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(71) Applicant: **EASTMAN KODAK COMPANY**
Rochester, New York 14650 (US)

(72) Inventor:
Zeltser, Alexander Michael
Rochester, New York 14650-2201 (US)

(74) Representative:
Lewandowsky, Klaus, Dipl.-Ing. et al
Kodak Aktiengesellschaft,
Patentabteilung
70323 Stuttgart (DE)

(54) Dye donor member for thermal printers

(57) A dye donor member has a matrix portion comprised of a composite material with anisotropic thermal conductivity, wherein the thermal conductivity in a direction perpendicular to the plane of the member is substantially greater than the thermal conductivity in the direction of the plane of the member.

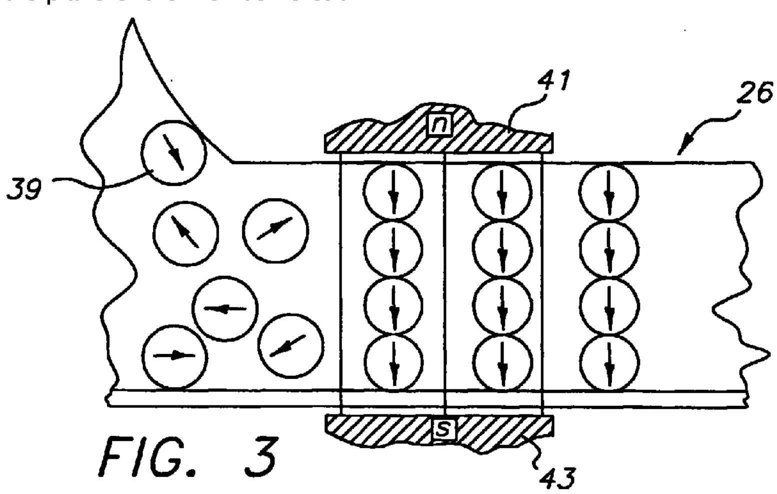

FIG. 3

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Description

BACKGROUND OF THE INVENTION

Technical Field

[0001] This invention relates generally to resistive thermal printers, and more particularly to a dye donor member for such printers.

Background Art

[0002] Color dye transfer thermal printers use a dye donor member which may be a sheet, but usually is in the form of a web advanced from a supply roll to a take-up roll. The dye donor member passes between a printhead and a dye receiver member. The thermal printhead comprises a linear array of resistive heat elements. In operation, the resistive heat elements of the printhead are selectively energized in accordance with data from a printhead control circuit. As a result, the image defined by the data from the printhead control circuit is placed on the receiver member.

[0003] A significant problem in this technology is that the dye donor members used to make the thermal prints are generally poor thermal conductors. Accordingly, there is a tradeoff between the desire to have thick dye donor members with their associated increased durability and/or strength and the desire to have thin dye donor member with their associated improved resolution, lower printhead power requirement, more efficient heat transfer, and/or increased printing speed.

[0004] While most dye donor members are intended for single (one time) use, it has been suggested that materials can be conserved by the re-application of dye to a dye donor element by diffusion of dye from a reservoir through a diffusion controlled permeation membrane into the dye donor element. The diffusion controlled permeation membrane inhibits diffusion of the carrier, whereby the dye partitions between the reservoir and the dye donor element but the carrier does not. With the addition of heat, dye diffuses through the membrane and is delivered to the donor patch. The dye partitions between the reservoir and the donor patch reestablishing the original dye concentration. Materials used as the support for the dye-donor member of the invention should have dimensional stability and withstand the heat of the laser or thermal head. Such materials include aluminum or other metals; polymers loaded with carbon black; metal/polymer composites such as polymers metalized with 500-1000 Å of metal; polyesters; polyamides; polycarbonates; cellulose esters; fluorine polymers; polyethers; polyacetals; polyolefins, polyethylene, polypropylene or methylpentene polymers; and polyimides. The support generally has a thickness of from about 5 μm to about 200 μm, and may also be coated with a subbing layer. Were the support more thermally conductive, re-inking head power requirements would be reduced because of more efficient heat transfer to the dye reservoir.

DISCLOSURE OF THE INVENTION

[0005] It is an object of the present invention to provide a dye donor member which improves printing resolution.

