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ELECTRICAL MEANS FOR REPRODUCING PHOTOGRAPHS

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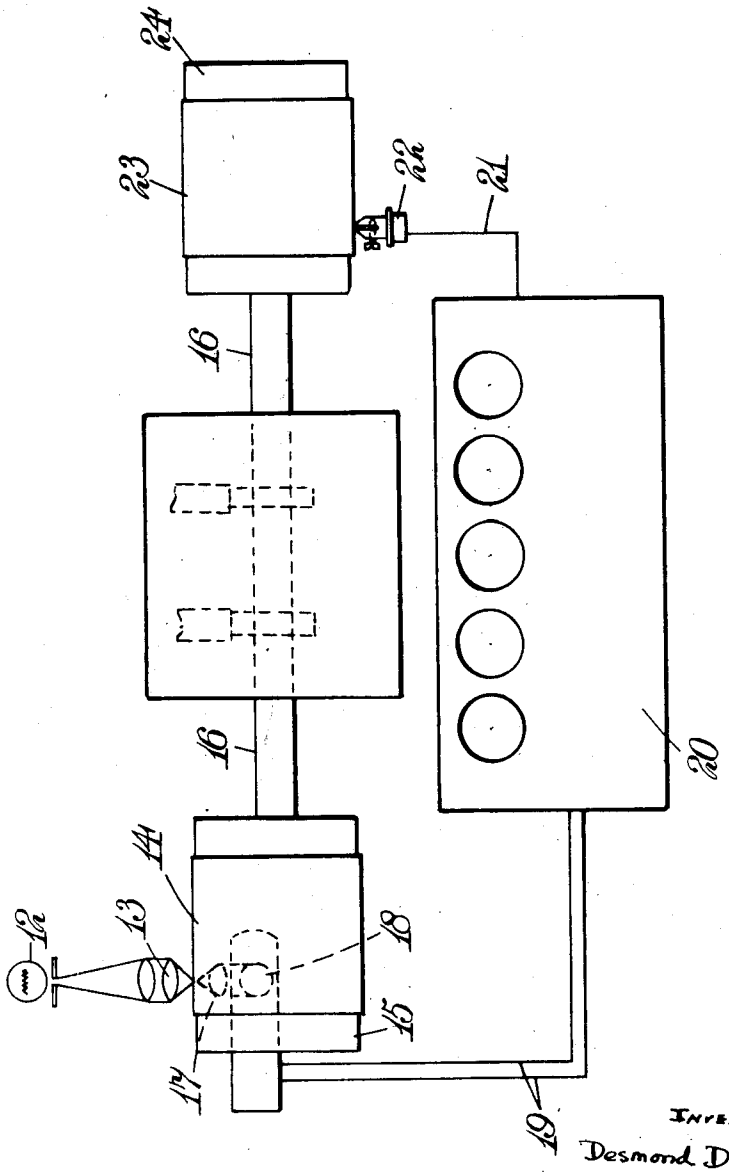

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ELECTRICAL MEANS FOR REPRODUCING PHOTOGRAPHS

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This invention relates to methods of electrical recording by deposition of dye, pigments or other coloring matter upon a receiving surface.

The recording of this invention is applicable to, and is intended for, the reproduction of monochromatic and color photographs, whether transparencies or otherwise.

It is an object of this invention to provide a novel method of recording.

It is a further object of this invention to provide a novel method of recording by deposition of coloring matter on a receiving surface, said deposition being controlled by a modulated electric current or voltage.

It is a still further object of the invention to provide a method of recording in which the coloring matter is attracted from a suitable device and deposited on to a receiving surface by the action of an electric field.

It is a still further object of the invention to provide a novel method of recording in which the coloring matter is supplied at zero or insignificant pressure.

Further objects of the invention will be apparent from the following specification.

According to the invention, the novel method of recording comprises the steps of:

(a) Supplying coloring matter to a device adjacent the desired receiving surface; the pressure of the supply is insufficient per se for the projection of the coloring matter from the device.

(b) Setting up an electrical potential gradient between the device and the receiving surface so as to attract particles of coloring matter from the device, to disintegrate the particles and to deposit them on the surface, and

(c) Varying the intensity of the potential gradient so as to vary the intensity of the deposition.

