Nov. 27, 1962 J. T. McNANEY 3,066,298

ELECTROSTATIC RECORDING

Filed June 2, 1958

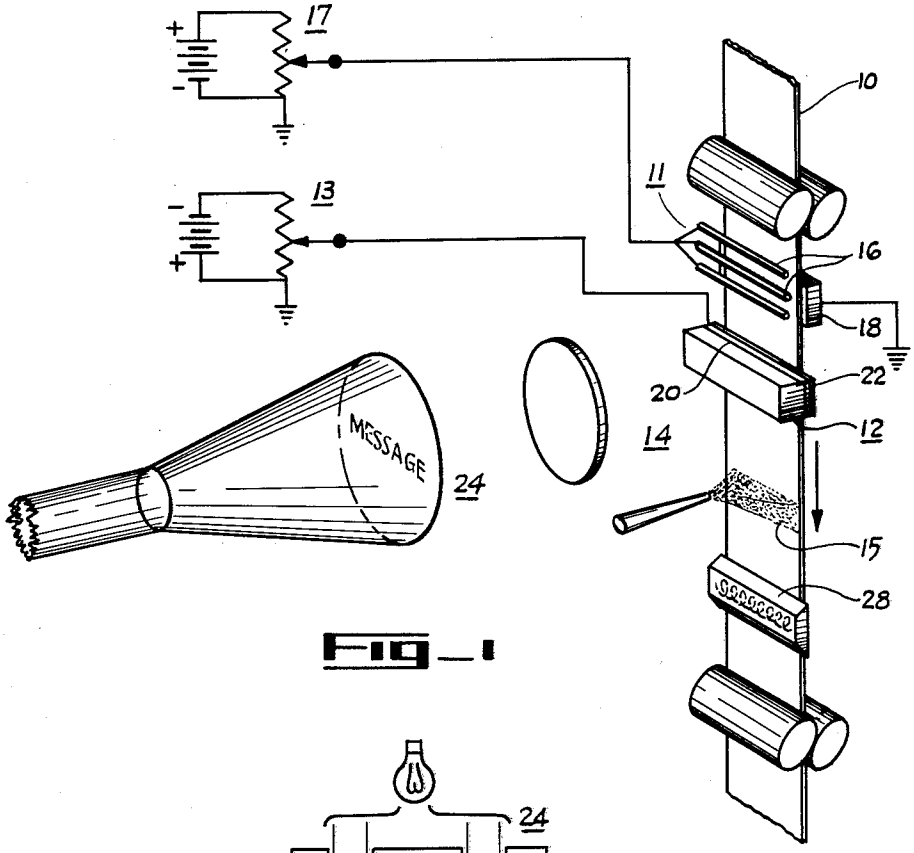


Fig. 1

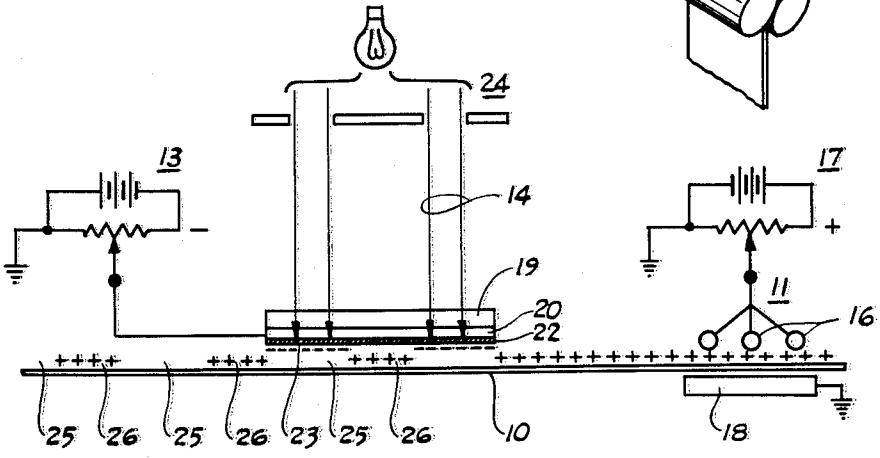


Fig. 2

INVENTOR.
JOSEPH T. McNANEY.

