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(54) Dye-transfer sheets for heat-sensitive recording and heat-sensitive recording apparatus.

(57) A dye transfer sheet for heat-sensitive recording is described, which sheet comprises a support and a basic dye layer formed on the support. The basic dye is preferably an aromatic tertiary amine. Better results are obtained when the dye transfer sheet is used inc combination with an image-receiving sheet having an electron acceptor layer thereon. A heat-sensitive recording apparatus suitable for the recording of the above-mentioned type of dye transfer sheet is also described.

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DESCRIPTION

DYE TRANSFER SHEETS FOR HEAT-SENSITIVE RECORDING AND HEAT-SENSITIVE RECORDING APPARATUS

This invention relates to the heat-sensitive recording and more particularly, to a novel type of dye transfer sheet or medium for use in heat-sensitive recording. Also, it relates to a heat-sensitive recording apparatus which is adapted to make the best use of the dye transfer sheet of the just-mentioned type.

In recent years, color recording has been widely effected in which there are used dye transfer sheets having sublimating dye layers on substrate. The dye transfer sheet is heated in an imagewise pattern by the use of a heat source such as a thermal head, by which the sublimating dye is transferred to a suitable image-receiving medium to obtain an intended color image thereon. For the above purposes, it is the common practice to use disperse dyes as the sublimating dye. However, dye transfer sheets using disperse dyes have the following problems.

(1) The range of color reproduction is narrower than in the case of color printing.

(2) Image-receiving layers adapted for disperse dyes

are limited only to those of polyesters and acetate resins.

(3) Because relatively low melting point polymers are used as an image-receiving layer, the ink or dye layer and image-receiving layer frequently melt together and adhere to each other.

(4) The transfer printing usually involve static conditions of a temperature of 180 to 200°C and a time of 5 to 30 seconds. This temperature range is too high when thermal head is used as a heat source. It will be noted that ordinary thermal heads are employed under conditions of 300 to 400°C and several milliseconds, which correspond to static conditions of about 130°C and about 5 seconds.

(5) Disperse dyes are merely dispersed in the image-receiving layer, and are thus greatly influenced by environmental conditions.

(6) Recording apparatuses using known disperse dye transfer sheets need a large quantity of recording energy and a great power supply, thus leading to a large-scale system and lowering the life of recording units such as thermal head.

It is accordingly an object of the present invention to provide dye transfer sheets for heat-sensitive recording which overcome the above-described drawbacks of the prior art.

It is another object of the invention to provide dye transfer sheets for heat-sensitive recording which make use of basic dyes sublimating at relatively low temperatures.

It is a further object of the invention to provide dye transfer sheets for heat-sensitive recording which make it possible to obtain full color hard copies having almost the same level of color reproduction as those obtained by color printing.

It is a still further object of the invention to provide a heat-sensitive recording apparatus of the type which is suitable for making the best use of the dye transfer sheets of the just-mentioned type.

The above objects can be achieved, according to one embodiment of the invention, by a dye transfer sheet for heat-sensitive recording which comprises a support and a layer of a sublimating basic dye formed on the support, whereby when heated in an imagewise pattern, the dye sublimates from from the dye layer and deposits on an image-receiving medium according to the imagewise pattern. The sublimating basic dyes are preferably aromatic tertiary amines.

According to another embodiment of the invention, there is also provided a heat-sensitive recording apparatus which comprises a first heat source which is controlled according to an information signal of picture element, a platen placed in face-to-face relation with the first heat source and establishing a gap with the first heat source so as to permit a transfer sheet having a sublimating basic dye layer to be passed therebetween along with an image-receiving sheet whose image-receiving surface is in face-to-face relation with the basic dye layer of the transfer sheet, and a second heat source located downstream of the first heat source to fix an image formed on the image-receiving surface, whereby when the transfer sheet is heated according to the information signal, the dye moves by sublimation toward the image-receiving layer in portions where heated thereby forming an intended image on the image-receiving layer, and the intended image is fixed by application of heat from the second heat source.

In the accompanying drawings,

Fig. 1 is a schematic side view illustrating the principle of heat-sensitive recording using a dye transfer sheet and a heat-sensitive recording apparatus according to the invention;

Fig. 2 is an enlarged view of the dye transfer sheet of Fig. 1 in combination with an image-receiving sheet;

Fig. 3 is a schematic view of a dye transfer sheet having dye layers of different types arranged in spaced relation with one another with separation at intervals;

Fig. 4 is a schematic view showing the state of dye molecules on an image-receiving sheet;

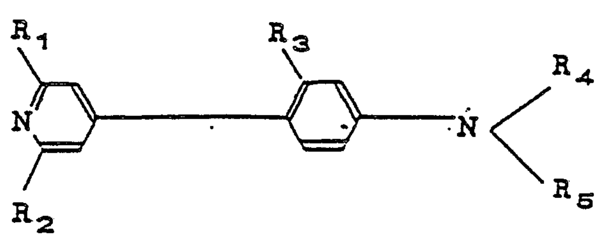
Fig. 5 is a schematic sectional view of a dye transfer sheet according to the invention including a polymer layer between a support and a dye layer;

Fig. 6 is a chromaticity diagram of color images obtained according to the invention;

Fig. 7 is graphical representation of the relation between the reflection density and the impressed pulse width for magenta, cyan and yellow images; and

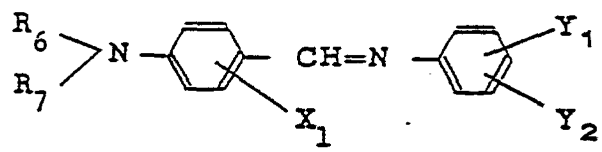
Fig. 8 is a CIE chromaticity diagram of color images prior to and after a light fastness test.

The dye transfer sheet according to the present invention is characterized by a layer of a sublimating basic dye formed on a support. A variety of basic dyes are known in the art and may be used in the practice of the invention provided that their melting point is not too high. Usually, basic dyes having about 100°C or below are used. Preferable basic dyes include aromatic tertiary amines. Most preferably, basic dyes of the following general formulae (1) through (6) are used:



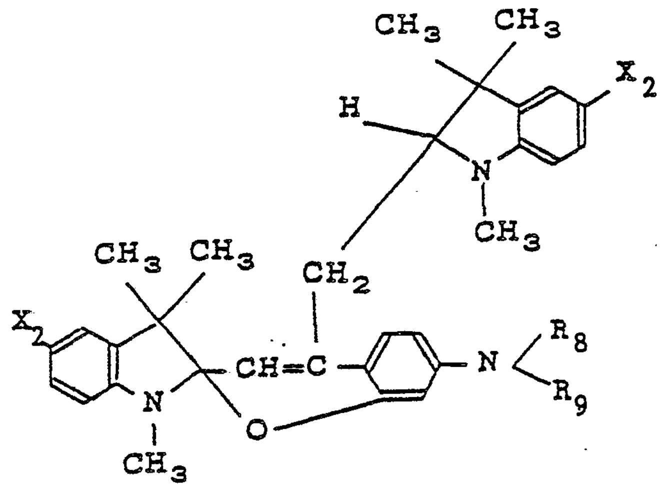
(1)

in which R_1 and R_2 independently represent a hydrogen atom or a phenyl group with or without being substituted with a chlorine atom, R_3 represent a hydrogen atom, a lower alkyl group, or an alkoxy group, R_4 and R_5 independently represent a lower alkyl group which is optionally substituted with a cyano group, a chlorine atom or a lower alkoxy group, or a benzyl group, or a phenyl group;