When this method of recording is applied to the reproduction of photographs and the like, the original is scanned with a beam of light which subsequently impinges on a photo-electric cell. The output from the photo-electric cell is amplified in an amplifier whose output controls the intensity of the potential gradient.

The receiving surface and the device are moved relatively in synchronism with the scanning of the original with the result that the deposit of coloring matter on a particular point on the receiving surface is in accordance with the light values of the corresponding point in the original.

When it is desired to reproduce a color photograph, for example, a transparency, the original

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is scanned with three different colored beams of light impinging upon different photo-electric cells and the amplified output of the photo-electric cells modulates the potential gradients between receiving surface and different ink sources.

There have already been proposals for electrically varying the deposit of coloring matter on to a receiving surface; for example, it has been proposed to project a jet of ink or the like under pressure towards the receiving surface and to deflect the jet by means of an electric field acting at right angles to the normal direction of the jet. However, the present invention is clearly distinguished from these prior proposals in that, in this invention, the coloring matter is not ejected from the source under the pressure of the ink but is attracted therefrom by the action of the electric field which acts in the direction between the source and the desired point of deposition and recording surface.

In our U. S. patent application, Serial No. 746,174, filed on May 5, 1947, there is described and claimed apparatus which may be employed for effecting the method of this invention.

The nature of this invention and the manner in which it is performed will be appreciated from the following description of an example in which it is assumed that a monochrome print is to be produced from a transparency: reference is made to the accompanying diagrammatic drawing.

A lamp 12 is used to produce a beam of light which may be circular in section (but might in certain cases take another, say rectangular, section). The lamp may be a high-power electric lamp with a small filament. The light passes through a lens system 13 (e. g. a collective lens or combination and a focussing lens) to bring the beam to a fine point (e. g. four one thousandths of an inch) at the transparency. An integrating sphere for obtaining the fine beam of light may be used. The transparency 14 is mounted on a rotary drum 15 in this example carried on a horizontal shaft 16 which can be rotated at a suitable rate for scanning and is simultaneously moved axially, thus giving helical scanning. The rotary drum may be of glass or transparent plastic which gives the minimum of interference to the scanning beam or the drum may be of metal with orifices at those places where the original picture lies. After passing through the transparency the light beam is collected by a lens system 17 and focussed on to the sensitive portion of the photoelectric cell 18. If the cell is arranged beyond the end of the

drum the collected beam may be reflected by a mirror or refracted by a prism. The photoelectric cell gives an electric output proportional to the intensity of the light falling on it and the current from the cell is led through a conductor 19 suitably screened from external influences to an amplifier 20 (D. C. or A. C.) which produces an output of high voltage which varies proportionally to the intensity of the light falling on the cell.

The apparatus for depositing colour units which vary in area or density or both proportionally to the output from the amplifier embodies a device 22 like a stylographic pen (not in contact with the paper), viz. a vetrical conduit for the passage of the ink or dye (e. g. a tube of fine bore such as 1 mm.) ground externally to a point and having an insulated fibre (say of glass) passing through said bore and carrying a bead at its extremity (external to the point) which bead forms an outlet valve. This conduit may be arranged above the receiving surface with the point downwards or alternatively the conduit may be arranged below the receiving surface with the point upwards. In either case the bead has a film of ink or dye on its surface.

There is an electric conductor 21 leading from the output of the amplifier to the depositing apparatus 22. It may lead to a metal wire dipping into the ink or dye with the interposition of a suitable limiting resistance if necessary. Alternatively the conductor from the amplifier may lead to a metallic sleeve on the outside of the conduit or jet. If the conduit is a glass tube the moisture on the tip of the tube between the metallic sleeve and the outlet acts as the conductor for this short distance. The tube or conduit may be of metal which will act as the conductor, and it may or may not have a tip of insulating material of glass or suitable plastic. Where the liquid is a dye dissolved in butyl alcohol the voltage from the amplifier may vary between 1,000 and 4,000 volts. The paper or like receiving surface 23 is mounted on an earthed metallic drum 24 which is rotated and moved axially in phase with the scanning drum. Preferably the metallic drum 24 for the receiving sheet is mounted on the same shaft 16 as the scanning drum and therefore partakes of identical movements.