BY

Egon W. Mueller

ATTORNEY.

United States Patent Office 3,066,298 Patented Nov. 27, 1962

3,066,298
ELECTROSTATIC RECORDING

Joseph T. McNaney, La Mesa, Calif., assignor to General Dynamics Corporation, Rochester, N.Y., a corporation of Delaware

Filed June 2, 1958, Ser. No. 739,034
7 Claims. (Cl. 346—74)

The invention relates generally to recordation of information utilizing electrical charge patterns. A development in this field closely allied to the instant invention has been designated as electrophotography or xerography.

In the normal practice of xerography, an electrostatic charge is applied to a free surface of a photoconductive insulating layer. The photoconductive insulating layer has its other surface backed by a transparent conductor layer. Illumination of select portions of the photoconductive insulating layer will cause the illuminated portions to become conductive, thereby causing the charge disposed upon the free surface of the photoconductive layer to be conducted therefrom to the conductor layer. In this manner, a pattern of light and shadow may be recorded on the free surface of the photoconductive layer as areas of differing electric charge conditons. In the usual practice of xerography, electrostatically attractable material is then dusted against the free surface of the photoconductive layer, so that the electrostatically attractable material, depending upon its charge, will adhere only to one of the two charged conditions upon the free surface of the photoconductive layer. The electrostatically attractable material then presents a visual image of the light and shadow charge pattern presented on the free surface of that photoconductive layer. The electrostatically attractable material may then be transferred either to an insulating layer for transfer to a final record medium, or, directly transferred from the surface of the photoconductive layer to the final record medium. The material may thereafter be fused into the record medium by application of heat thereto, and glazed if preferred, in order to insure the permanent nature of the recordation.

One of the requirements in utilizing xerography as now known, is the establishment of potential fields giving rise to appropriate current paths throughout the entire xerographic operation. That is, the sources of potential are applied across air gaps, slightly conductive insulators and the like, all to aid in transferring charges by conduction between the record medium, the photoconductive layer or the insulating layer. All are under the influence of the source of potential and minute currents therefore flow across the air gap in between the two adjacent members. The establishment of such fields, the use of currents tend to limit the life of the various components in the practice of xerography. Further, in such practice, rather high voltages using small currents, require expensive, well regulated power supplies. In order to remedy some of the aforestated difficulties and to simplify materially the recording of information upon a record medium, the instant invention has been evolved.

The present invention utilizes a record medium capable of holding, for a short duration of time at least, an electric charge pattern. The record medium may be charged in various known ways, for example by the application of corona charge applied to the surface of the record medium. Such charge application is usually effected by very minute currents under the influence of rather high potential sources. The charge, in effect, migrates from the elements on which it is created presenting corona discharge to the record medium. The record medium, charged in this manner, may then be placed in spaced apart relation, but in close physical proximty to a conversion unit or converter means capable of transforming light images into electric potential charge patterns. The

electric potential charge patterns or disposition so established should be such that it is capable of altering the charge upon the record medium. The electric potential charge disposition is exemplified as being of a polarity opposed to the polarity of the charge carried on the record medium. The converter means may be exemplified as a unit including a photoconductor whose free surface is adjacent the record medium and in spaced apart relation therewith. The other surface of the photoconductor is overcoated with an optically transparent conductive layer. A source of potential, variable, if desired, may then be applied to the conductive layer, which source may have a voltage at a polarity opposed to, or capable of neutralizing, reorienting or attracting the charge existing upon the record medium. It is essential to the instant invention that the charge pattern upon the record medium be changed or altered by electrical potential influence or direct charge transfer, thus recording the information.

Subsequent light irradiation of the photoconductor will cause the irradiated portions of the photoconductor to become conductive thereby presenting the voltage adjacent the record medium to alter the electrical conditions thereon in conformity with the irradiated pattern upon the photoconductor. The exacting description of the electrical alteration of the charge on the record medium is not perfectly understood. The voltage may be directly applied to transfer the charge by conduction from the record medium in the irradiated areas, or indirectly by its influence in spaced apart relation, alter the charge pattern upon the medium. All un-irradiated areas of the photoconductor will appear on the record medium as still charged with the original charge disposed thereupon by the corona charging. The record medium therefore presents the electric charge pattern record of the light information.

