

- [54] METHOD AND APPARATUS FOR PRINTING
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[51] Int. Cl. B41m 5/00
[58] Field of Search 117/36.1; 250/65 T; 101/470, 471, 493; 96/27 R

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[57] **ABSTRACT**
A method and apparatus for printing intelligence on a surface by the use of short pulses of visible light energy impinging on a coating formed of a colorant and an absorber of radiant energy. A stack is formed including a sheet of material having transparent areas, a coating made up of the colorant and energy absorber and a surface to be printed. A burst of light is caused to pass through the transparent areas of the sheet material causing momentary heating of the exposed areas of the coating and volatilization of the colorant in the exposed areas followed by immediate condensation of the colorant on the printing surface immediately adjacent the coating. The colorant transference corresponds exactly to the shape of the transparent areas in the sheet of material.

9 Claims, 3 Drawing Figures

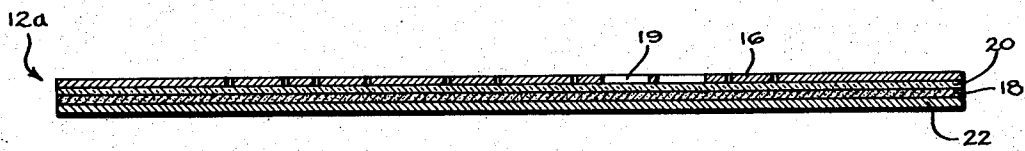


FIG. 1

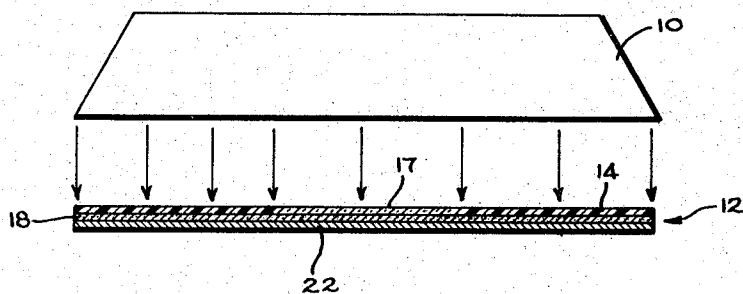


FIG. 3

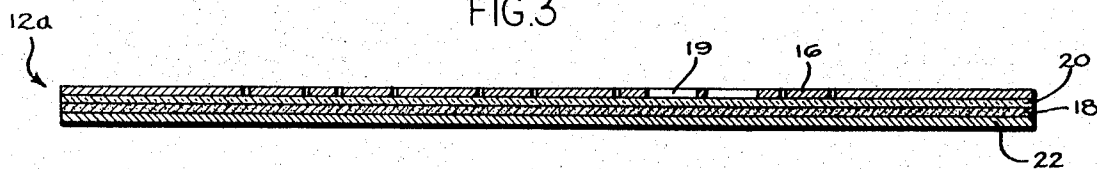
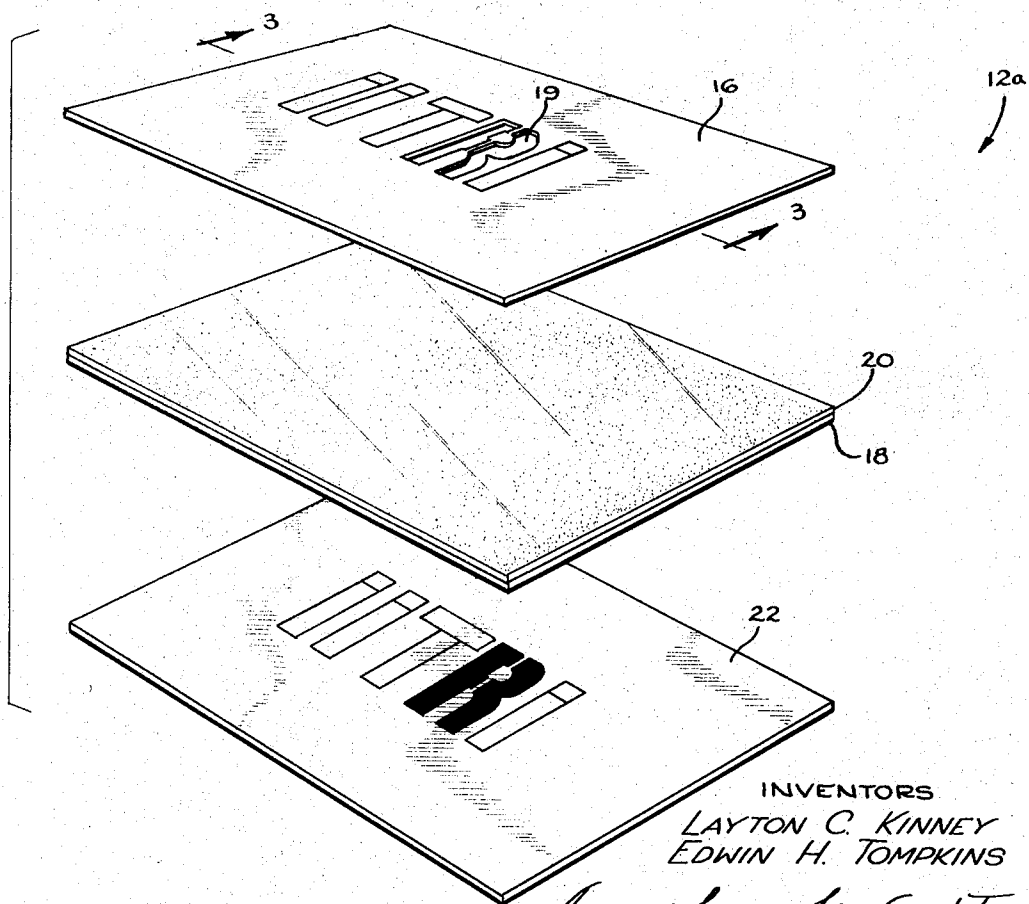


