United States Patent [19]

Bestenreiner et al.

[11] **3,745,235**

[45] **July 10, 1973**

[54] **METHOD AND APPARATUS FOR THE PRODUCTION OF COLOR PRINTS ON PAPER**

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[22] Filed: **May 25, 1971**

[21] Appl. No.: **174,871**

[30] **Foreign Application Priority Data**

Aug. 31, 1970 Germany ..... P 20 43 140.7

[52] **U.S. Cl.** ..... **178/5.2 R,** 178/5.4 CD, 178/6.6 B, 346/76 L

[51] **Int. Cl.** **H04n 9/02**

[58] **Field of Search** ..... 178/5.2 R, 5.2 A, 178/5.4 CD, 6.6 B; 346/76 R, 76 L

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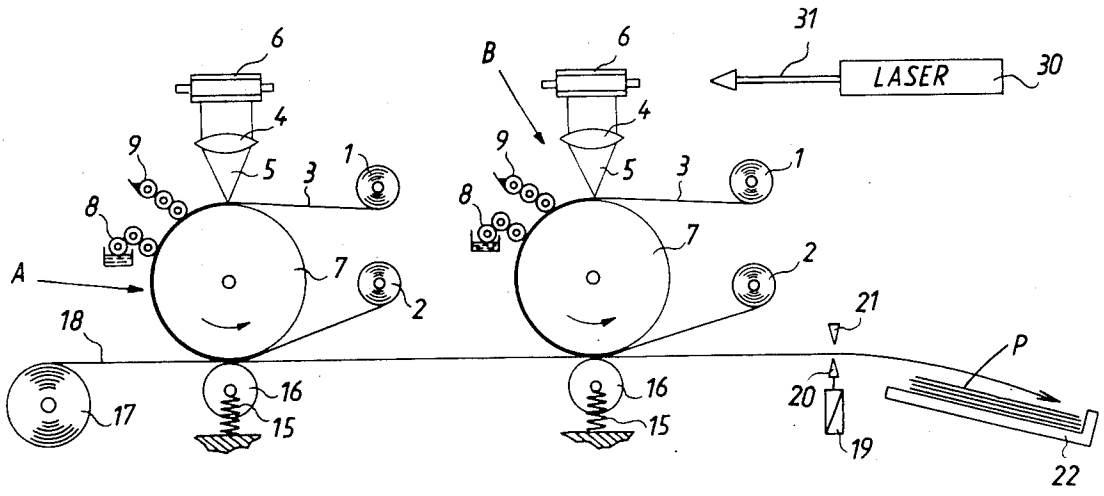
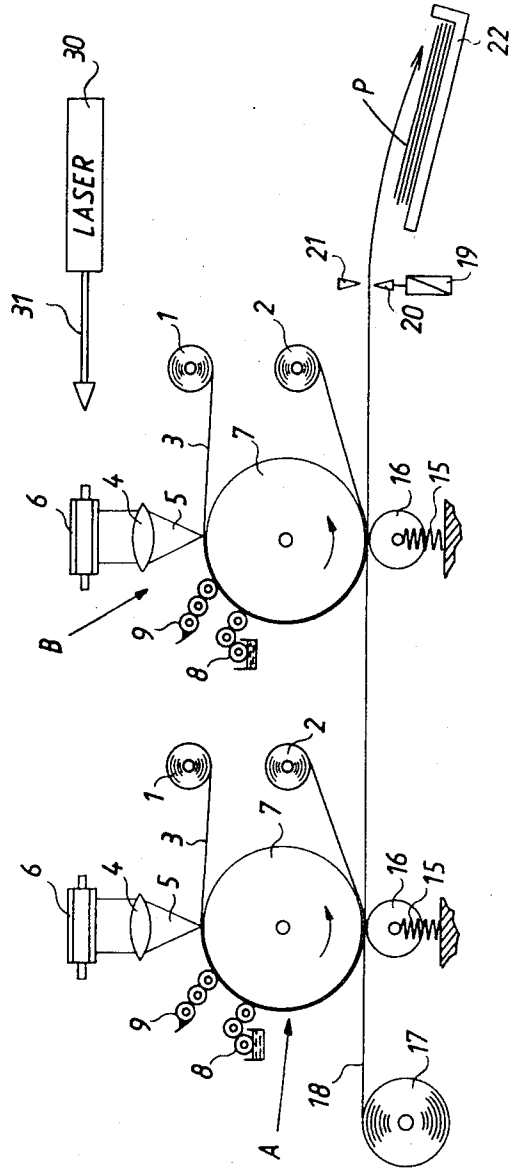
[57] **ABSTRACT**