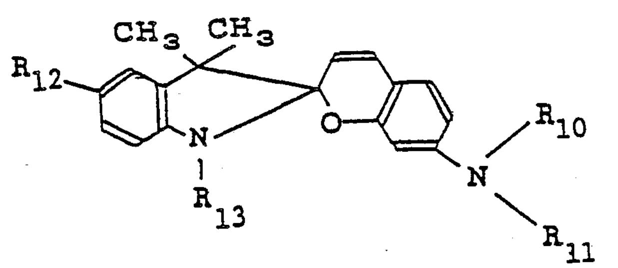
(2)

in which R_6 and R_7 independently represent a lower alkyl group which is optionally substituted with a cyano group, a chlorine atom or a lower alkoxy group, or a benzyl group, or a phenyl group, X_1 and Y_1 independently represent a hydrogen atom, a chlorine atom, a methyl group, or a lower alkoxy group, and Y_2 represents a hydrogen atom, a chlorine atom, a lower alkyl group, a lower alkoxy group, a phenoxy group which is optionally substituted with a chlorine atom, a benzoylamino group, or a lower alkanoylamino group;



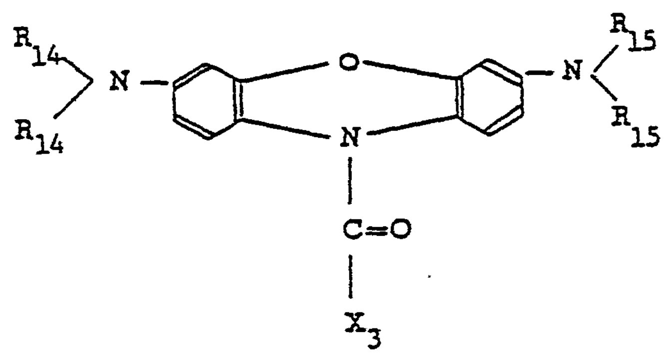
(3)

in which R_8 and R_9 independently represent a methyl group, an ethyl group or a phenyl group, and each X_2 represents a hydrogen atom, a methyl group or a halogen atom;



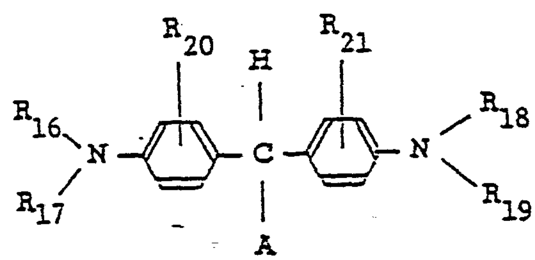
(4)

in which R_{10} represents a lower alkyl group or a benzyl group, R_{11} represents a lower alkyl group, a benzyl group or a phenyl group, R_{12} represents a hydrogen atom, a lower alkyl group, a lower alkoxy group or a halogen atom, and R_{13} represents a lower alkyl group, a benzyl group or a phenyl group;



(5)

in which R_{14} and R_{15} independently represent a lower alkyl group, and X_3 represents a phenyl group, an alkenyl group, an alkyl group or a halogen-substituted alkyl group; and



(6)

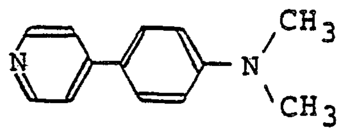
in which R_{16} through R_{21} independently represent a lower alkyl group, and A represents an alkoxy group, an acetamido group, an amino group, a hydroxyl group, an alkyl amino group, an anilino group, an N-alkylanilino group, or a nahthylamino group provided that the benzene ring of the anilino group or N-alkylanilino group, or the naphthalene ring of the naphthylamino group may optionally have a substituent such as a halogen atom, a lower alkyl group, a lower alkoxy group, or a hydroxyethyl group.

In the above formulae, the term 'lower alkyl group' or 'lower alkoxy group' means a group having not larger than 8 carbon atoms. The dyes represented by the general formulae (1) and (2), (3) and (4), and (5) and (6) are yellow, magenta and cyan in color, respectively.

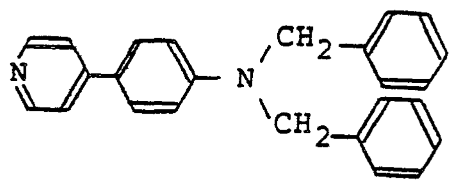
Typical and preferable examples of the dyes include the following dyes of the formulas (1) through (6).

Dyes of the formula (1):

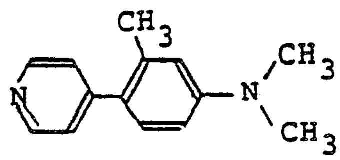
(a)



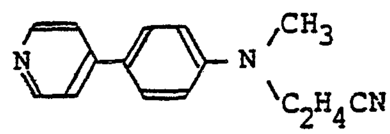
(b)



(c)

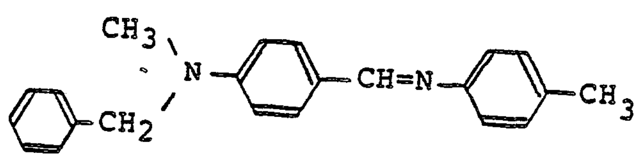


(d)

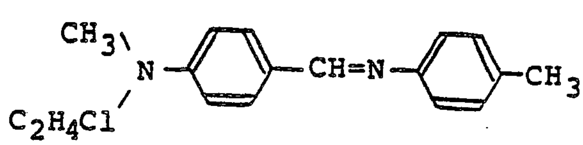


Dyes of the formula (2):

(a)

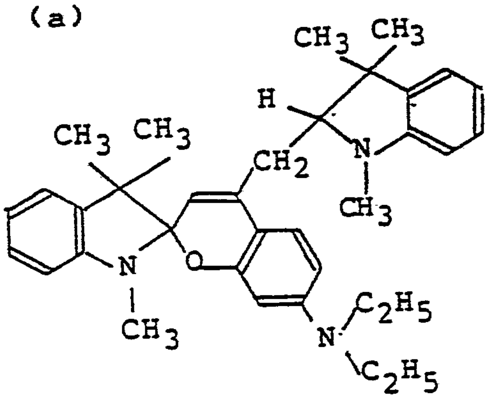


(b)

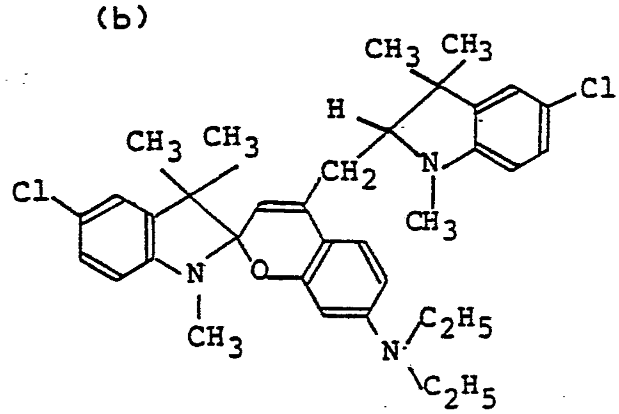


Dyes of the formula (3):

(a)

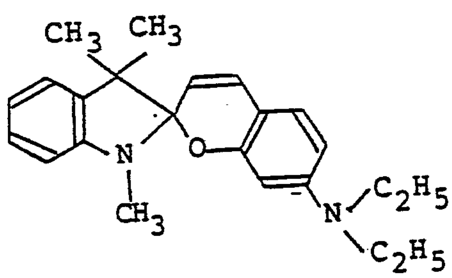


(b)