[0006] It is another object of the present invention to provide a dye donor member which increases printing speed.

[0007] It is still another object of the present invention to provide a dye donor member with improved durability.

[0008] It is a feature of the present invention to provide a dye donor member which has a support portion which is a composite material with anisotropic thermal conductivity, wherein the thermal conductivity in a direction perpendicular to the plane of the member is substantially greater than the thermal conductivity in the direction of the plane of the member.

[0009] The invention, and its objects and advantages, will become more apparent in the detailed description of the preferred embodiments presented below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] In the detailed description of the preferred embodiments of the invention presented below, reference is made to the accompanying drawings, in which:

Figure 1 is a schematic side view of a dye donor ribbon thermal printer in which the present invention is particularly useful;

Figure 2(a) is a schematic cross-sectional view of a first embodiment of the dye donor ribbon according to the present invention;

Figure 2(b) is a schematic cross-sectional view of a second embodiment of the dye donor ribbon according to the present invention;

Figure 2(c) is a schematic cross-sectional view of a third embodiment of the dye donor ribbon according to the present invention; and

Figure 3 is a schematic cross-sectional view of the third embodiment of the dye donor ribbon according to the present invention showing a preferred process for manufacturing the ribbon.

BEST MODE FOR CARRYING OUT THE INVENTION

[0011] The present description will be directed in particular to elements forming part of, or cooperating more directly with, apparatus in accordance with the present invention. It is to be understood that elements not specifically shown or described may take various forms well known to those skilled in the art.

[0012] Referring to Figure 1, a reusable dye donor member is provided, such as in the form of a belt 10 that is trained about a pair of rollers 12 and 14. At least one of the two rollers is driven to advance belt 10 past a plurality of dye reservoir rollers 16, 18, and 20; one or more re-ink heads 22; and a resistive thermal printhead 24 at a printing station.

[0013] A dye donor member, such as belt 10, comprises a support 26 and a dye donor element such as a plurality of dye donor patches 28, 30, and 32. Referring to Figures 2(a), support 26 includes a low thermal conductivity isotropic matrix (e.g., polymer with a thermal conductivity of less than approximately 10^{-1} W/Km) in which high thermal conductivity, rod-like aciculae 33 (e.g., metal particles with a thermal conductivity of at least about 10 W/Km) are dispersed. The rod-like aciculae are distributed with their long axes parallel to the thickness of the support (perpendicular to the plane of the support), and extend substantially the entire thickness of the support. The thickness of the dye donor member may be selected in accordance with the system requirements; strength and durability being enhanced by thicker members at the expense of image resolution and/or printing speed.

[0014] In Figure 2(b), rod-like aciculae 35 are not as long as the support thickness, and link together to span the support. Referring to Figure 2(c), high thermal conductivity spherical particles are arranged in chains 37 with chain axes perpendicular to the plane of the support. A choice of the volume fraction, diameter and aspect ratio of particles may be selected by experimentation to provide continuous thermally-conducting channels perpendicular to the plane of the support.

[0015] One may fabricate a support as illustrated in Figure 2(c) by the method shown in Figure 3. Small (less than about 50 μm diameter) spherical magnetic particles 39 (ferromagnetic materials such as Ni, Fe, Co, or their alloys; or ferrimagnetic material such as barium-ferrite) are dispersed in a polymeric matrix binder and extruded into a sheet form. The particles are of at least a factor of ten greater thermal conductivity than the matrix. Other materials may be added to improve dispersion or other properties of the composite material, as desired.

[0016] Before the binder is cured, the extruded sheet is passed between the poles of a magnet 41, 43 which applies a magnetic field perpendicular to the sheet plane. The magnetic field strength is sufficient to magnetize spherical particles 39 in a direction parallel to the field and re-arrange them into chains of spheres.

[0017] The matrix viscosity in the pre-cured state should be low enough so that the drag force on the particles is less than the magnetic force. The driving force for re-arranging the spherical particles into chains is a significant reduction in magnetostatic energy of the particle assembly. To prevent metallic particles from oxidation and to improve thermal conductivity of the composite material, particles can be coated with a noble metal, such as for example Au, prior to the dispersion in the polymeric matrix.