Color prints of multicolored originals are obtained on absorbent paper by exposing recording layers to the action of electrooptically intensity-regulated laser beams so that the laser beams influence the affinity of recording layers to liquids and pigments in dependency on the distribution of different colors in a multicolored original. The thus treated recording layers are thereupon wetted and pigmented in the respective colors prior to being brought into contact with a strip of paper to form thereon a series of overlapping images of the original, each such image being of a different color.

11 Claims, 1 Drawing Figure





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METHOD AND APPARATUS FOR THE PRODUCTION OF COLOR PRINTS ON PAPER

CROSS-REFERENCE TO RELATED APPLICATION

The method and apparatus of the present invention constitute an improvement over and a further development of the method and apparatus disclosed in the copending application Ser. No. 172,158, for "Method and Apparatus for Making Color Prints on Paper," filed Aug. 16, 1971 by Friedrich Bestenreiner et al. and owned by the assignee of the present application.

BACKGROUND OF THE INVENTION

The present invention relates to a method and apparatus for the making of color prints on paper, and more particularly to a method and apparatus for making colored replicas of multicolored originals which are scanned, point-by-point or line-by-line, by electrooptical means serving to produce several sets of signals each of which can be used to regulate the intensity of a discrete light beam in accordance with the distribution of a particular color in the original.

At the present time, color prints (especially of amateur-exposed film frames) are made by resorting to an expensive, time-consuming and complicated wet treatment of costly printing material, such as a strip or sheet of paper which is coated with a layer of photosensitive silver-containing composition. Such procedure is not suited for the making of satisfactory color prints after prolonged storage of paper which is coated with photosensitive material.

It was further proposed to make color prints by an electrophotographic method and by utilizing a paper coated with a mixture of ZnO granules which are sensitized for different colors. The ZnO granules are normally of a whitish-grey color and it was found that such granules cannot contain requisite quantities of pigments which wuld suffice to insure satisfactory reproduction of deep and intensive colors in the original. The admission of excessive quantities of pigments affects the photoconductivity of the ZnO carrier to such an extent that the carrier is not suited for the practice of the electrophotographic method.

The aforementioned copending application of Bestenreiner et al. (to which reference may be had, if necessary) discloses a method and apparatus for making color prints on untreated paper by transferring onto or by forming on such paper thermal images which are made by intensity-regulated laser beams, one for each of two, three or more colors in the original. The intensity of the laser beams is regulated by signals which are obtained as a result of optical scanning of the original to detect the distribution of respective colors. The laser beams cause melting, sublimation, evaporation or chemical changes in recording layers which contain pigments in the respective colors and the resulting thermal images are superimposed upon each other on the paper strip to form a color print. The quality of such color prints depends to a considerable extent on the thickness of the recording layers. The making of thermal images on relatively thick recording layers necessitates the use of relatively strong lasers.

SUMMARY OF THE INVENTION

An object of the invention is to provide a novel method of making color prints from multicolored originals in an energy-saving manner.

Another object of the invention is to provide an apparatus for making color prints from multicolored originals which is capable of producing high-quality prints in two or more colors, which can make such prints on untreated paper, and whose energy requirements are even lower than in the apparatus which is disclosed in the aforementioned copending application of Bestenreiner et al.

The method of the present invention is utilized for making color prints on paper, particularly on untreated paper which is absorbent and need not be provided with a layer of photosensitive material. The method comprises the steps of optically scanning in a well-known manner a multi-colored original and producing, also in a known manner, several sets of signals each of which indicates the distribution of a different color in a substantial number of minute regions of the original, utilizing each such set of signals to regulate the intensity of a discrete laser beam so that the intensity of such laser beams varies as a function of changes in distribution of the respective colors in the multicolored original, training each intensity-regulated laser beam upon a discrete recording layer whose affinity to liquids (e.g., its hydrophylic or oleophylic characteristics) is variable as a function of changes in the intensity of the impinging laser beam, wetting the thus obtained thermal images on the recording layers and applying pigments in respective colors to the thus wetted images, and transferring the pigments from the recording layers onto a strip of paper so that the resulting color images overlie each other and form a true and accurate replica of the original.