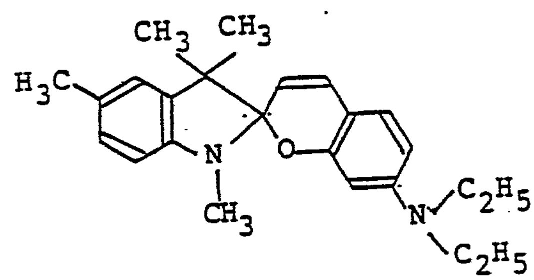


Dyes of the formula (4):

(a)

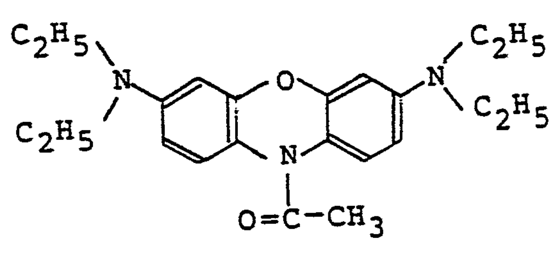


(b)

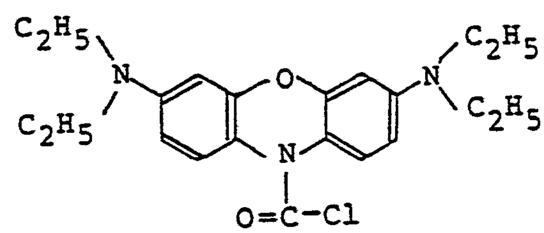


Dyes of the formula (5):

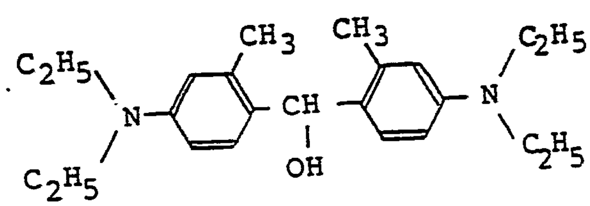
(a)



(b)



Dyes of the formula (6):



These dyes should preferably sublimate at temperatures below 100°C. The dyes may be applied to a support by a variety of techniques. For instance, dyes may be sublimated or vacuum evaporated onto support, or solutions of dyes may be applied to support by casting or gravure printing. Solvents for the dyes are, for example, chlorinated compounds such as chloroform, dichloromethane, dichloroethane, monochlorobenzene, o-dichlorobenzene and the like, and ethylene glycol compounds such as ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, methyl cellosolve, acetate, ethyl cellosolve acetate and the like. The support should preferably be thin enough to efficiently transmit heat to an applied dye therethrough, e.g. its thickness is generally in the range of 5 to 20 microns. Useful supports are condenser papers, electrolytic capacitor papers, porous thin papers, polymer films, metallic foils, metal-evaporated papers and the like. Dyes are applied to support generally in an amount of 10^{-2} to 10 g/m^2. As a matter of course, additives such as stabilizers for dyes may be added to dyes.

In order to provide better images by more uniform sublimation of basic dyes, it is preferable to use resin binders having melting or softening temperatures over 100°C along with the dyes. As mentioned before, the basic dyes used in the practice of the invention have sublimation temperatures below 100°C. Accordingly, when resin binders whose softening or melting temperatures exceed 100°C are used in combination, unfavorable phenomena such as softening of binders, simultaneous transfer of binders with dyes, and troubles in sublimation of dyes will be suppressed even when high temperatures are applied at the time of recording.

Resin binders useful for the purposes are, for example, phenolic resins, melamine resins, urethane resins, epoxy resins, silicone resins, urea resins, diallyl phthalate resins, alkyd resins, acetal resins, methacrylic resins such as polymethyl methacrylate, polyesters, starch and its derivatives, cellulose derivatives, polyethylene, polypropylene, polystyrene, polyvinyl acetals such as polyvinyl butyral, polyamides such as 6-nylon, 11-nylon, 12-nylon, 6,6-nylon, 6,10-nylon and the like, polyvinyl alcohol, polycarbonates, polysulfones, polyether sulfones, polyethylene terephthalate, polybutylene terephthalate, polyphenylene sulfides, polyethylene naphthalate, polyimides, polyamide-imides, AS resins, ABS resins, and the like.

Of these, polymers which are soluble in solvents such as acrylic resins, methacrylic resins, polystyrene, polyvinyl acetals, polyamides, polyvinyl alcohol, polycarbonates, polysulfones, polyether sulfones, polyphenylene oxides, cellulose derivatives and the like, are preferably used because of easy handling thereof.

These binder resins may be applied to substrate after mixing with dyes, or may be applied in the form of a layer intervening between a support and a dye layer. Better results are obtained in the latter case.

Dye transfer sheets for heat-sensitive recording using binder resins can yield images of almost the same reflection density as dye transfer sheets free of binder resins. Presumably, this is considered as follows. A binder resin-containing dye transfer sheet is more uniform than a resin-free sheet in distribution of sublimating dyes over substrate. Moreover, heat transmission also becomes more uniform because irregularities and fine pores on the surface of substrate are filled with binder resins applied. In addition, heat from a heating unit of, for example, a thermal head of a recording apparatus is not consumed as latent heat for melting or softening of resin binder, so that not only sublimation of dye is not impeded, but also heat transmission becomes better because of filling of fine pores in substrate.

Better results are obtained, as mentioned above, when a layer of resin binder is provided between the dye layer and the substrate. This is because basic dyes sublimate without moving through resin binder and directly transfer to an image-receiving medium.

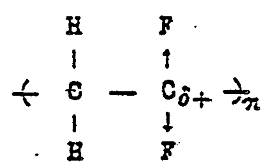
When basic dyes and resin binders are used in combination, it is sufficient that solutions or dispersions of dyes and binder resins in solvents are applied to support by casting or the like techniques. In this case, dyes are mixed in an amount of from 10 to 1000 parts by weight per 100 parts by weight of resin binder.

Where a resin binder layer is formed between a dye layer and a substrate, an intended resin is applied to the substrate, such as, for example, by lamination or baking, or by application of reactive monomer onto substrate and curing of the monomer. After this, dyes are applied by vacuum evaporation or sputtering.

The basic dye transfer sheet of the present invention has been described above. This type of transfer sheet is particularly effective when used in combination with an image-receiving medium which comprises a layer of nonionic electron acceptor. This type of medium can yield images which are resistant to environmental changes.

The electron acceptors useful for the purposes include halogenated polyethylenes such as polyvinyl chloride, polyvinylidene chloride, chlorinated polyethylene, polyvinylidene fluoride, or the like, cyanated polyethylenes such as polyacrylonitrile, aromatic nitro compounds such as 2,4,7-trinitrofluorenone, aromatic nitrile compounds such as phthalodinitrile, 1,3,6,8-tetracyanopyrene, and the like, tetracyanoethylene, 7,7,8,8-tetracyanoquinodimethane derivatives, 11,11,12,12-tetracyanonaphthaquinodimethane derivatives, benzoquinone derivatives such as p-benzoquinone, p-fluoranyl, dichlorodicyanoquinone, and the like, aluminium halides such as aluminium fluoride, aluminium chloride, and the like, gallium halides, antimony halides, and the like.