FIG. 2



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METHOD AND APPARATUS FOR PRINTING

The present invention relates to the art of printing and more particularly is directed to a printing method and apparatus employing colorants and reusable trans-

parencies or stencils for the formation of an image on a printed surface.

The printing industry today employs at least three major methods of transferring ink to paper. These can be conveniently termed relief or letter press printing, in which the printing surface is in relief above the non-printing parts; planographic printing, in which the printed material is transferred, for example, by photography, to a single plate and printed from an even surface; and intaglio printing in which the parts which are to be printed are cut into the plate below the plate surface. Each of these types of printing operations involves the preparation of a printing plate of the appropriate type. Printing plates are normally of a heavy permanent construction usually metal and are formed originally by some transferal process of an image from a photographic transparency onto the metal surface. Accordingly, the preparation of printing plates is both costly and time consuming resulting in high printing costs for short runs as well as delays in the availability of a plate for the printing process.

The present invention avoids the cost and delays encountered in the prior art by the elimination of the conventional printing plate. It is directed to a printing process in which a mask in the form of a photographic transparency or stencil is employed in combination with a coating as a printing plate. The mask is employed directly in the printing process and is not destroyed by the printing operation, and can be reused an unlimited number of times without changing its basic character. Due to a saving in weight, the printing presses employing the present invention can also be made of lighter construction since the mass of the printing plate will not be so great as to cause vibrations and misalignment in the remainder of the apparatus at high speeds.

It is an object of the present invention to provide a novel process for the printing of intelligence on a surface.

Another object of the present invention is to provide a low cost high speed printing process without the necessity of employing a conventional printing plate.

Still another object of the present invention is to provide a low cost printing plate.

These and other objects of the present invention will become evident from the following description in connection with the drawings, in which:

FIG. 1 is an elevational view partially in section of an apparatus embodying the present invention;

FIG. 2 is an exploded perspective view of an alternate form of the apparatus illustrating the present invention; and

FIG. 3 is a sectional view of the apparatus taken along line 3—3 of FIG. 2 and showing the elements in assembled form.

The invention is illustrated in the drawings in two different embodiments of apparatus useful in performing the improved process. Each arrangement shown in the drawings has a source 10 of radiant energy (shown only in FIG. 1) preferably in the visible light range of wavelength. The source is capable of delivering short pulses

of radiant energy and may take the form of a photoflash or other similar light sources.

The present invention resides in the provision of a novel printing plate 12 which is placed in the path of the radiant energy and has two elements. The first is the mask which may be a photographic transparency 14 or alternatively a stencil 16 (FIG. 2). In either case, the particular configuration which is to be printed onto a printing surface is present in the mask either in the form of a transparent area 17 or by a cutout 19 of the desired shape.