[0018] Referring back to Figure 1, a conventional dye receiver medium 34 is drawn through a nip formed between printhead 24 and a platen roller 36 by a capstan drive roller pair 38 and 40. Dye receiver medium 34 is conventional, and includes a support 42 and a receiving layer 44. Image-wise activation of linear printhead 24 causes dye to be transferred from the dye donor element of belt 10 into the dye receiving layer of medium 34; at least partially image-wise depleting portions of the patches of dye.

[0019] Dye reservoir rollers 16, 18, and 20 include a permeation membrane. Examples of membrane material include cellulose and derivatezed cellulose used alone or blended with other components, polyesters, polyamides, polysufone, crosslinked polystyrene, phenol/formaldehyde resin and fluorinated polymers to include polytetrafluoroethuylene and polyvinylidene fluoride, polycarbonate, poly(vinyl alcohol) and silicon containing polymers. Membranes can be constructed from a dense layer of polymer supported on a porous sub-layer. These polymeric membranes can be crosslinked to further reduce permeability.

[0020] Dye reservoir rollers 16, 18, and 20 may be replaced by wicks formed of similar materials, but not mounted for rotation.

[0021] Each dye reservoir roller is opposed by a re-ink head 22 (only one head is illustrated in the drawing), and the rollers are selectively raised and lowered into contact with belt 10 as necessary. When a dye reservoir roller is lowered to belt 10, and the associated re-ink head activated, heat and/or pressure between the dye reservoir roller and the belt effects re-inking of the dye donor element, and the depleted dye donor layer of the patch is re-saturated with dye from the dye reservoir roller.

[0022] In this method, dye is thermally transferred from a reservoir to the depleted donor patch. The dye and a carrier are contained in the reservoir. The reservoir is covered with a diffusion controlled permeation membrane. With the addition of heat dye diffuses through the membrane and is delivered to the donor patch. The dye partitions between the reservoir and the donor patch reestablishing the original dye concentration.

[0023] During the re-diffusion, dye separates from the solvent. A semi-permeable membrane allows only the dye to diffuse out of the dye supply and into the donor element. Solvent is retained within the supply. Other methods of replenishment require that solvent is removed either prior to the replenishment step (intermediate transfer) or after transfer of dye to the donor ribbon. Solvents must be volatile in these alternative approaches. In addition, the removal of solvent results in more complex hardware as well as the potential health and safety problems associated with this process.

[0024] Dye transfer from the reservoir through the semi-permeable membrane may not require any carrier solvent. In a solid dye transfer mechanism, dye would melt and diffuse through the membrane to re-ink the donor patch.

Advantages:

[0025] Among the advantages of the present invention are:

1. Improved printing resolution because of decreased lateral spreading in the donor member support.
2. Reduced printhead power requirements because of more efficient heat transfer to the donor element.
3. Reduced re-inking head power requirements because of more efficient heat transfer to the dye reservoir.
4. Reduced ink utilization during printhead firing because of more efficient heat transfer to the donor element.
5. Increased printing speed because of reduced donor element cool-off time.
6. Improved donor member durability due to greater acceptable thickness and/or strength of the donor member support.
7. Improved donor member durability because of reduced maximum temperature and duration of a heating pulse.
8. Improved donor member traction or reduced slippage because of increased roughness of the donor member support.
9. A donor member support material that can be used in conjunction with diverse types of thermal printheads.

Claims

1. A dye donor member for dye transfer thermal printers, said dye donor member having a support comprising:

a low thermal conductivity matrix; and
a plurality of high thermal conductivity particles dispersed within the matrix.

2. A dye donor member as set forth in Claim 1 wherein the high thermal conductivity particles are aciculae.

3. A dye donor member as set forth in Claim 1 wherein:

the matrix has a predetermined thickness; and
the high thermal conductivity particles are distributed with long axes substantially parallel to the thickness of the matrix to provide continuous thermally-conducting channels parallel to the thickness of the matrix.

4. A dye donor member as set forth in Claim 1 wherein the high thermal conductivity particles are spherical particles arranged in chains.

5. A dye donor member as set forth in Claim 1 wherein the support is anisotropic with respect to thermal conductivity properties.

6. A dye donor member as set forth in Claim 1 wherein the matrix is a polymer matrix with a thermal conductivity of less than approximately 10^{-1} W/Km.