Of the electron acceptors mentioned above, for example, polyvinylidene fluoride is considered to serve as an electron acceptor for the reason that the carbon positively polarizes as shown in the following formula



The image-receiving medium using electron acceptors produces better results when used in combination with basic dye transfer sheets of the present invention. The resultant image is excellent in image transparency, uniform quality of image and stable in color reproduction, and has an enlarged range of color reproduction.

The reasons for this are considered as follows. Color formation by formation of the charge transfer complex between the basic dye and the electron acceptor is based only on movement of electrons between electrically neutral molecules. Accordingly, color formation is hardly influenced by external factors such as environmental conditions and the once formed complex undergoes little changes in relation to time. In addition, electron acceptors themselves used in the present invention are so stable that images formed on the electron acceptor layer are scarcely affected by the hysteresis of an image-receiving medium. Moreover, electron acceptors are transparent, or has only a slight degree of color, thus yielding highly transparent images.

Preferably, electron acceptors should be supported on substrate in the form of a thin layer, by which images of good quality can be obtained. Electron acceptors can be formed on the surface of a substrate by vacuum evaporation, sputtering, casting or gravure printing. Needless to say, electron acceptors may be admixed with ordinarily employed additives or binders.

The recording principle is described using a basic dye transfer sheet of the invention. In order to carry out the recording, it is preferable to use a specific type of recording apparatus according to one embodiment of the invention.

Reference is now made to the accompanying drawings and particularly Fig. 1. In Fig. 1, there is shown a recording apparatus 1 including a thermal head 2 having a heating unit

3, and a platen 4. A space S is established between the thermal head 2 and the platen 4 to permit a sublimating basic dye transfer sheet 5 and an image-receiving medium 6 to pass therethrough. In this figure, the sheet 5 and medium 6 are moved in the direction of arrow A. The apparatus 1 further includes a pair of rollers 7 at least one of which is a heat roller for thermally fixing an image transferred on the image-receiving medium 6.

The basic dye transfer sheet 5 having a substrate 8 and a layer 9 of a sublimating basic dye with or without a binder formed on the substrate 8. The basic dye may be applied to the substrate 8 as impregnated therein. In this case, the dye may not form a discrete layer on the substrate 8. The basic dye layer 9 is heated in an imagewise pattern by means of the heating unit 3 which is electrically controlled according to an information signal from a control circuit not shown. In order to efficiently transmit the heat from the heating unit 3, the substrate is usually made of a thin sheet of about 5 to 20 microns in thickness. As described before, condenser papers, electrolytic capacitor papers, porous thin papers, polymer films, metallic foils, metal-vaporized papers and the like are used as the thin substrate. The image-receiving sheet 6 has a substrate 10 and an image-receiving layer 11. The transfer sheet 5 and the image-receiving sheet 6 are set between the thermal head

2 and the platen 4 so that the dye layer 9 and the image-receiving layer 11 are facing each other. The sheets 5 and 6 are separately moved by suitable drive means not shown.

In operation, when heated by the heating unit 3 in accordance with an image signal from the control circuit not shown, the basic dye of the dye layer 9 is transferred to the image-receiving sheet 6 by sublimation or melting in an amount corresponding to an amount of heat generated from the heating unit 3. The transferred dye diffuses into the image-receiving layer 11 where it reacts with an electron acceptor to form a color. At the time, the sublimated or melted basic dye is attracted toward the image-receiving layer 11 by chemical reaction with the electron acceptor and diffuses into the image-receiving layer 11. The dye moves toward the image-receiving layer not only by sublimation, but also by chemical reaction, so that it shows a greater tendency of sublimation than in the case where no chemical reaction is involved. The transferred dye is not only deposited merely on the image-receiving sheet, but also chemically combined with the image-receiving layer. Thus, the once combined dye suffers little changes when placed under varying environmental conditions.

The image formed on the image-receiving layer is then heated by the paired rollers 7 to a temperature of 100 to 170°C for thermal fixation. This thermal fixation assists the transferred dye to satisfactorily diffuse into the image-receiving layer. Unless the thermal fixation is effected, it takes a long time before full color formation takes place. Accordingly, the thermal fixation is essential from the practical standpoint. The temperature of the thermal fixation depends on the type of dye and is generally in the range of 100 to 170°C. Lower temperatures are less effective whereas higher temperatures may result in discoloration of dye.

Fig. 2 schematically shows an enlarged sectional view of the transfer sheet 5 and the image-receiving layer 6. In this case, the dye layer 9 is made of a sublimating basic dye 12 dispersed in a binder 13 and the image-receiving layer 11 is made of an electron acceptor 14 dispersed in a binder 15. When electron-acceptive polymers such as polyvinylidene chloride or polyvinylidene fluoride are used, they may also serve as a substrate 10.

The transfer sheet 5 has been illustrated hereinbefore as forming thereon the continuous basic dye layer 9. In order to obtain full color image, it is convenient to use a transfer sheet 5′ as shown in Fig. 3. The transfer sheet 5′ includes the substrate 8 and basic dye layers 9a, 9b and 9c which are formed on the substrate in spaced relation with one another. The basic dye layers 9a, 9b and 9c are made, for example, of cyan, magenta and yellow dyes, respectively.

A full color image can be obtained by superposing images from the basic dye layers 9a, 9b and 9c on a single image-receiving sheet according to an information signal. This is schematically shown in Fig. 4. The dyes 9a, 9b and 9c transferred from the transfer sheet 5 by sublimation or melting diffuse into the image-receiving layer 11. These dyes 9a, 9b and 9c are mixed in molecular state in the image-receiving layer.

The mixing of the dyes in the molecular state has an advantage in that the resulting color is much brighter than a color obtained by superposition of dye layers as in color printing.

In Fig. 5, there is shown another type of basic dye transfer sheet in which a polymer resin layer 16 is formed between the substrate 8 and the dye layer 9 as discussed before.

Fig. 6 shows a CIE chromaticity diagram of single and mixed colors obtained by the use of basic dye transfer sheets according to the present invention in comparison with those colors obtained from the ordinary color printing by an ordinary sublimation transfer printing technique. From the graph, it will be seen that the dye transfer technique of the present invention is comparable in color reproduction to ordinary color printing techniques.

As will be apparent from the above, the basic dye transfer sheet of the present invention can yield full color hard copies by application of low recording energy. The copies have a wide range of color reproduction, continuous graduation, and are resistant to environmental changes.

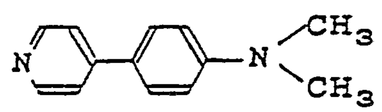
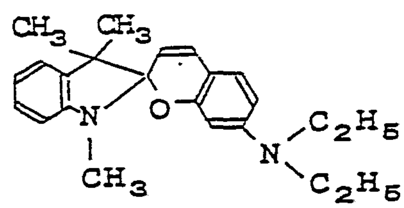
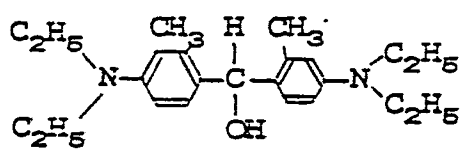
It will be noted that use of a substrate 8 which is uniform in thickness and smooth and also use of a thermal head 2 which is in the form of an blade edge will further improve the quality of image.

The present invention is more particularly described by way of examples.

Example 1

Ink compositions which contained dyes and binders indicated in Table 1 were each applied onto a 12 microns thick condenser paper by the use of a wire bar and dried as usual. Thereafter, each basic dye transfer paper was used for recording by a recording apparatus as shown in Fig. 1, in which a clay-coated paper was used as a dye-receiving sheet.