If desired, through the practice then of well known techniques of xerography, electrostatically attractable material of opposite polarity to that of the charge pattern, may then be utilized to effect a positive visual indication of the electrostatic record upon the record medium.

As the present invention alters, neutralizes or dissipates the charge upon the record medium in correspondence to the light information to be recorded thereupon, and the photoconductor does not have upon its surface any electrostatically attractable material, it can readily be seen that the life span of the photoconductor has been immeasurably increased. Further, the normal problems of charge migration are mitigated over those normally present when the photoconductor physically transfers the visual pattern in direct contact with the record medium. As the instant invention merely alters, neutralizes or dissipates the charge electrostatically, it can further be seen that the source of potential utilized with the photoconductor need not be an exacting highly regulated source, nor need it have any current delivery capability; it being merely desired to present the voltage sufficient intensity to alter, attract or neutralize the charge appearing on the record medium, or the direct neutralizing of the charge, no current transfer being effected through the record medium. The instant invention therefore creates its latent images not by embodying latent charge images upon the record medium, but rather by changing or discharging discrete areas of a normally charged record medium.

In addition to objects and advantages aforestated, it is an object of the present invention to provide a simple and inexpensive method and apparatus for recording light information upon inexpensive record medium.

It is another object of the present invention to provide an apparatus and method for recording information as electric charge patterns upon a record medium which is of simple operation and trouble-free design.

It is another object of the present invention to effect

electrostatic recordation upon a record medium of light information in a manner and through the utilization of apparatus so as to minimize both the current regulation, as well as, the current carrying capacity of sources of potential.

It is another object of the present invention to provide an apparatus and method for effecting electrostatic recordation of information upon a record medium utilizing a photoconductive member to transform the light into selectively charged areas wherein the photoconductive member will either not come in contact with or have only point contact with the record medium and thereby prolonging its useful life.

Objects and advantages other than those set forth above will become apparent when read in connection with the accompanying specification and drawings, in which:

FIGURE 1 is a schematic perspective representation embodying a method and apparatus incorporating for practice the invention;

FIGURE 2 is a schematic representation of the invention of FIGURE 1 demonstrating its operation.

In brief, the invention shown in FIGURE 1 basically includes recordation in electric charge pattern form of light information upon a record medium **10**. The charge pattern may subsequently be developed into visual images. The record medium should be capable of accepting and holding, for a short duration of time, an electrostatic charge. The charge may be applied by a corona charging unit **11** including a high voltage source (very low current) and several wires from which corona is generated. The record medium is preferably uniformly charged upon its surface and so is presented to an assembly **12** under the influence of a source of potential **13** and light irradiation **14**, the total assembly or converter means being capable of converting the light ray information into electric potential charge patterns to effect electrical influencing of the charges carried by the record medium. The electric potential charge arranged in patterns determined by the light irradiation will, when placed into electrical contact with the charge on the surface of the record medium, or in close spaced apart physical proximity thereto, alter, dissipate or neutralize the charge on the record medium in accordance with the areas of irradiation of the assembly **12**. The charges, as changed on the record medium **10**, may thereafter be transferred from the record medium onto another record medium, or, as herein exemplified, may then be developed directly on the record medium through the use of electrostatically attractable material **15** such as practiced in the prior art in xerography. Subsequently, heat may be used to fuse the material **15** into the record medium to provide a permanent record.

In greater detail, and to further explain the invention, FIGURE 1 shows the record medium **10** traveling between several pairs of rollers and first presenting an area on the medium to the conductors **16** of the corona charging unit **11**. The conductors or wires **16** may be energized by high voltage source **17** to a point at which charges are emitted in as corona from the wires, some of which are deposited upon the record medium, thus, completing the low current path through a conductive backing **18** to ground. It should be understood that the present corona schematics, as exemplified in FIGURES 1 and 2 is not intended to so limit the invention. There are other known ways of effecting electrostatic charge disposition upon material capable of holding charges, such as spraying the surface with positive or negative ions or the like. It is merely desired herein to exemplify one way of charging the record medium.

