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ELECTROSTATIC REPRODUCTION APPARATUS WITH PHOTOCONDUCTIVE MEANS TO CONTROL THE APPLIED VOLTAGE AT THE COPY SHEET SURFACE

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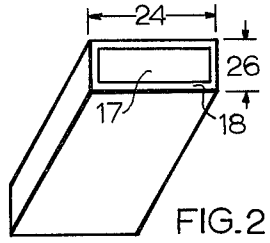


FIG. 2

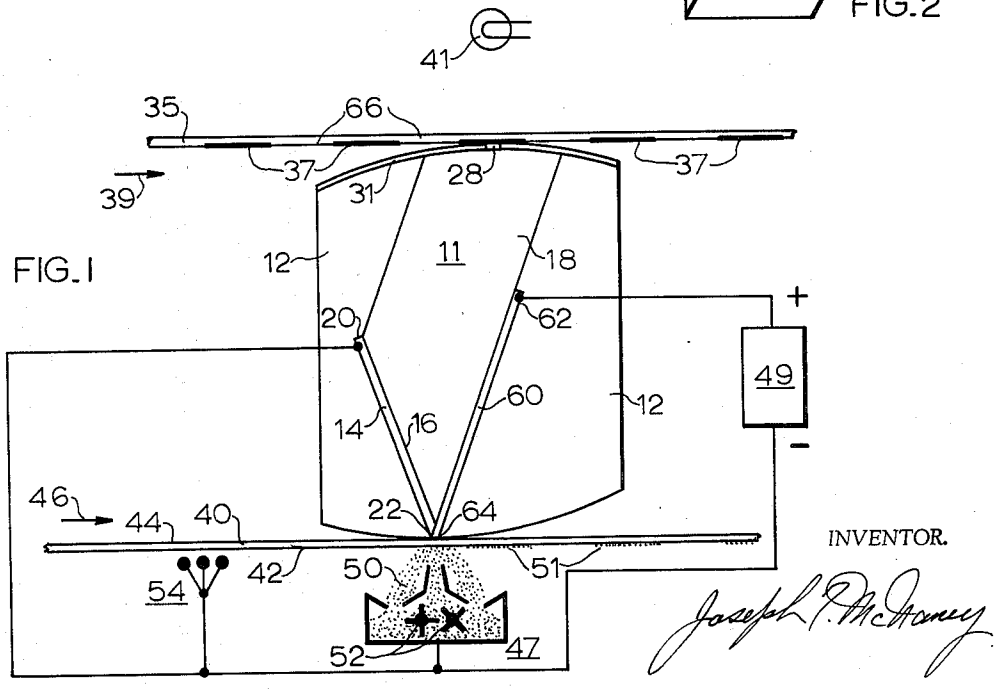


FIG. 1

INVENTOR.

Joseph T. McNaney

United States Patent Office

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ELECTROSTATIC REPRODUCTION APPARATUS WITH PHOTOCONDUCTIVE MEANS TO CONTROL THE APPLIED VOLTAGE AT THE COPY SHEET SURFACE

Joseph T. McNaney, 8548 Boulder Drive, La Mesa, Calif.

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This invention relates to a copy duplicating machine designed to print information on a sheet of copy material under the control of printed information appearing on an original copy.

The invention relates more particularly to an improvement in copy duplicating machines involving the use of radiation-to-electron converter means wherein a printing material, such as carbon, lampblack, or like materials, is made to attach itself to the copy material as a function of the opaque print areas on the original and simultaneously with the detection of these areas by the converter means.

In the invention the opaque print areas appearing on the original prevents the passage of radiation to a layer of radiation sensitive material to provide the generation of electrostatic flux necessary to effect the attachment of the printing material to the copy material.

It is an object of this invention to provide an improved copy duplicating machine capable of rendering extremely sharp copies of originals.

It is another object of this invention to provide a copy duplicating machine which is extremely simple, compact, positive in operation, and trouble-free in continued use.

It is still another object of this invention to provide a more effective means of creating an electrostatic latent image while simultaneously effecting a visual development thereof.

A further object of this invention is to utilize the flux being generated by the radiation-to-electron converter means to do both the creating of an electrostatic latent image on the copy material and the attraction of printing material thereto.

Other objects and advantages will appear hereinafter as a description of the invention proceeds.

The novel features that are considered characteristic of this improvement in copy duplicating machines 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, will best be understood from the following description when read in combination with the accompanying drawing in which:

FIGURE 1 is a diagrammatic illustration of an embodiment of the invention which will be designed to be sensitive to radiant energy involving the visible spectrum; and

FIGURE 2 shows a detail of a jacketed light conductor being utilized in the invention.