Table 1 Ink Compositions

Ink	Dye	Binder
Yellow	 2 wt% chloroform solution, 8 parts by weight	Polyester (Commercial Name: Vylon) 2 wt% chloroform solution, 2 parts by weight
Magenta	 1 wt% dichloroethane solution, 6 parts by wt.	Polyester (Commercial Name: Vylon) 2 wt% dichloroethane solution, 4 parts by weight
Cyan	 1 wt% dichloroethane solution, 8 parts by wt.	Polysulfone 2 wt% dichloroethane solution, 2 parts by weight

The recording conditions were as follows.

Line density of main and sub scannings: 8 dots/mm

Recording power: 0.2 W/dot

Heating time of thermal head: 2 - 8 m.s.

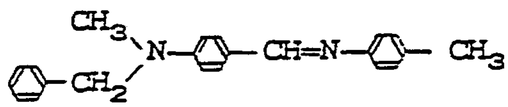
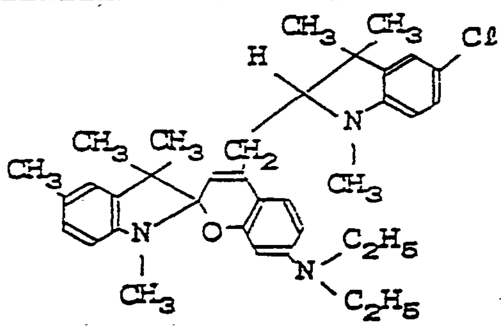
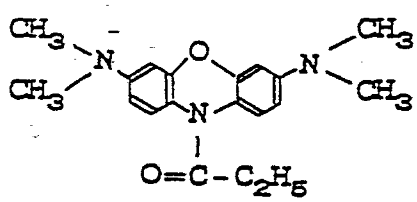
The chromaticity diagram of single and mixed colors is shown in Fig. 6 in comparison with a diagram by ordinary color printing. The color mixing is in the order of cyan, yellow and magenta. In Fig. 7, there is shown the relation between the reflection density and the head heating time for different colors.

Saturation densities of the cyan and magenta were greater than 1.4 and a saturation density of yellow was greater than 1.1. From Fig. 7, it will be seen that smooth graduation is obtained for the respective colors.

Example 2

Ink compositions containing dyes indicated in Table 2 were prepared by mixing 8 parts by weight of a 1wt% dye solution in dichloroethane and 2 parts by weight of a 2 wt% polycarbonate solution in dichloroethane and treated in the same manner as in Example 1.

Table 2 Ink Compositions

Ink	Dye
Yellow	
Magenta	
Cyan	

As a result, there was obtained a chromaticity diagram similar to the diagram shown in Fig. 6. Saturation densities of the respective colors were greater than 1.2. Graduation of each color was smooth as in Fig. 7.

Example 3

Ink compositions containing dyes of the same types as used in Example 2 and various polymer resins indicated in Table 3 were each applied to a 12 microns thick condenser

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paper by means of a wire bar and dried. Each basic dye transfer paper was used along with a clay-coated paper for recording by the use of a thermal head. The ink compositions were prepared by mixing 8 parts by weight of a 1 wt% ink solution and 2 parts by weight of a 2 wt% polymer solution.

The recording conditions were as follows.

Line density of main and sub scannings: 8 dots/mm

Electric power for recording: 0.2 W/dot

Heating time of head: 5 m.s.

The reflection densities of the respective color images are shown in Table 3 in relation to the type of polymer. The values shown in the table are average reflection densities measured at five portions, each having a 1 x 1 mm area, by a micro densitometer. In each parenthesis, there is shown a difference between maximum and minimum reflection densities.

Table 3

Ink / Polymer	Yellow	Magenta	Cyan
polymethyl methacrylate	0.47 (0.21)	0.70 (0.20)	0.60 (0.22)
polystyrene	0.50 (0.19)	0.69 (0.22)	0.60 (0.20)
12-nylon	0.51 (0.18)	0.68 (0.23)	0.61 (0.71)
polyvinyl alcohol	0.46 (0.21)	0.72 (0.24)	0.58 (0.19)
polycarbonate	0.52 (0.18)	0.72 (0.23)	0.61 (0.18)
polysulfone	0.52 (0.21)	0.71 (0.22)	0.60 (0.22)
polyvinyl butyral	0.47 (0.22)	0.70 (0.27)	0.60 (0.24)
ABS resin	0.46 (0.21)	0.69 (0.22)	0.57 (0.26)
Polyester resin (Commercial name: Vylon)	0.51 (0.19)	0.73 (0.20)	0.60 (0.21)
Reference (no polymer contained)	0.52 (0.38)	0.73 (0.46)	0.61 (0.40)

Example 4

Each of 2 wt% polymer solutions as used in Example 3 was applied to a condenser paper of the same type as used in Example 3 by means of a wire bar, and each of 1 wt% dye solutions as used in Example 2 was further applied to the condenser paper in such a state that the applied polymer solution did not dry fully, followed by drying to obtain a basic dye transfer sheet.

The sheets were treated under the same conditions as in Example 3, thereby obtaining images. These images had average reflection densities greater by 0.01 to 0.05 than those densities indicated in Table 3.

Example 5

Chloroform solutions containing three types of dyes as used in Example 1, each in an amount of 1 wt%, were applied onto a 12 microns thick condenser paper by a wire bar and dried to obtain basic dye transfer sheets. These transfer sheets were used for recording by a thermal head in combination with an image-receiving sheet made of a 50 microns thick polyvinylidene fluoride film. The recording conditions were the same as those used in Example 1.

Images which had been recorded on the image-receiving sheet used in this example and also on a phenolic resin-containing paper were subjected to the light fastness test using a xenone arc lamp according to the method prescribed in JIS L0843. The chromaticity diagram of these images prior to and after the test are shown in Fig. 8.

From the above figure, it will be seen that the image on the image-receiving sheet of the present invention has a wider range of color reproduction and suffers a less influence of the arc lamp than in the case of the phenolic resin-containing sheet. Moreover, saturation densities of the respective colors prior to and after the xenone arc lamp test were greater than 1.2.

Example 6

One part by weight of 7,7,8,8-tetracyanoquinodimethane and 1 part by weight of polycarbonate were dissolved in 100 parts by weight of dichlormethane. The solution was applied onto an ordinary paper and dried to obtain an image-receiving paper. Basic dye transfer papers were made using three inks of the same types as used in Example 1. Images were recorded under the same conditions as in Example 1 using the image-receiving and transfer papers.

The resultant images were evaluated similar to Example 5 with similar results of the chromaticity diagram. Saturation densities of the respective colors were all greater than 1.4.

Example 7

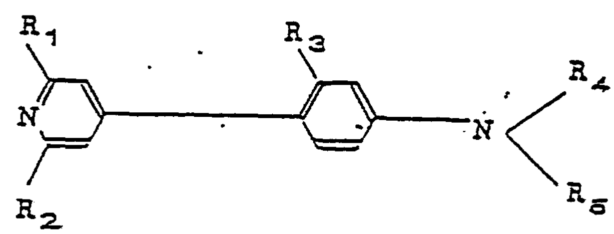
Various image-receiving sheets were made including 50 microns thick polyvinyl chloride, polyvinylidene chloride and polyacrylonitrile films, and ordinary papers which had been applied with, instead of 7,7,8,8-tetracyanoquinodimethane of Example 6, 2,4,7-trinitrofluorenone, phthalodinitrile, p-fluoranyl, dichlorodicyanoquinone, aluminium chloride, aluminium fluoride and gallium chloride in the same manner as in Example 6. These sheets were tested in the same manner as in Example 5 with similar results. Saturation densities of the respective colors were all greater than 1.0.