The liquid on the surface of the bead is drawn to a point by the electric field between the liquid and the metallic drum which is closely adjacent and the electric charge on the liquid particle and the tension in the electric field causes the liquid particle to disintegrate into a fine mist which is directed towards the metallic drum and therefore on to the paper. The important fact is that the area and density of the colour unit or deposit on the paper at any instant is proportional to the electrical output from the amplifier and therefore the reproduction which is built up on the paper is a faithful reproduction of the original. The position of the bead in relation to the nozzle (i. e. the extent of opening of the outlet valve) may be controlled from the amplifier to take care of violent changes in light and shade. Thus if the original had a part consisting of heavy shadow and another part of high light the effect of the amplifier on the bead may be to open and close the valve to give a coarse control of ink supply.

Where the original is a three-colour transparency and it is desired to produce a three-colour print, the scanning drum and receiving drum are operated as above described but there are three separate scanning beams, three separate cells of appropriate sensitivity, three separate electric circuits and three separate depositing devices, the disposition of these parts in relation to the drums being such as to ensure the proper relationship of the three deposits both in relation to the original and to one another.

The apparatus and method above described may be adapted to the production of print enlargements by increasing the size and/or speed of the scanning and printing drums.

It is well known when using an amplifier of a modulated current that it is possible to inject into the input compensating or correcting voltages. It is within the present invention to effect contrast control, density control, colour control or corrections for possible distortions or aberrations by injecting into the amplifier input voltages designed to modify the output for any of these purposes.

It will be appreciated that modifications are possible in each of the steps or parts above referred to. Thus the scanning or depositing instead of being in helical paths may be effected in spiral paths or according to other known scanning technique.

Again instead of using a stationary beam with an axially movable scanning drum the necessary relative motion may be effected in other ways.

Means may be provided for adjusting the various parts mentioned. In particular the ink conduit or nozzle may be adjusted in relation to the receiving drum, the bead and fibre may be adjusted in relation to the nozzle and so forth.

We claim:

1. Electrical recording apparatus for reproducing a picture, comprising in combination a support for the picture, a light beam for scanning the picture on the support, means for continuously moving the picture support to cause the light beam to follow a linear path over the picture during scanning, means for modulating an electric current in accordance with the transmitted intensity of the light beam after it has impinged on the picture, a recording surface moving in synchronism with the picture support, a liquid depositing device for tracing a line over the recording surface as the latter moves, said device having a tip which is located out of contact with, but close to, the recording surface and which is fed with liquid colouring matter through a capillary opening, means for feeding the liquid colouring matter to the liquid depositing device, means for setting up a high voltage potential gradient between the recording surface and the liquid depositing device sufficient to project colouring matter from the tip of the liquid depositing device on to the recording surface across the intervening gap, and means controlled by the said modulated electric current for varying the intensity of the said potential gradient across the gap between the tip of the liquid depositing device and the recording surface in accordance with the intensity of the modulated electric current, whereby the intensity of deposit of the said liquid colouring matter varies from point to point along a line traced by the liquid depositing device on the recording surface in accordance with the colour density at corresponding points on the picture.

2. Electrical recording apparatus for reproducing a picture, comprising in combination a support for the picture, a light beam for scanning the picture on the support, means for contin-

uously moving the picture support to cause the light beam to follow a linear path over the picture during scanning, means for modulating an electric current in accordance with the transmitted intensity of the light beam after it has impinged on the picture, a recording surface moving in synchronism with the picture support, a liquid depositing device for tracing a line over the recording surface as the latter moves, said device comprising a tube having a capillary bore and being pointed at one end, a filament formed with a bead on its one end positioned in the bore of said tube to support said beam at the pointed end of said tube, the said tube being positioned to locate said bead out of contact with, but close to, the said recording surface, means for feeding liquid colouring matter to said capillary bore, means for setting up a high voltage potential gradient between the recording surface and the liquid depositing device sufficient to project colouring matter from the bead of the liquid depositing device on to the recording surface across the intervening gap, and means controlled by the said modulated electric current for varying the intensity of the said potential gradient across the

gap between the bead of the liquid depositing device and the recording surface in accordance with the intensity of the modulated electric current, whereby the intensity of deposit of the said liquid colouring matter varies from point to point along a line traced by the liquid depositing device on the recording surface in accordance with the colour density at corresponding points on the picture.

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