Referring now to FIGURE 1, and also to FIGURE 2 to the extent that it is a part of the invention, a radiation-to-electron converter means **11** is shown as being supported in a bonding material **12**. The converter means **11** includes a light conductor means **17**, which can be in the form of an optical fiber **17** shown in FIGURE 2, jacketed by a light reflector means **18**, and a layer **14** of photoconductor material intimately joined with a second end **16** surface of the converter means **11**. The layer **14** has a first terminal **20** and a second terminal **22**. The

material of layer **14** will be selected from a number of well known solids, such as lead selenide, lead sulfide, zinc sulfide, cadmium sulphide, selenium, germanium, silicon, or combinations of such materials, either in their pure state or in a modified state. The light conductor means **17** will take the form of an optical fiber **17** having an index of refraction of a predetermined amount and jacketed with a light conducting material **18** having an index of refraction less than the predetermined index of the fiber **17**. The fiber **17** will be of a flint glass and jacketed in a crown glass. To meet the requirements of the invention the fiber **17** and the jacket **18** may, of course, be selected from any other suitable materials.

In the process of fabricating such an assembly of materials, the fiber **17** and the jacket **18** are drawn together in order to provide an extremely important fire-polished, contamination-free, interface between the two different materials at and along the juncture. The jacket **18** and its relation to the fiber **17** permits the jacket to function as an extremely efficient radiant energy reflector in the system of conducting such energy upon entering an aperture **28** in a light mask **31** adjacent the one end of the converter **11** to the other end **16**. The fiber **17** and the jacket **18** assembly, as illustrated in FIGURE 2, may have a cross sectional dimension whereby the length **24** will be greater than the width **26**. The length **24** may be, for example, 0.010" and the width **26** may be as small as 0.001". The small width dimension **26** is important to the invention in that it will permit relatively large numbers of the converter means **11** to be placed and supported side-by-side in a very small space. The length **24** will be utilized in supporting the layer **14** of photoconductor material adjacent the second end of the converter means **11**.

It is an object of the invention to support from 500 to 1,000 converter means **11** to the inch, extending from one side of the sheet of copy material to the other. This capability, of course, insofar as the data duplicating resolution requirements is concerned will be a contributing factor. From the standpoint of achieving good data duplicating resolution, the relatively large length dimension **24** of the converter means **11** will be effectively reduced by means of a radiation limiting aperture **28** of a radiation mask **30** adjacent the first end **32** surface of the converter means **10**. The width of the aperture **28** will be as small as 0.001", extending from one end of the array of converter means **10** to the other.

A source **41** of light will be directed onto the surface of an original copy **35**, having areas thereon to represent opaque print areas **37**. The original **35** will be adjacent an aperture **28** of a light mask **31**, and movable in the direction of the arrow **39**. The opaque print areas **37** on the original **35** will prevent the passage of light from the source **41** to the layer **14** of photoconductor material. A sheet of copy material **40**, having a first surface **42** and a second surface **44**, is supported adjacent the second terminal **22** of the layer **14**. The sheet **40** is movable in the direction of the arrow **46**. A source of printing material **50** is positioned adjacent the first surface **42** of the sheet **40**, whereby the printing material **50** will be extended upward and applied to the first surface **42**, by a material **50** circulating means **52**.

In order to provide a copy of the opaque areas **37** in the form of opaque areas **51** on the sheet **40**, a prevention of the passage of radiation through the aperture **28** by the opaque areas **37** will result in the generation of a positive voltage flux from the converter means **11**. The

latter, therefore, is provided with an additional element **60**, having a first terminal **62** and a second terminal **64**, and the second terminal being operatively connected to the second terminal **22** of the layer **14**. The element **60** is an electrical conductor means **60**, presenting a predetermined electrical resistance between the first terminal **62** and the second terminal **64**.

An electrostatic flux generator means **54** is positioned adjacent the first surface **42** of the sheet **40** for the purpose of establishing thereon a uniform electrostatic charge, and upon which the sheet **40** will be moved to the position whereby it will be adjacent the second terminal **64** of the element **60**. The first terminal of the element **60** is connected to the positive polarity of a source **49** of voltage. The first terminal **20** of the layer **14**, the flux generator **54**, and the source **47** of printing material **50** is connected to the negative polarity of the voltage source **49**.