CLAIMS

1. A dye transfer sheet for heat-sensitive recording which comprises a support and a layer of a sublimating basic dye formed on the support, whereby when heated in an imagewise pattern, the dye sublimates from the dye layer and deposits on an image-receiving sheet according to the imagewise pattern.

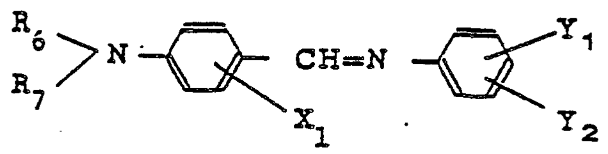
2. A dye transfer sheet according to Claim 1, wherein the basic dye is an aromatic tertiary amine.

3. A dye transfer sheet according to Claim 2, wherein said aromatic tertiary amine is selected from the group consisting of compounds of the following formulae (1) through (6):



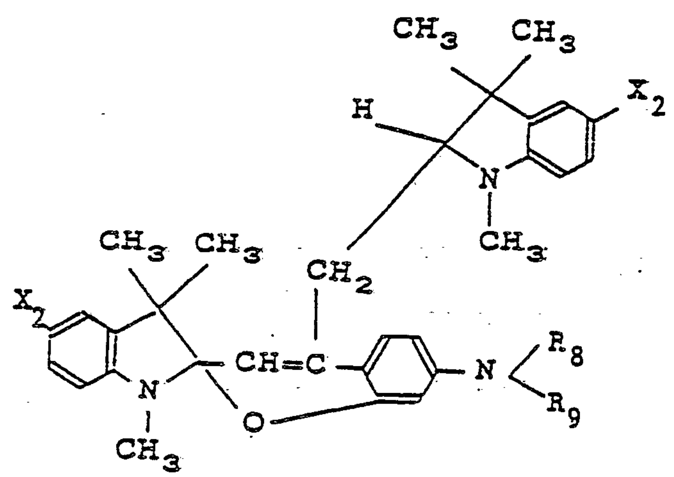
(1)

in which R_1 and R_2 independently represent a hydrogen atom or a phenyl group with or without being substituted with a chlorine atom, R_3 represent a hydrogen atom, a lower alkyl group, or an alkoxy group, R_4 and R_5 independently represent a lower alkyl group which is optionally substituted with a cyano group, a chlorine atom or a lower alkoxy group, or a benzyl group, or a phenyl group;



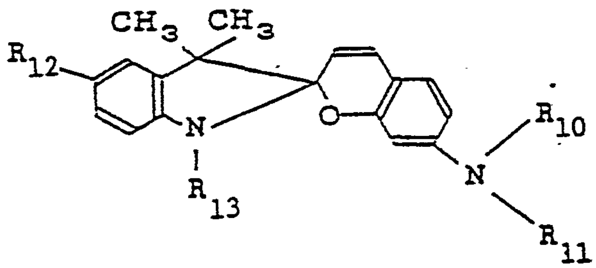
(2)

in which R_6 and R_7 independently represent a lower alkyl group which is optionally substituted with a cyano group, a chlorine atom or a lower alkoxy group, or a benzyl group, or a phenyl group, X_1 and Y_1 independently represent a hydrogen atom, a chlorine atom, a methyl group, or a lower alkoxy group, and Y_2 represents a hydrogen atom, a chlorine atom, a lower alkyl group, a lower alkoxy group, a phenoxy group which is optionally substituted with a chlorine atom, a benzoylamino group, or a lower alkanoylamino group;



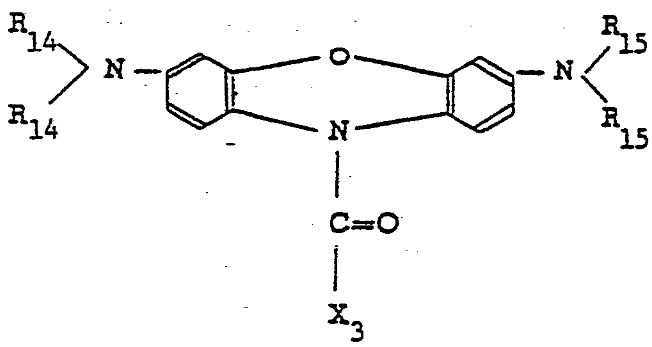
(3)

in which R_8 and R_9 independently represent a methyl group, an ethyl group or a phenyl group, and each X_2 represents a hydrogen atom, a methyl group or a halogen atom;



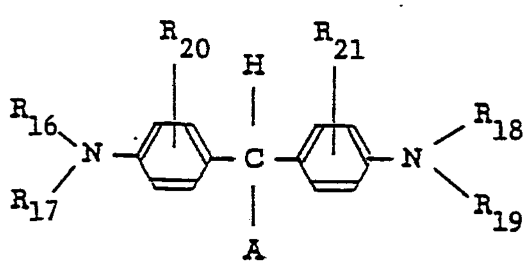
(4)

in which R_{10} represents a lower alkyl group or a benzyl group, R_{11} represents a lower alkyl group, a benzyl group or a phenyl group, R_{12} represents a hydrogen atom, a lower alkyl group, a lower alkoxy group or a halogen atom, and R_{13} represents a lower alkyl group, a benzyl group or a phenyl group;



(5)

in which R_{14} and R_{15} independently represent a lower alkyl group, and X_3 represents a phenyl group, an alkenyl group, an alkyl group or a halogen-substituted alkyl group; and



(6)

in which R_{16} through R_{21} independently represent a lower alkyl group, and A represents an alkoxy group, an acetamido group, an amino group, a hydroxyl group, an alkylamino group, an anilino group, an N-alkylanilino group, or a nahthylamino group provided that the benzene ring of the anilino group or N-alkylanilino group, or the naphthalene ring of the naphthylamino group may optionally have a substituent selected from the group consisting of a halogen atom, a lower alkyl group, a lower alkoxy group, or a hydroxyethyl group.

4. A dye transfer sheet according to Claim 1, 2 or 3, wherein the layer is made of the sublimating basic dye admixed with a polymer having a melting or softening point exceeding 100°C.

5. A dye transfer sheet according to Claim 1, further comprising a layer of a polymer having a melting or softening point exceeding 100°C, the polymer layer being provided between the support and the basic dye layer.

6. A dye transfer sheet according to Claim 1, wherein the image-receiving sheet has a layer of an electron acceptor.

7. A dye transfer sheet according to Claim 6, wherein the electron acceptor is non-ionic.

8. A dye transfer sheet according to Claim 6 or 7, wherein the electron acceptor is a member selected from the group consisting of halogenated polyethylenes, cyanated

polyethylenes, aromatic nitro compounds, aromatic nitrile compounds, tetracyanoethylene, 7,7,8,8-tetracyanoquinodimethane derivatives, 11,11,12,12-tetracyanonaphthaquinodimethane derivatives, benzoquinone derivatives, aluminium halides, gallium halides, and antimony halides.