The recording layers may consist of very thin or extremely thin coats of wax applied to flexible carriers consisting of absorbent paper or the like. The coats of wax can melt in response to exposure to laser beams so as to expose certain portions of absorbent carriers which are thereupon wetted to absorb different quantities of pigments.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved printing apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE is a diagrammatic elevational view of the portion of a printing apparatus which embodies the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drawing illustrates a printing apparatus with two printing stations A and B. In actual practice, the apparatus will normally comprise at least three but preferably four, five, six or even more printing stations.

At each of the stations A and B, there is provided a supply reel 1 for convoluted flexible web-like carrier 3 and a takeup device 2 for such carrier. The carriers 3 are trained over driven conveyors in the form of rollers or drums 7 which rotate in a counterclockwise direction, as viewed in the drawing.

Each of the stations A, B further accommodates a lens 4 which focusses a laser beam 5 onto the exposed surface of the respective carrier 3. Each laser beam 5 is intensity-regulated by an electrooptical system of known design and is directed against a mirrored wheel or drum 6 which in turn directs the beam against the respective lens 4. The electrooptical system scans the multicolored originals (not shown) point-by-point and regulates the corresponding laser beam 5 in accordance with distribution of the respective color (e.g., green, red or blue) in the original. The lenses 4 may consist of gallium arsenide (GaAs). Each laser beam 5 is deflected line-by-line in synchronism with the scanning of the original.

Each of the stations A and B further accommodates a lithographic wetting unit 8 and a lithographic coloring or pigment-applying unit 9 of known design. These units are located downstream of the point where the laser beam 5 impinges against the respective carrier 3. Each carrier changes its affinity to water or fat in dependency on changes in the intensity of the respective laser beam 5. Thus, the extent of wetting and transfer of pigments by the units 8, 9 will depend on variations in affinity of the carrier portions which were exposed to the respective laser beams 5 so that the carriers transport images of the original in the respective colors.

Such images are transferred onto a strip or sheet 18 of preferably untreated paper which is stored in convoluted form (see the roll 17) and is advanced along the stations A and B by a conveyor including two rollers 16 which are biased by springs 15 against the adjacent portions of the strip 18 so that the latter bears against the carriers 3 and receives the color images therefrom. The color images of the same original are superimposed upon each other so as to form thereon a multicolor image. The strip 18 is thereupon severed by a device including a stationary knife 21 and a movable knife 20 which is reciprocable by an electromagnet 19 at such intervals that the severing device forms a series of discrete prints P which are collected on a suitably configurated and inclined table 22 or an analogous receptacle. Each print P carries a plurality of superimposed different color images of the same original.

The laser 30 which furnishes the beam 5 is preferably constructed and its main beam 31 deflected and/or reflected in a manner as shown in FIGS. 1 and 2 of the aforementioned copending application of Bestenreiner et al. The same applies for the regulation of intensity of the beams 5 as a function of changes in distribution of the respective colors in the original.

The carriers 3 are of a well-known composition which insures that their affinity to a liquid (such as water or fat) changes as a function of changes in the intensity of laser beams 5. At the present time, we prefer to employ carriers which are made of paper coated with a thin recording layer of wax. The wax layers can be extremely thin. In some instances, it is sufficient to employ monomolecular recording layers in order to impart to portions of such layers oleophylic or hydrophylic characteristics and to thus regulate the application of color layers of any desired practical thickness. The laser output which is needed to influence such extremely thin recording layers is but a very small fraction of the output required for the formation of thermal images by partial fusing, sublimation and/or chemical changes in toners and/or other types of recording layers. Such minimal outputs can be furnished by a variety of commercially available lasers. The laser 30 (or lasers) employed in the apparatus of the present invention is a preferably 10.6μ–CO_2 laser with a constant-line output of 100–1,000 watts and is electrooptically controlled by GaAs crystals. Such lasers render it possible to produce color prints at a rate unmatched by presently known printing apparatus.