The second element of the printing plate is in the form of a layer or coating 18 of colorant and a radiant energy absorber such as carbon black. The coating 18 can be formed on the underside of the photographic transparency or alternatively it can be formed on a transparent sheet 20 (FIG. 2) and positioned adjacent the underside of the mask with the transparent sheet interposed between the mask and the coating. The foregoing two elements constitute the printing plate 12 and 12a of the present invention and are placed with the coating in contact with the surface of a printing medium 22, normally paper, in the path of radiation from the source of radiant energy.

The radiant energy source is flashed briefly causing energy to impinge on the entire surface of the mask. Some of this energy is blocked by the nontransparent areas of the mask while the remainder passes through the transparent areas and momentarily heats the coating in the corresponding area due to the radiant energy absorber contained therein. The colorant, usually in the form of a dye having a low volatilization temperature, volatilizes or vaporizes leaving the energy absorber intact and immediately condenses on the surface of the printing medium resulting in a well defined print of the desired color and configuration which is immediately dry and ready for handling.

In the detailed description of the invention which follows, the mask may be alternately referred to as a sheet of material which combines with the coating or layer to form the printing plate. It should be understood throughout that the term mask is used for convenience only and may refer to either a photographic transparency, a stencil or other types of transparencies. In addition, the term colorant will be used interchangeably with the term dye; however, the substances which can be utilized as colorants are not limited to dyes in the conventional use of the term dye.

FIG. 1 illustrates the source of radiant energy 10 which in the preferred embodiment takes the form of an electronic flash lamp. The lamp is required to provide the input of radiant energy to cause the volatilization of the colorant from the coating formed on the transparency. The pulse of light which is required to perform the process of the present invention is typically very short, of the order of milliseconds, and the total energy incident on the surface of the photographic transparency is of the order of 20 joules per square inch for the typical colorant.

The exact duration and energy level of the light source is one of a great number of variables in the process of the present invention which, similar to photography, can be manipulated to achieve the desired result. Specifically, the energy required is a function of the thickness of the coating, the transparency of the negative, the duration of the flash, the latent heat of vaporization of the particular colorant employed and the

thermal conductivities of the colorant and transparency. The values of the latent heats of vaporization of the particular colorants which may be employed and the thermal conductivities of the colorants and the transparencies used are well known by persons skilled in this art and are also readily available from standard references such as chemistry handbooks. By using such well-known values, printing, according to this invention, can be readily obtained according to the examples given herein or according to the particular desires of the user by altering the thickness of the coating, duration of the flash, the transparency or colorants as he sees fit. It is desirable for the operation of the process that the energy input be of such a nature that the dye is vaporized while retaining the integrity of the carbon or light absorbing portion of the coating and without sufficient heating of the coating under the opaque areas of the mask to permit vaporization of the dye present on that portion of the coating. The present invention operates on a principle of differential heating of the coating below the transparent and nontransparent areas of the mask. Accordingly, a long term low energy level source of light energy might result in the destruction of the mask or in the vaporization of the entire surface of the coating rather than just the area adjacent the transparent portion of the mask.

Since it is the relative transparency of the two portions of the mask to visible light which makes the operation of the present process possible, it is preferred that the preponderance of the energy employed in the present invention be visible light because the efficiency of transmission and blocking of the light by the transparent areas gradually drops as one approaches and enters either the infrared or ultraviolet wavelengths. Accordingly, differential heating is easiest to obtain with visible light.

The mask as stated earlier may be in the form of an ordinary photographic positive or negative 14 having the desired design as a transparent area bounded by nontransparent areas and may be glass mounted. The transparent area permits the light energy to pass through while the nontransparent areas block the light. The result is selective heating of the coating beneath the transparent area. In this connection translucent areas are sufficiently inefficient to be regarded as nontransparent for purposes of the present invention.

The nontransparent area of the mask is normally dark in color and absorbs energy itself. Due to the shortness of the burst of light, however, the nontransparent area does not heat sufficiently to cause the coating beneath it to heat to the volatilization temperature of the colorant. If in using a particular colorant the heat tends to cause slight volatilization under the nontransparent areas of the mask, these areas can be coated with a radiation reflective substance to reduce heating. If instead of a photographic transparency the stencil 16 is employed, the foregoing remarks still apply except that the coating 18 is applied to a separate transparent sheet of material such as Mylar. The reason for this difference is that the transparent areas 19 of the stencil are cut out and provide no surface to which the coating may be applied.