When in operation, the flux generator **54** will subject the surface **42** of the sheet **40** to a negatively charged condition whereby a negatively charged printing material **50** will be unable to attach itself to the surface **42** of the sheet **40** when applied thereto. When light from the source **41** is prevented passage to the converter means **11** through the aperture **28** by means of the opaque areas **37** on the original **35**, the influence of the voltage on the first terminal **62**, which is capable of being extended to the second terminal **64**, will allow an electrostatic flux to be generated from the second terminal **64** of the element **60**. However, when light enters the aperture **28** through transparent areas **66** of the original **35**, the light is conducted through the fiber **17** and reflected to the layer **14** by the jacket **18** of the converter means **11**, allowing the negative potential on the first terminal **20** to be extended to the second terminal thereof and to the second terminal **64** of the element **60**. The photoconductor layer **14** performs the function of a switch means in connecting the second terminal **64** to the negative polarity of the voltage source **49**.

The converter means **11** utilizes a plurality of elements **60**, or, one element **60** for each light conductor fiber **17** in the array, allowing each element **60** to have an area dimension of 0.001″ square at its second terminal **64** which is in contact with the second surface **44** of the sheet **40**. The sheet **40** need not be of a thickness any greater than 0.002″, allowing the printing material **50** to be not much more than this thickness dimension away from the terminal **64**.

The object of the flux generated from the second terminal **64** of the element **60**, in the direction of the negatively charged printing material **50**, is to hold a predetermined amount of this material in a position adjacent the sheet **40** so that such printing material can attach itself thereto. In the process, the negatively charged surface **42** within a limited area will be sufficiently neutralized so that the printing material **50** may attach itself to the sheet **40**. The sufficiently neutralized condition of the surface **42** to which I refer would, by itself, not be strong enough to attract and hold in position the predetermined amount of printing material so that this material can attach itself to the surface **42**. Without the aid of the flux from the terminal **64** the desired printing effects would not be achieved. The surface **42** could, of course, be made sufficiently positive to attract and hold in position the printing material for printing purposes, but this method presents problems which the present invention is designed to overcome. For example, under a set of conditions whereby the charge on the surface **42** is first made positive and then exposed to and permitted to receive printing material **50**, the positive potential charge on the surface **42** would be required to generate a flux of the strength necessary to attract and hold in position the predetermined amount of printing material **50** so that this material can attach itself to the copy material. The flux being generated from the terminal **64** for the purpose of establishing such a positive charge would be required to be many times greater than that which is needed in light of the present invention. Such flux requirements would also result in a much greater divergement of the flux, extending well beyond the 0.001″ square terminal **64** area of the layer **60**. This effect would, of course, defeat the object and advantage of the present invention in providing sharp copies of an original copy of information. Therefore, the concept of this invention, which includes the utilization of the flux being generated by the terminal **64** to simultaneously neutralize the charge on the surface **42** and effect the attachment of printing material to the surface **42**, embodies the advantages hereinbefore set forth.

It should, of course, be understood that many of the other embodiments embracing the general principles and constructions hereinbefore set forth may be utilized and still be within the ambit of the present invention.

The embodiment, as illustrated in FIGURE 1 for example, is not to be limited to the passage of light from the source **41** through the transparent areas **66** of the original **35**, since it will be apparent to those skilled in the arts that the source of light **41** can be directed at the opposite surface of the original and a reflection of the light can be used to derive a copy therefrom. The opaque areas **37** will not reflect light through the aperture **28** and, therefore, the concept of printing hereinbefore set forth will remain the same.

The particular embodiments of the invention illustrated and described herein are illustrative only, and the invention includes such other modifications and equivalents as may readily appear to those skilled in the arts and within the scope of the appended claims.

I claim:

1. In a duplicating machine designed to print information on a sheet of copy material under the control of printed information appearing on an original including

(a) a layer of photoconductor material having first and second terminals;

(b) light conductor means having a predetermined index of refraction for supporting said layer and conducting light to said layer;

(c) light reflector means jacketing said light conductor means having an index of refraction less than said predetermined index for controlling the reflection of light through said light conductor means and reflection of light to said layer;

(d) said copy material having first and second surfaces and said second surface being adjacent the second terminal of said layer and movable in relation thereto;

(e) said original being adapted to control the admittance of light to said light conductor means as a function of the printed information thereon and the position of said printed information in relation to said light conductor means;

the improvement comprising

(f) a source of printing material and means for bringing said printing material in contact with the first surface of said copy material directly opposite the second terminal of said layer;

(g) means for uniformly electrostatically charging the first surface of said copy material to preclude the attachment of said printing material to said first surface;

(h) electrical conductor means having first and second terminals and a predetermined electrical resistance therebetween, and said second terminal thereof being operatively connected to the second terminal of said layer and adjacent the second surface of said copy material;

(i) means for presenting the influence of an electrical potential between said second terminal of the elec-

trical conductor means and the printing material for allowing the attachment of said printing material to the first surface of said copy material; and

(j) means for extending a potential neutralizing influence from the first terminal of said layer to said second terminal of the electrical conductor means upon the reflection of light to said layer to thereby prevent the attachment of printing material to said first surface of said copy material.

