at the writing stylus **16** under white, grey and black conditions of illumination of the photoconductor **12**.

The voltage at any of the writing styli **16** under a full or white illumination is shown in FIGURE 3A and it never quite reaches the threshold value required for deposition. During grey intervals of illumination of the photoconductor **12** the voltage at any of the writing styli **16** is shown in FIGURE 3B. It is above the threshold half of the time and below the threshold half of the time. When the illumination on the photoconductor corresponds to black, then the voltage at any of the writing styli **16** is always above the threshold value. Thus, the combination of the fixed potential **30** and the saw tooth potential **32** combine to provide a charge deposition on the dielectric

paper which substantially corresponds to the light image which illuminates the photoconductor.

An alternative arrangement to that shown in FIGURE 3 for connecting the saw tooth potential and for achieving the same result is to connect the saw tooth potential between the drum **20** and ground, and to ground the end of the photoconductive material to which the source of potential is connected.

There has accordingly been shown and described herein a novel, useful and unique light-to-electrostatic image transducer.

What is claimed is:

1. In a system of the type wherein light from an image desired to be reproduced is caused to illuminate a light-to-electrostatic image transducer for depositing a charge image corresponding to said light image on dielectric writing material, the improvement in said light-to-electrostatic image transducer comprising a strip of photoconductive material, a strip of resistive material, one end of said photoconductive material abutting one end of said resistive meterial, a source of potential connected between the other ends of said strip of photoconductive material and resistive material, stylus means, and means connecting the junction of said abutted ends of photoconductive and resistive material string to said stylus means.

2. Apparatus as recited in claim **1** wherein the resistance of said resistive material is selected to be substantially equal to the resistance of said strip of photoconductive material when it is illuminated with light corresponding to a predetermined light level between the light extremes of said image.

3. In a system of the type wherein light from an image desired to be reproduced is caused to illuminate a light-to-electrostatic image transducer for depositing a charge image corresponding to said light image on dielectric writing material, the improvement in said light to charge image transducer comprising a strip of photoconductive material, a strip of resistive material, one end of said photoconductive material abutting one end of said resistive material, a source of potential connected between the other ends of said strip of photoconductive material and resistive material, stylus means, a source of saw tooth voltage, and means for applying said saw tooth voltage across said photoconductive strip and said dielectric paper.

4. Apparatus for converting a light image to an electrostatic image comprising a photoconductive strip upon which light representative of picture elements from said image is directed, a resistive strip, one end of said photoconductive strip abutting one end of said resistive strip, stylus means, means connecting said abutting ends to said stylus means, dielectric writing material in contact with said stylus means, a source of potential connected between the two ends of said photoconductive strip and resistive strip which are not abutting one another, a conductive means and means connecting said conductive means to the one end of said photoconductive strip to which said source of potential is connected.

5. Apparatus as recited in claim **4** wherein said resistive strip has it sresistance selected to equal the value of said photoconductive strip when it is illuminated with grey light.

6. Apparatus as recited in claim **4** wherein said photoconductive strip is dimensioned to respond to illumination by a line of picture elements of said light image, and there is included means for illuminating said photoconductive strip with a line of picture elements from said light image.

7. Apparatus for converting a light image to an electrostatic image comprising a photoconductive strip upon which light representative of picture elements of said image is directed, a resistive strip, one end of said photoconductive strip abutting one end of said resistive strip, stylus means, means connecting said abutting ends to said stylus means, dielectric writing material opposite to said stylus means, a source of potential connected between the two ends of said photoconductive strip and resistive

strip which are not abutting one another, a saw tooth voltage source, means connecting said saw tooth voltage source between said one end of said photoconductive strip and said conductive means, said saw tooth voltage source having the amplitude thereof determined as the value of voltage required to equal the threshold required for charge deposition on said dielectric medium.

8. Apparatus as recited in claim 7 wherein said photoconductive strip is dimensioned to respond to illumination by a line of picture elements of said light image, and there is included means for illuminanting said photoconductive strip with a line of picture elements from said light image.

9. Apparatus as recited in claim 7 wherein the frequency of said saw tooth voltage is equal to the interval required to scan the picture element of said light image.

References Cited

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