The coating can take many forms though it is preferred that it contain a colorant substance which volatilizes without decomposition at relatively low temperatures and that it contain a radiant energy absorber such as carbon black. The radiant energy absorber is desir-

able so that the coating will heat sufficiently under the brief pulse of light to cause the vaporization of the volatile portion of the coating. Examples of typical colorant employed in the present invention include Victoria green, fuchsin, manganic acetyl acetate, crystal violet, Victoria blue, Du Pont oil blue A, Saphranine T, and Rhodamine 5 GDN. The colorant employed should vaporize without decolorizing or decomposing and should not set off onto the printing surface upon contact at room temperature. In order to provide additional structural strength to the coating, a binder such as silicone resin is preferably employed for most coatings to cause the carbon portion of the coating to adhere to itself.

The coating may be formed in two basic ways, the first of which involves the formation of a black coating of energy absorber and binder which is subsequently spray coated with the desired colorant. This type of coating provides the advantage of being rechargeable without restructuring the carbon phase of the coating. In other words, if the plate is mounted in a rotary printing press, after each use of the plate in the printing process, an additional film of colorant is sprayed on the outer surface of the carbon black coating for use in the subsequent printing operation.

The other basic approach is the incorporation of the colorant or dye with the energy absorber and the binder directly into the coating so that the particles of dye are interspersed throughout the coating. This approach might be employed for short runs in which a small multiple of prints would be made without recharging the coating.

The coating may be formed as in FIG. 1 integrally on the surface of the mask or alternatively on the surface of a totally transparent substrate 20 which is then placed against the mask (FIGS. 2 and 3). The direct coating provides the advantage of little or no loss of sharpness in the transfer of the image from the photographic transparency to the printing paper. The second approach has the advantage of not contacting the mask with the coating and only results in a slight loss of sharpness depending on the thickness of the transparent sheet upon which the coating is formed. The loss of sharpness is due primarily to the scattering of light at the boundaries of the transparent areas due to the thickness of the transparent sheet.

The coating may be formed by brushing, rolling or spraying and is accomplished by use of a solvent such as toluene mixed with the constituents of the remainder of the coating which are pulverized or milled in powder form. The application of the coating should be done with care because of the need for uniform thickness throughout the coating. This need is due in part to the vaporization of the dye material which requires a certain temperature for each particular dye and which will occur only in the areas where that temperature is achieved. It is therefore possible that having the coating of uneven thickness or too thick overall may result in insufficient heat being conducted to the surface adjacent the printing paper resulting in an inferior print.

The printing medium employed in the basic process may be sheet material of any type and not be specially treated. Certain variations which will be described hereinafter do involve, however, the treating of the paper as well as an optional step of developing an image with steam.

In the operation of the present invention it is possible that some of the binder may also volatilize with the dye. Accordingly, the binder employed is preferably colorless although it might also be colored if it does not volatilize or may be entirely absent from some coatings.

The system of the present invention lends itself to multicolor printing as well as single color printing. One means for achieving the two color print involves the use of a mask as described earlier with reference to the basic process and a coating having a single dye material of the desired color. The transparent portion of the mask corresponds to only a portion of the image to be printed. The mask and coating are placed in contact with the paper and the light source is flashed transferring the colorant to the desired portions of the design. The mask is removed along with the coating and a second mask having areas complementary to the already printed areas is put in its place. The coating on this mask utilizes the other color dye to be employed and the mask is placed over the same paper and the light is again flashed at an energy level sufficient to vaporize the second dye which in turn condenses on the desired portions of the paper resulting in a two color print. Obviously, this operation could be extended to as many colors as desired without departing from the scope of the invention.

An added feature which can be achieved by the use of a first mask and a second mask having mutual transparent areas is a three color print where the dye of the first mask and the second mask mixes in these areas creating a secondary color. For example, a blue dye and a yellow dye create a green area.

In still another embodiment of the present invention a transparent sheet of material is coated with a coating containing two distinct colorants having different latent heats of vaporization contained within the single coating. A first mask having a portion of the area to be printed in transparent form is then placed against the coating and the light is flashed to an energy level sufficient to vaporize one but not both of the colorants. The mask is removed and a second mask is employed having complementary areas to the areas of the first mask. The light is again flashed this time at an energy level sufficient to vaporize both of the colorants. The resultant print is a two color print having a first color corresponding to the lower latent heat of vaporization colorant and a second color corresponding to the mix of the lower and higher colorants which have volatilized at the same time.