2. The invention as set forth in claim **1** wherein the improvement additionally includes

(k) said influence of electrical potential being presented as a function of printed information on said original immediately adjacent said light conductor means and preventing the admittance of light to said light conductor means.

3. The invention as set forth in claim **1** wherein the improvement additionally includes

(k) said layer being adapted to receive reflection of light as a function of light received from said original for controlling the generation of an electrostatic flux counter to the printer material repelling charge on the first surface of said copy material.

4. The invention as set forth forth in claim **1** wherein the improvement additionally includes

(k) said light conductor means having an end and aperture means adjacent thereto; and

(l) said attachment of printing material to said first surface of the copy material occurring simultaneously with the positioning of the printed information on said original adjacent said aperture means and the preventing of the admittance of light to said light conductor means.

5. Means for utilization in a duplicating machine designed to print information on a copy sheet under the control of information appearing on an original sheet comprising:

(a) a source of light and means for exposing said original sheet to light therefrom;

(b) said copy sheet presenting first and second surfaces;

(c) a source of voltage having first and second terminals;

(d) a first electrode means adjacent said first surface and connected electrically with said first terminal;

(e) said first electrode means including a source of printing material;

(f) a second electrode means adjacent said second surface directly opposite said first electrode means;

(g) said second electrode means including a layer of photoconductor material having first and second terminals, and an electrical conductor having first and second terminals and a predetermined electrical resistance therebetween, the second terminal of said layer being connected electrically with said conductor adjacent the second terminal thereof;

(h) the first terminal of said layer being connected electrically with the first terminal of said source of voltage, and the first terminal of said conductor being connected electrically with the second terminal of said source of voltage;

(i) optical fiber means for supporting said layer and for controlling the reflection of light to said layer upon the admittance of light thereto from said original sheet;

(j) said voltage being extended through said second electrode means to said second surface, in the absence of said reflection of light to said layer, and through said first electrode means to said first surface for allowing the attachment of said printing material to the first surface of said copy material; and

(k) means for extending a voltage neutralizing influence from the first terminal of said layer to the second terminal of said electrical conductor upon the reflection of light to said layer to thereby prevent the attachment of printing material to said first surface of said copy material.

6. Means for utilization in a duplicating machine designed to print information on a copy sheet under the control of information appearing on an original sheet comprising:

(a) a source of light and means for exposing said original sheet to light therefrom;

(b) said copy sheet presenting first and second surfaces;

(c) a source of voltage having first and second terminals;

(d) first electrode means, including a source of printing material, adjacent said first surface and connected electrically with said first terminal;

(e) second electrode means adjacent said second surface directly opposite said printing material including an electrical conductor having first and second terminals and a predetermined electrical resistance therebetween, and the first terminal thereof being connected electrically with the second terminal of said source of voltage;

(f) a layer of photoconductor material having first and second terminals, the second terminal of said material being connected electrically with said electrical conductor adjacent the second terminal thereof;

(g) means for presenting the influence of said voltage across said copy sheet between said first electrode means and the second terminal of said electrical conductor for allowing the attachment of said printing material to the first surface of said copy material;

(h) optical fiber means for supporting said photoconductor material and for controlling the reflection of light thereto from said original sheet; and

(i) means for extending a voltage neutralizing influence from the first terminal of said layer to said second terminal of the electrical conductor upon the reflection of light to said layer to thereby prevent the attachment of printing material to said first surface.

7. Means for utilization in a duplicating machine designed to print information on a copy sheet under the control of information appearing on an original sheet comprising:

(a) a source of light and means for exposing said original sheet to light therefrom;

(b) said copy sheet presenting first and second surfaces;

(c) a source of voltage having first and second terminals;

(d) first electrode means, including a source of printing material, adjacent said first surface and connected electrically with said first terminal;

(e) second electrode means adjacent said second surface directly opposite said printing material having first and second terminals and a predetermined electrical resistance therebetween, and the first terminal thereof being connected electrically with the second terminal of said source of voltage;

(f) a photoconductor having first and second terminals, the second terminal of said photoconductor being connected electrically with the second terminal of said second electrode means;

(g) means for presenting the influence of said voltage across said copy sheet between said printing material and the second terminal of said second electrode means for allowing the attachment of said printing material to the first surface of said copy material;

(h) means for electrically coupling the first terminal of said photoconductor to said source of printing material and the first terminal of said voltage; and

(i) means for extending the voltage from said first voltage terminal to the second terminal of said

photoconductor upon the reflection of light thereto, thereby decreasing the influence of said voltage across said copy sheet and to prevent the attachment of printing material to said first surface of said copy sheet.

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RALPH G. NILSON, *Primary Examiner.*