The record medium **10** may be any well known paper, and, need not necessarily be a special paper. Ordinary paper, glazed or unglazed, will accept charges and retain them for a short duration of time. The short period of time may be measured in seconds. Usually, this time depends upon the transport of the record medium from charging to charge alteration or recording information and to development. Of course, longer duration storage of information as charges is also contemplated. Transport mechanisms exist which are capable of transporting the medium from one station to another and completing the entire cycle from initial charging through recordation and development in about 2 to 8 seconds. Of course, if longer time duration is desired between various transport stages, the record medium must be capable of holding its charge pattern for such a desired longer period.

After a charge has been disposed upon the record medium under the influence of conductors **16**, the record medium **10** may be transported to a station opposing the light-to-electron converter or converter means and namely, assembly **12**. Assembly **12** may effect conversion of light-to-electric charge potential and by its placement present such charge to influence the charge on the record medium. Assembly **12** may include a glass member **19** and a conductive layer **20** disposed thereon. The glass member **19** merely carries the other components of assembly **12**. The conductive layer **20**, preferably, is light transparent as well as of low electrical resistance. Conductive glass known by the trademark "NESA" is satisfactory. Disposed upon the conductive layer **20** is a photoconductive layer **22**. The free surface **23** of the photoconductive layer **22** is preferably positioned adjacent and in actual contact with or spaced apart a slight distance from the record medium **10**. If spaced apart, the spacing intermediate surface **23** and medium **10** is such that the potential charge on surface **23** will permit reorientation of the charges on the record medium **10** to either alter, neutralize or dissipate such last stated charges. Connected to the conductive layer **20** is the source of potential **13** capable of presenting a predetermined voltage which may be varied. The predetermined voltage is exemplified as establishing upon the conductive layer **20** an electric potential charge disposition of polarity opposed to the predetermined polarity of the charge substantially uniformly disposed upon the record medium **10**.

Information presented from a source **24** in the form of light rays **14**, as light and shadow, causes irradiation of corresponding patterns appropriate upon the photoconductive layer **22** through the glass backing **19** and the transparent conductor **20**. Such illumination will cause the photoconductor to become conductive in the irradiated areas and thereby presenting at the outer surface **23** the electric potential charges established by the source of potential **13** and shown in the exemplification of FIGURE 2 as negative. Charges on the record medium are exemplified as positive. The presentation of the information as negative charges in close proximity to the positive charges on the record medium causes an electrical influence or reorientation of the charges on the record medium. In the case of the practice of the invention using actual contact, the positive charges are conducted away from the record medium or dissipated. But when the invention utilizes spacing apart of the surface **23** and the record medium **10**, it is believed that electrostatic or electrical influence exists between the charges of different signs (basically different degrees of potential) cause the reorientation of charges upon the record medium. The irradiated areas having presented the potential charge imposed upon conductor **20** have neutralized, attracted, altered or dissipated the opposite polarity charge on the record medium. It is believed that the electrical influence may be stated to be electrostatic charge influence. Therefore, the pattern of light and shadow as presented by light rays **14** appears on record medium **10**, exemplary, as areas **25** devoid of charges, alternate areas **26** retaining the original charges upon the record medium, thus, presenting the light and shadow pattern recorded.

Subsequent transport of the record medium **10** from the position adjacent the converter means **12** permit development of the charged and uncharged areas **25**, **26**

through the utilization of electrostatically attractable material 15 into visual patterns of light and shadow. Such development may, of course, be accomplished in any of the well known prior art teachings as for example, in the xerography prior art illustrated by U.S. Patents 2,659,670, 2,701,765, and 2,705,199. The visual pattern may then, of course, be subsequently fused into the record medium by application of heat from a heater unit 28. The record medium may, after such fusing, be overcoated with glazes of various types to further aid in preserving as the permanent record of the information originally presented in the form of light and shadow.

The method and apparatus herein described and illustrated by the embodiment may be variously changed and modified by those skilled in the art, or, features thereof, singly or collectively, may be embodied in other combinations than those illustrated, all without departing from the spirit of the invention or sacrificing any or all of the advantages thereof. The disclosure herein is illustrative and exemplary only and the invention is not limited thereto, being limited only by the appended claims.