7. A dye donor member as set forth in Claim 1 wherein the high thermal conductivity spherical particles have a thermal conductivity of at least about 10 W/Km.

8. A process for fabricating a dye donor member, said process comprising:

dispersing spherical magnetic particles in a polymeric matrix binder;
extruding the dispersion into a sheet form;
passing the extruded sheet between poles of a magnet before the binder is cured to apply a magnetic field perpendicular to the sheet plane, thereby magnetizing the spherical particles in a direction parallel to the field and rearranging them into chains of spheres.

9. A process for fabricating a dye donor member as set forth in claim 8, wherein the magnetic particles have diameters less than about 50 μm.

10. A process for fabricating a dye donor member as set forth in claim 8, wherein the magnetic particles are ferromagnetic particles.

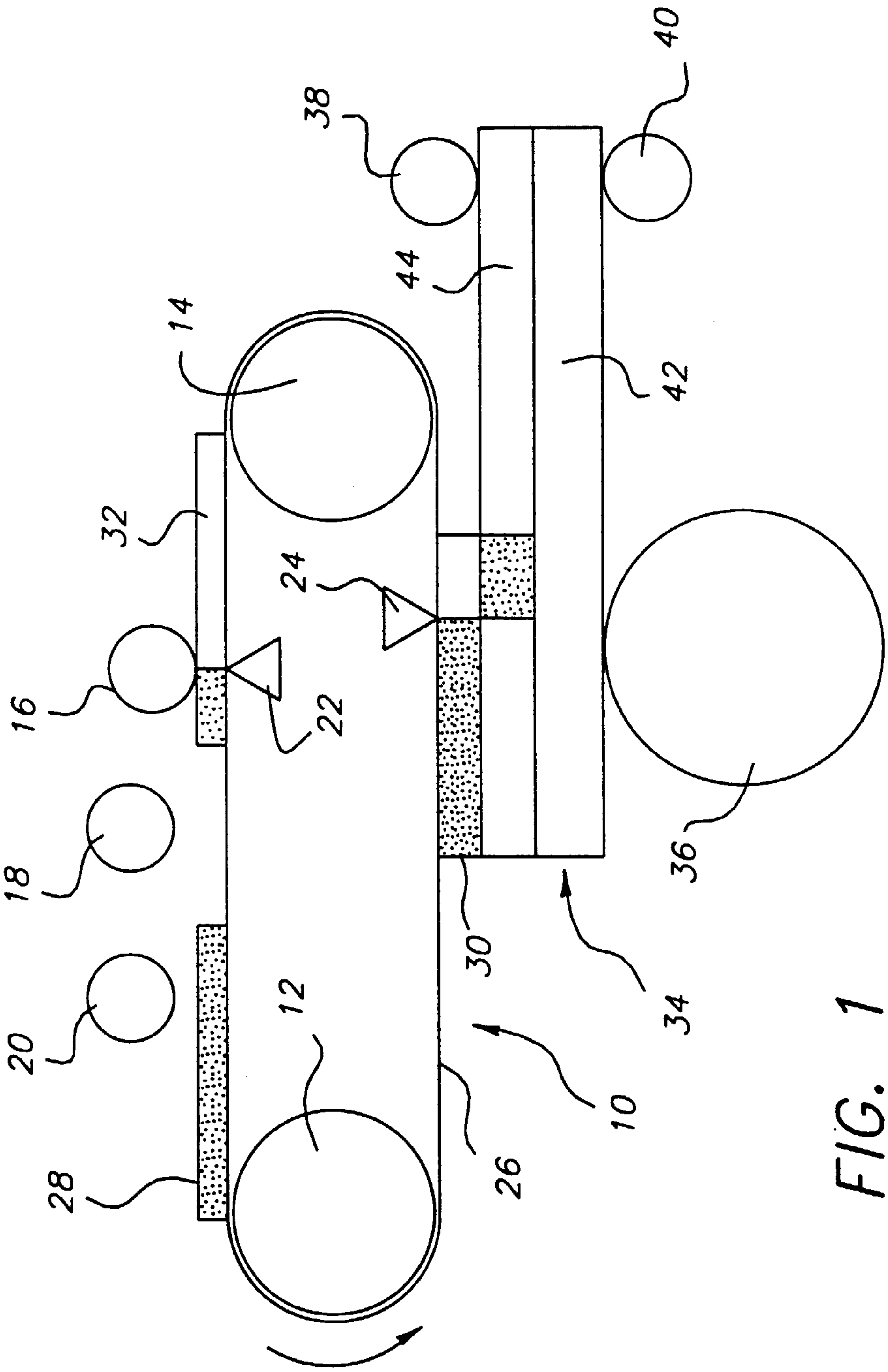

FIG. 1

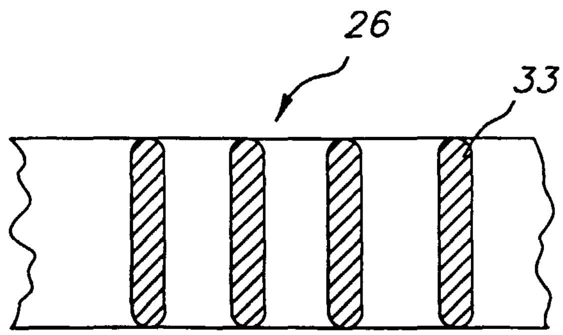

FIG. 2a

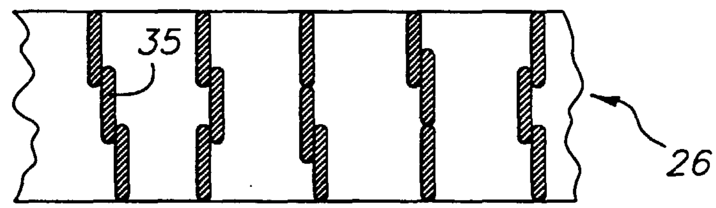

FIG. 2b

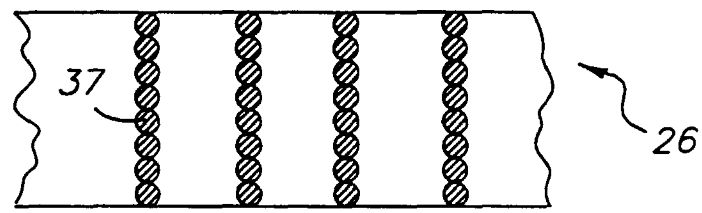

FIG. 2c

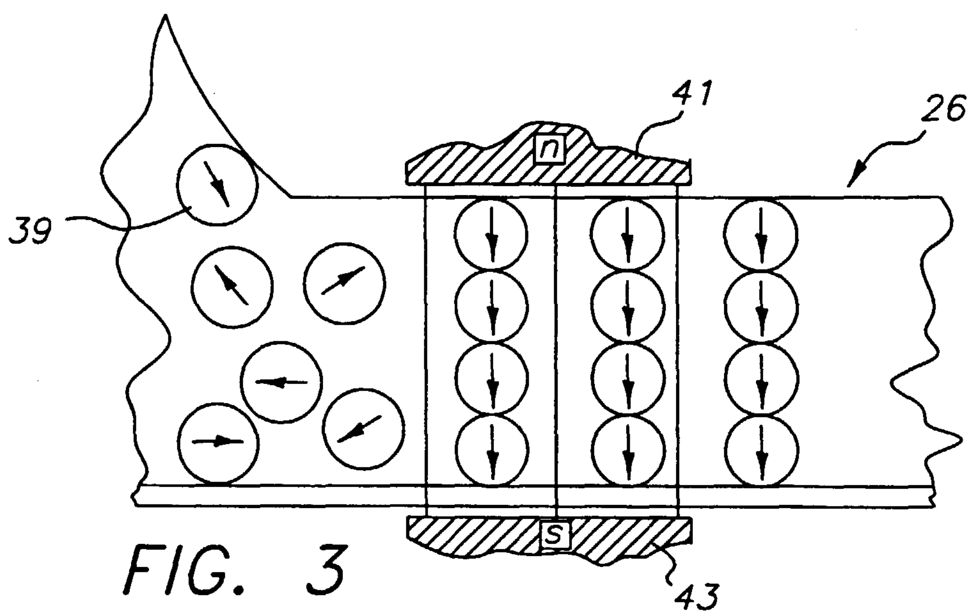

FIG. 3