As mentioned earlier the paper employed in the present invention is normally untreated. It is possible, however, to treat the paper with an impregnation or coating of a chemical and to condense the dye or other material onto the surface of the paper causing an image to appear due to the interaction of the two materials or by subjecting the paper to a further step to develop the latent print. One example of such system includes the impregnation of paper with ferric ammonium sulfate and the use of tannic acid in place of the dye in the coating on the mask. The tannic acid is caused by the photoflash to vaporize and condense on the paper. The resulting blue black iron tannate image is developed by briefly subjecting the print to steam.

The present invention will be better understood with reference to the following examples.

EXAMPLE I

A mixture of 7.59 parts silicone resin binder (GE SR-80), 0.59 parts carbon black and toluene was milled for 24 hours in a ball mill. Additional toluene was added until the mixture was of a sprayable consistency. The mixture was then sprayed with an air brush onto the emulsion side of a glass mounted photographic negative. A coating was formed to a thickness sufficient to prevent transmission of visible light.

The black coating was cured for 48 hours at 120°C. in a dry oven and was sprayed with a Victoria green dye solution in menthanol. The dye was sprayed until the black was obscured. After drying the negative was placed in a contact printing frame with the dye in contact with a sheet of paper.

An electronic flash lamp was positioned 4½ inches from the surface of the negative and was flashed. The energy at the surface of the negative was approximately 20 joules per square inch. The resultant print was an exact reproduction of the transparent areas of the negative and the negative was not damaged during the creation of the print.

EXAMPLE II

The preparation of the photographic negative was as set forth in Example I. The paper in this case was impregnated with ferric ammonium sulfate, and the black coating of the transparency was sprayed with an alcohol solution of tannic acid. After the acid was dried the assembly was subjected to photoflash radiation. The resultant blue black iron tannate image was developed by briefly subjecting the print to steam. The resultant print showed high fidelity to the original.

EXAMPLE III

The steps of Example I were followed precisely except that the dye employed was fuchsin.

EXAMPLE IV

The steps of Example I were followed precisely except that the dye employed was crystal violet.

Other prints were made employing the steps of Example I and substituting as dyes the following materials: Victoria Blue, and Du Pont dyes Rhodamine 5 GDN, Saphranine T, and oil blue A. In each case the resultant print was clear and showed high fidelity to the original.

EXAMPLE V

The transparency was prepared in accordance with Examples I and II and the paper was prepared in accordance with Example II. The transparency was then sprayed with gallic acid and the image was developed by subjecting the paper briefly to steam.

EXAMPLE VI

A composition was prepared containing 0.5 parts carbon black and 2.0 parts manganic acetyl acetate and toluene. The mixture was ball milled for 24 hours. Additional toluene was added to permit spraying and the solution was sprayed on the emulsion side of a glass mounted transparency to the point of incipient opacity and dried in the manner described in Example I.

The exposure to photoflash energy was also accomplished in the same manner as set forth in Example I. The resultant image was brownish black. In this example no binder was required since the manganese com-

plex forms a coherent adherent film which prevents incorporated carbon black from rubbing off the coating.

EXAMPLE VII

A glass mounted negative was sprayed with a thin coat of silicone resin which was then cured by heating for 48 hours at 120°C. A composition consisting of 1.6 parts Victoria blue, 2.0 parts carbon black and 1.0 parts paraffin wax was mixed with petroleum ether (65°-110°C boiling point) until a spraying consistency was reached. The mixture was sprayed onto the surface of the silicone resin coating and after drying the assembly was subjected to photoflash energy in the manner set forth in Example I. The result was a brilliant blue print indistinguishable in sharpness and resolution from the original. The solid tones were rendered with excellent density.

EXAMPLE VIII

The following composition was milled in accordance with Example I: Paraffin wax — 2 parts; Victoria blue — 1 part; carbon black — 2 parts; and toluene. The mixture was heated to dissolve the wax prior to the milling operation. Additional toluene was added to achieve spray consistency and the spray coating was applied to a transparent Mylar sheet until opacity was reached. After drying as in Example I coated film was placed in contact with paper and was overlaid with a negative transparency. The assembly was placed in a contact printing frame and subjected to flash energy as described previously. A blue print of good resolution was produced.

EXAMPLE IX

A glass mounted negative was sprayed with a thin coat of silicone resin which was cured by heating for 48 hours at 120°C. A composition consisting of 2.0 parts Victoria blue, 0.5 parts carbon black and 0.5 parts cetyl alcohol was mixed with 50 parts methanol until spraying consistency was reached. The mixture was sprayed onto the surface of the silicone resin coating and after drying the assembly was subjected to photoflash energy in the manner set forth in Example I. The result was a brilliant blue print of good resolution and sharpness.