9. A heat-sensitive recording apparatus which comprises a first heat source which is controlled according to an information signal, a platen placed in face-to-face relation with the first heat source and establishing a gap with the first heat source so as to permit a transfer sheet having a sublimating basic dye layer to be passed therebetween along with an image-receiving sheet whose image-receiving surface is in face-to-face relation with the basic dye layer of the transfer sheet, and a second heat source located downstream of the first heat source to fix an image formed on the image-receiving surface, whereby when the transfer sheet is heated according to the information signal, the dye moves by sublimation toward the image-receiving layer in portions where heated and an intended image is formed on the image-receiving layer and is fixed by application of heat from the second heat source.

Fig. 1

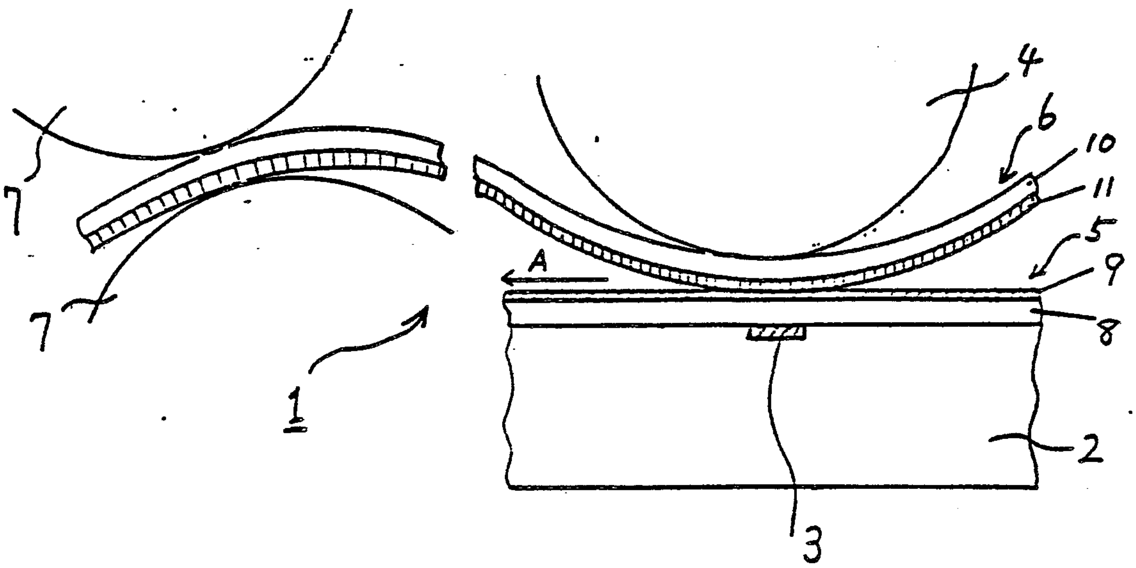


Fig. 2

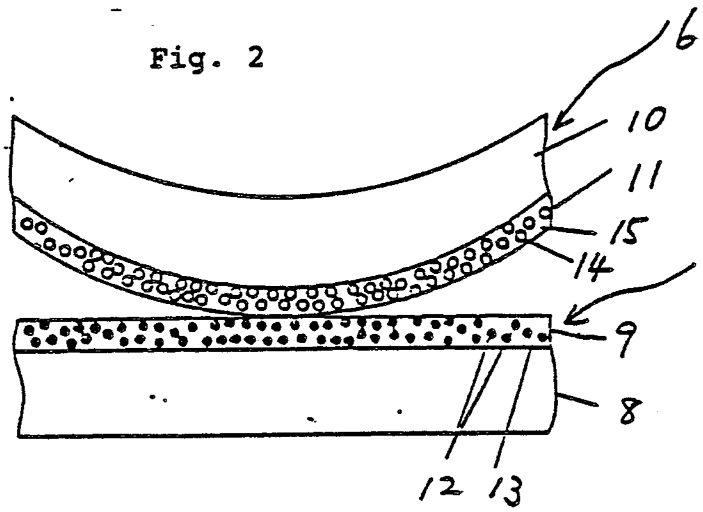


Fig. 3

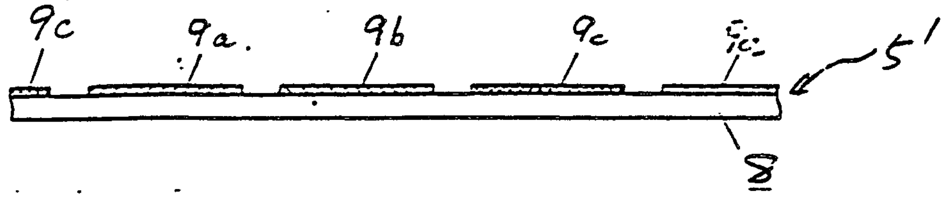


Fig. 4

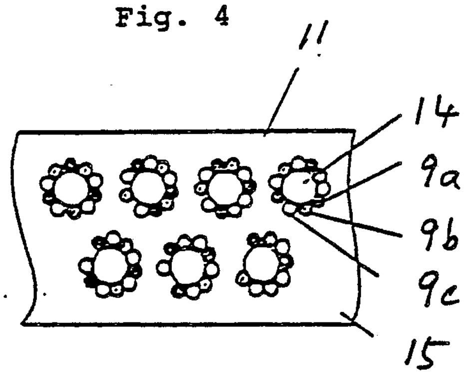


Fig. 5

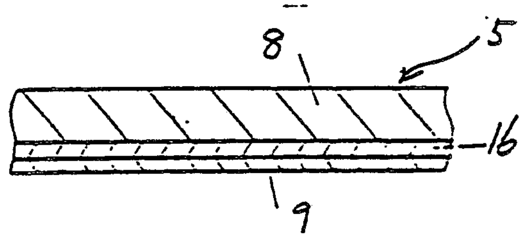
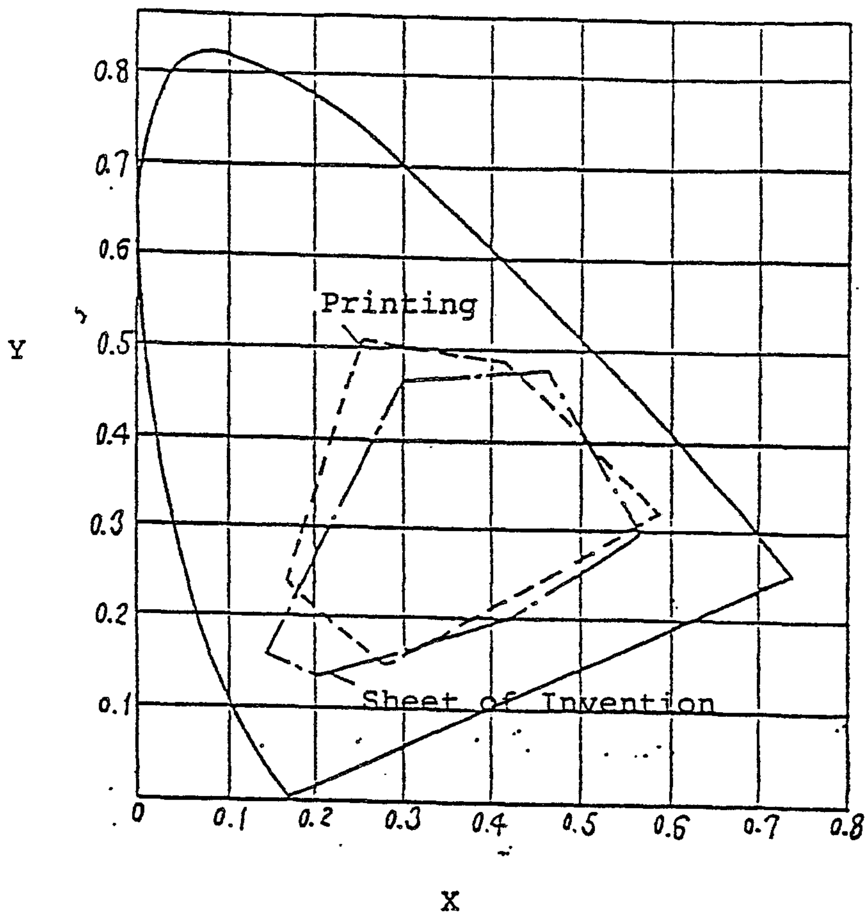