It was found that, in spite of the utilization of homogenous pigment layers which are applied by the respective coloring units, the apparatus of the present invention can insure true and accurate reproduction of all half-tones even if the original is not provided with rasters or gratings of the type known from the art of holograms. This is attributed to the fact that a lasr beam which is concentrated upon a minute spot exhibits an intensity profile which decreases toward the marginal portions of the spot. In dependency on the threshold value of the recording layer, the spots of such layer are influenced by the respective laser beam as a function of the intensity of the beam so that the area of each spot which is exposed to the laser beam extends through a different distance from its centrum, depending on the intensity of the beam. If the original is scanned line-by-line with a linear laser beam, there develops an autotypographic linear grating or raster. By resorting to a pulsating laser, one can obtain autotypographic points of any desired degree of fineness.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended clams:

1. A method of making color prints on paper, particularly on a strip of untreated paper, comprising the steps of optically scanning a multicolored original and producing several sets of signals each indicating the distribution of a different color in a substantial number of minute regions of said original; utilizing each of said sets of signals to regulate the intensity of a discrete CO_2 laser beam so that the intensity of said beams varies as a function of changes in distribution of the respective colors in said original; training each of said intensity-regulated laser beams upon a discrete moving recording layer which consists of a thin coat of wax applied to a flexible carrier and whose affinity to liquids and pigments is variable as a function of changes in the intensity of the impinging laser beam to thus produce on each of said recording layers a thermal image of the original in the respective color; wetting the thermal images on said recording layers and applying to the thus wetted images pigments in the respective colors; transferring the pigments from said recording layers onto a moving strip of paper so that the resulting color images overlie each other and form on said strip a multicolored print of the original; and severing said strip to separate the multicolored print therefrom.

2. A method as defined in claim 1, wherein said carriers consist of paper.

3. A method as defined in claim 1, wherein said wetting step comprises applying water to said thermal images.

4. A method as defined in claim 1, wherein said intensity-regulated laser beams influence the hydrophylic characteristics of said recording layers.

5. A method as defined in claim 1, wherein said intensity-regulated laser beam influence the oleophilic characteristics of said recording layers.

6. Apparatus for making color prints on paper, particularly on a strip of untreated paper, comprising means for furnishing a plurality of discrete laser beams whose intensities vary as a function of changes in the distribution of different colors in a multicolored original, said means comprising at least one CO_2 laser; means for conveying across the path of said laser beams recording layers which consist of thin coats of wax applied to flexible carrier and whose affinity to 'iquids and pigments is variable as a function of changes in the intensity of the impinging laser beams whereby said laser beams produce on said recording layers thermal images of the original in the respective colors; means for wetting the thermal images on said recording layers; means for applying to wetted thermal images pigments in the respective colors; means for transporting a strip of paper lengthwise; means for transferring the pigments from said recording layers onto said strip of paper to form thereon prints each having a plurality of overlying color images; and means for severing said strip to separate said prints therefrom.

7. Apparatus as defined in claim 6, wherein said laser is a 10.6μ – CO_2 laser which is electrooptically regulated by GaAs crystals.

8. Apparatus as defined in claim 6, wherein said conveying means comprises discrete sources of recording layers, means for transporting said recording layers from such sources across the paths of the respective laser beams, and means for collecting the thus transported recording layers subsequent to transfer of the respective color images onto said paper strip.

9. Apparatus as defined in claim 8, wherein said transporting means comprises rotary drums and wherein said wetting means and said pigment-applying means are adjacent to such drums.

10. Apparatus as defined in claim 9, wherein said transferring means comprises spring-biased rollers arranged to press successive increments of said paper strip against successive increments of said recording layers on said drums downstream of the respective wetting and pigment-applying means.

11. Apparatus as defined in claim 6, wherein said paper strip is stored in convoluted condition in the form of a roll and said transferring means includes means for withdrawing said paper strip from said roll and for advancing the thus withdrawn paper strip past successive recording layers and thereupon through said severing means.

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