EXAMPLE X

The composition of Example IX was mixed to spraying consistency and the spray coating was applied to a transparent Mylar sheet until opacity as reached after drying as in Example I. The coated film was placed in contact with paper and was overlaid with a negative transparency. The assembly was placed in a contact printing frame and subjected to flash energy as described previously. A blue print of good resolution was produced.

The prints formed in the preceding examples were each tested for set off by being inserted into a book and subjected to the normal pressure of a closed book. No appreciable set off was observed on the facing pages after a period of several months.

While the foregoing description has been presented with reference to particular materials and configurations, these are presented by way of example only and not by way of limitation. The present invention includes other embodiments within the scope of the following claims.

We claim:

1. A method of printing intelligence on a surface of a printing medium comprising steps of:
 - forming a layer comprising a volatilizable colorant and an absorber of radiant energy,
 - positioning said layer between the surface to be printed and a sheet of material having an area transparent to radiant energy and corresponding to the intelligence to be printed, and
 - subjecting said sheet of material and the portion of said layer adjacent said transparent area to a pulse of radiant energy sufficient to cause said colorant in said area to volatilize under the influence of the radiant energy absorbed by said absorber of radiant energy and to condense on said surface to be printed.
2. A method as set forth in claim 1 wherein said layer is a coating and is formed on the surface of said sheet of material.
3. A method as set forth in claim 1 further comprising the steps of forming said layer as a coating on a transparent substrate and positioning said substrate between said sheet material and said surface to be printed.
4. A method as set forth in claim 3 wherein said sheet material is a stencil having cutout areas corresponding to said intelligence to permit said radiant energy to pass through said substrate to said layer.
5. A method as set forth in claim 1 wherein forming said layer comprises the steps of:
 - mixing colorant, radiant energy absorbent material and a binder with a solvent,
 - applying the resultant mixture to one surface of said sheet of material to form a coating, and
 - driving off the solvent without disrupting said coating.
6. A method as set forth in claim 1 wherein said layer and said sheet material are employed for multiple prints, said method including the steps of providing successive surfaces to be printed adjacent said layer, and
 - subjecting said sheet of material to successively stronger pulses of radiant energy for each successive surface to be printed whereby said colorant is partially volatilized by each successive pulse.
7. A method as set forth in claim 1 wherein the strength of said pulse of radiant energy on said sheet of material is of the order of 20 joules per square inch.
8. A method of printing intelligence onto a surface of a printing medium comprising the steps of:
 - forming a first layer having a first dye and an absorber of radiant energy,
 - positioning said first layer between said surface to be printed and a first sheet of material having a first area transparent to radiant energy and corresponding to a first portion of the intelligence to be printed,
 - subjecting said first sheet of material and the portion of said first layer adjacent said first transparent area to a pulse of radiant energy effective to cause said first dye in said area to volatilize under the influence of the radiant energy absorbed by said absorber of radiant energy and to condense on said surface to be printed,
 - forming a second layer comprising a second dye and an absorber of radiant energy,
 - positioning said second layer between said surface to be printed and a second sheet of material having a

second area transparent to radiant energy and corresponding to a second portion of the intelligence to be printed, and

subjecting said second sheet of material and the portion of said second layer adjacent said second transparent area to a pulse of radiant energy effective to cause said second dye in said second area to volatilize due to the influence of radiant energy absorbed by said absorber of radiant energy and to condense on said surface to be printed.

9. A method of printing intelligence onto a surface of printing medium comprising the steps of:

forming a layer comprising a first colorant, a second colorant, and an absorber of radiant energy, said first colorant and said second colorant having different latent heats of vaporization,

positioning said layer between the surface to be printed and a first sheet of material having a first area transparent to radiant energy and corresponding to a first portion of the intelligence to be

printed,

subjecting said first sheet of material and the portion of said layer adjacent said transparent area to a pulse of radiant energy of sufficient strength to volatilize under the influence of the radiant energy absorbed by said absorber of radiant energy said first colorant adjacent said first transparent area,

substituting a second sheet of material for said first sheet of material said second sheet of material having a second area transparent to radiant energy and corresponding to a second portion of the intelligence to be printed, and

subjecting said second sheet of material and the portion of said layer adjacent said second transparent area to a pulse of radiant energy of sufficient strength to volatilize said second colorant under the influence of the radiant energy absorbed by said absorber of radiant energy.

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