Fig. 6



Y
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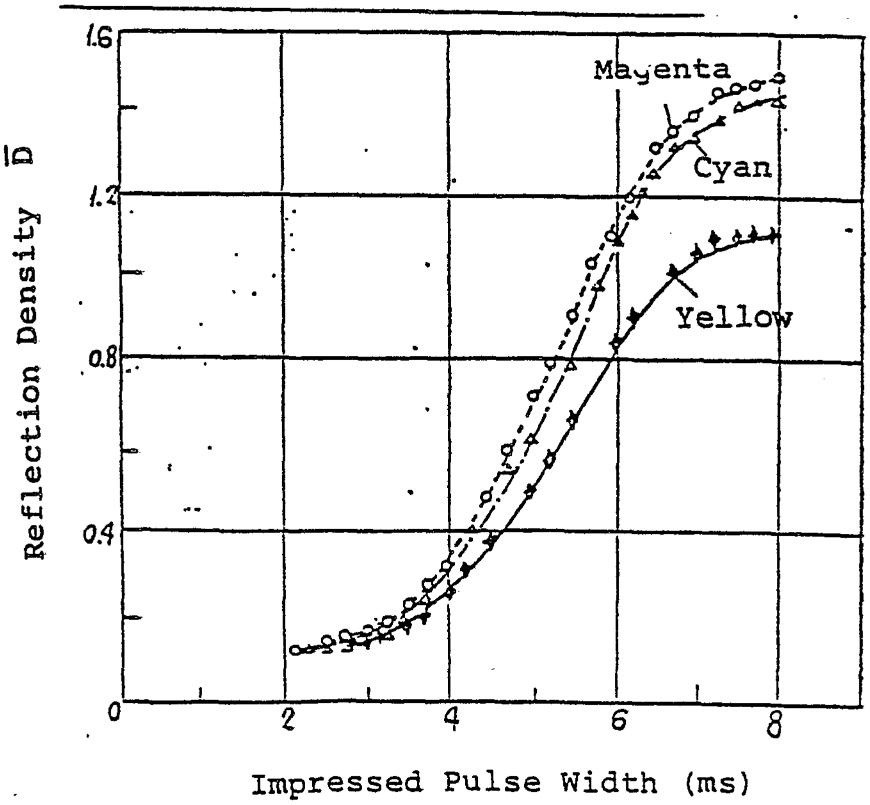
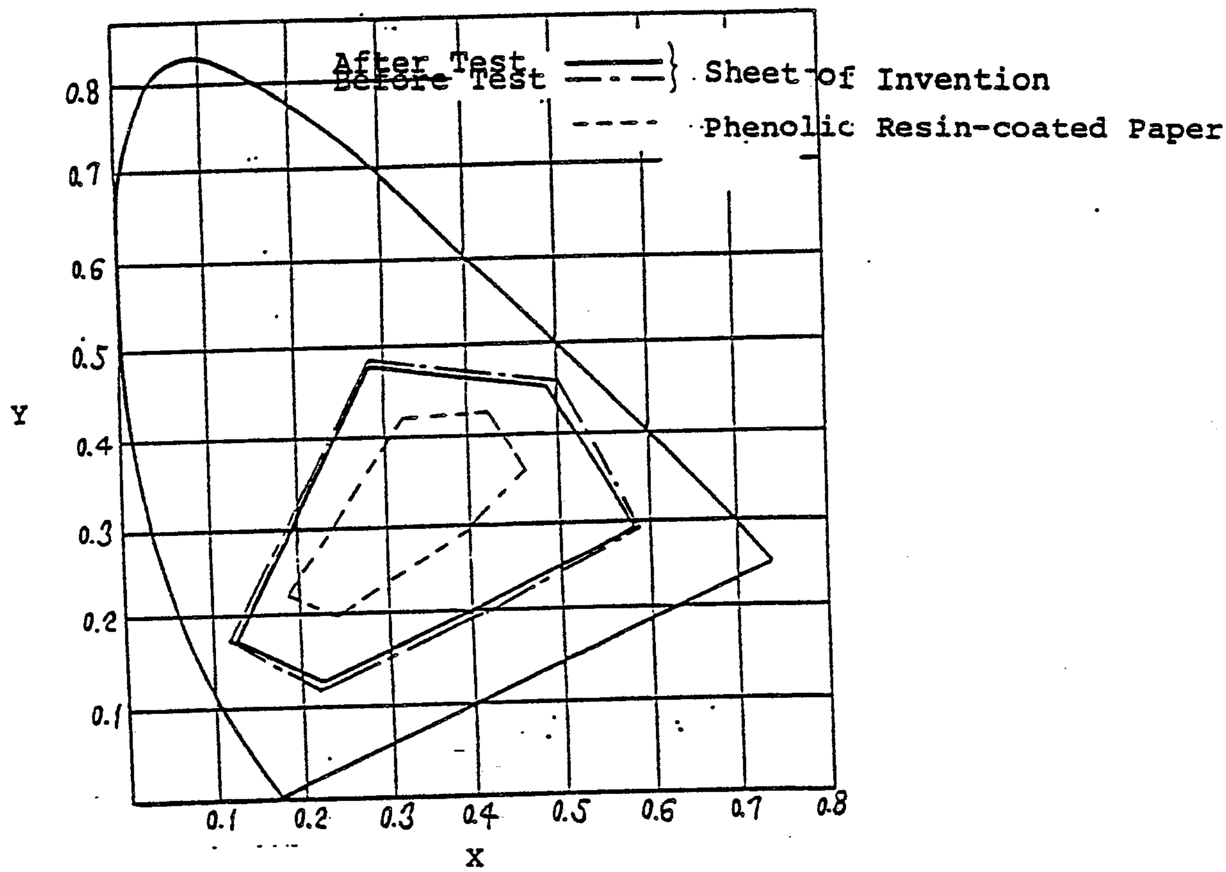
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Printing
Sheet of Invention
X

Fig. 7



Reflection Density D
1.6
1.2
0.8
0.4
0
2
4
6
8
Magenta
Cyan
Yellow
Impressed Pulse Width (ms)

Fig. 8


After Test
Before Test
Sheet of Invention
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0.4
0.3
0.2
0.1
Y
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
X

European Patent Office

EUROPEAN SEARCH REPORT

0097493

Application number

EP 83 30 3487

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
X,Y	NL-A-6 500 108 (NEDERLANDSCHE FOTOGRAFISCHE INDUSTRIE) * Page 3, line 7 - page 4, line 8; page 5, line 29 - page 6, line 31; page 8, line 33 - page 10, line 5; page 12, line 20 - page 13, line 29; claims 1-7 *	1-9	B 41 M 5/26

X,Y	US-A-3 239 366 (R.E. MILLER et al.) * Example 1; claims *	1-9	

			TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
			B 41 M 5/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17-08-1983	PHILOSOPH L.P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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