I claim:

1. A printer comprising a record medium capable of accepting and retaining charges upon a given surface, means for placing a uniform electrostatic charge upon said surface, a source of information, converter means located solely on said given surface side of said record medium for selectively creating a charge pattern upon a surface of said converter in accordance with information supplied thereto, said converter means being located with said surface in spaced relationship with respect to said given surface of said record medium, said charge pattern and said uniform charge being of magnitudes and polarities to selectively create an electric field of greater than a predetermined intensity, said predetermined intensity being the intensity above which charge transfer takes place between said converter surface and said record medium solely due to said electric field, whereby said uniform charge is selectively discharged in accordance with said charge pattern and means for supplying information from said source to said selective charging means.

2. The combination of claim 1 in which said selective charging means includes a source of potential, and means responsive to the information supplied thereto for selectively connecting said source of potential to said surface in accordance with the information supplied thereto, said source of potential being of a magnitude to provide a charge pattern of magnitude sufficient to create an electric field in excess of said predetermined intensity in cooperation with the charge provided by said uniform charging means, whereby a charge pattern representative of said information is created upon said surface.

3. The combination of claim 2 in which said source of information includes a light source and said selective connecting means includes a photoconductive layer, a transparent conductive layer connected to said source of potential said conductive layer being interposed between said source of light information and said photoconductive layer and in contact with one surface of said photoconductive layer, the opposed surface of said photoconductive layer forming said surface of said selective charging means.

4. The combination of claim 3 further including means for transporting said record medium with respect to said uniform charging means and said selective charging means so as to present a uniformly charged record medium to said selective charging means.

5. Means for recording light information electrostatically upon a record medium comprising a record medium having electric charges uniformly disposed upon one of its surfaces, said charges being of a predetermined polarity, a photoconductive layer disposed adjacent but spaced apart from said record medium, a conductive transparent layer carrying said photoconductive layer, a source of potential, said source of potential being connected with said conductive layer and establishing thereon an electric potential charge disposition of a polarity opposing said predetermined polarity, and means for selectively irradiating said photoconductive layer so as to present a charge pattern of said polarity in electric charge influencing relation to the charge disposition of said predetermined polarity, said source of potential and said uniform charges upon said record medium being of magnitudes sufficient to cooperate and create an electric field of greater than a predetermined intensity, said predetermined intensity being the intensity above which charge transfer takes place between said photoconductive layer and said record medium solely due to said electric field.

6. Means for recording light information electrostatically upon a record medium comprising said record medium having uniform electric charges disposed upon one of its surfaces, said charges being of a predetermined polarity, a photoconductive layer disposed adjacent but spaced apart from said record medium, a conductive transparent layer carrying said photoconductive layer, a source of potential, said source of potential being connected with said conductive layer and establishing thereon an electric potential charge disposition of a polarity opposing said charges of predetermined polarity upon said record medium, means for selectively irradiating said photoconductive layer so as to present a charge pattern of said opposing polarity in electric charge influencing relation to the charge disposition of said predetermined polarity said source of potential and said uniform charges upon said record medium being of magnitudes sufficient to cooperate and create an electric field of greater than a predetermined intensity, said predetermined intensity being the intensity above which charge transfer takes place between said photoconductive layer and said record medium solely due to said electric field.

7. Means for recording light information electrostatically upon a record medium comprising a record medium having electric charges uniformly disposed on one of its surfaces, said charges being of a predetermined polarity with respect to a reference potential; a source of potential presenting a predetermined voltage opposite in polarity to said polarity; converter means for changing light information into corresponding electrical charge patterns upon a surface thereof, said converter means including means for selectively connecting said source of potential to predetermined areas of said surface to provide a charge pattern in said predetermined areas of said opposing polarity in response to the selective irradiation of said converter means, means for selectively irradiating said converter means, said converter means being positioned with respect to said record medium so that said opposing charge pattern upon said surface is in electric charge influencing relation to the uniform charge disposition of said predetermined polarity on the record medium, the magnitude of the charge on said record medium and the magnitude of said charge patterns being sufficient to create an electric field of greater than a predetermined intensity, said predetermined intensity being the intensity above which charge transfer takes place between said converter surface and said record medium solely due to said electric field, to thereby create a charge pattern upon said record medium corresponding to said charge pattern upon said converter means surface.

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