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(54) Thermal transfer ink ribbon.

(57) A thermal transfer ink ribbon requiring less printing energy is provided which includes a foundation, and one or more coat layers provided on at least one side of the foundation and including at least one heat-meltable ink layer, the ink layer having a melting or softening point of from about 60° to 120°C, the ink ribbon requiring a heat quantity of not more than about 1,350 J/m^2 to raise the temperature thereof from 25° up to 120°C.

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The present invention relates to a thermal transfer ink ribbon.

Hitherto, there has widely been employed a thermal transfer printing method in which a thermal transfer ink ribbon having a heat-meltable ink layer formed on one side of a film foundation is heated with a thermal head from the back of the film foundation to selectively transfer the heat-meltable ink layer thereby forming printed images.

To form printed images of satisfactory quality even on a paper sheet of poor surface smoothness (hereinafter referred to as "rough paper"), a thermal transfer ink ribbon has recently been employed of the type having an ink layer exhibiting bridging characteristics (i.e. an ink layer having a high melt viscosity which is capable of being transferred as bridging over depressed portions of the rough paper).

This thermal transfer ink ribbon, however, has required a large amount of energy for printing and hence has posed the following problems. Due to great energy consumption, a battery of large capacity is required particularly where a printer is driven with a battery, resulting in a problem of a power source section increased in dimension. Further, since the pulse width of an electrical signal to be applied to a heating element of the thermal head for heating it cannot be narrowed, a problem arises that printing at an increased speed is infeasible.

In view of the foregoing, an object of the present invention is to provide a thermal transfer ink ribbon requiring less printing energy.

This and other objects of the present invention will become apparent from the description hereinafter.

According to the present invention, there is provided a thermal transfer ink ribbon comprising a foundation, and one or more coat layers provided on at least one side of the foundation and including at least one heat-meltable ink layer, the ink layer having a melting or softening point of from 60° to 120°C, the ink ribbon requiring a heat quantity of not more than about 1,350 J/m^2 to raise the temperature thereof from 25°C up to 120°C.

The present invention is characterized in that the heat quantity required to raise the temperature of the thermal transfer ink ribbon from 25°C up to 120°C (hereinafter referred to as "heat capacity" for simplicity) is not more than about 1,350 J/m^2, preferably not more than about 900 J/m^2.

The use of such an ink ribbon requires less printing energy and hence allows the use of a battery of decreased capacity for driving a printer. This results in a printer having a power source section minimized in dimension. Further, this ink ribbon allows the pulse width of an electrical signal applied to a thermal head to be narrowed and, hence, printing at an increased speed becomes feasible.

However, an ink ribbon having a heat capacity exceeding the above range requires an increased printing energy, so that disadvantages are brought in battery-drive printing as well as infeasibility of high speed printing. The heat capacity of the ink ribbon of the present invention is desirably as small as possible. Nevertheless, in view of the limitations imposed by the materials now available, the lower limit of the heat capacity of the ink ribbon using currently available materials is about 500 J/m^2. For reference, the heat capacity of a typical ink ribbon conventionally used is about 1,650 to about 2,050 J/m^2.

In the present invention it is preferable to take the following measures in order that an ink ribbon has the aforesaid low heat capacity.

(1) Providing coat layers having a decreased heat capacity

The coat layers are herein meant to comprise at least one heat-meltable ink layer and, provided as required, a non-transferable release layer, a non-transferable release control layer, a transferable release layer, a top coat layer, a stick-preventive layer and the like.

One way to decrease the heat capacity of the coat layers is to reduce the coating amount of the coat layers (on a dry weight basis, hereinafter the same). Preferably, the total coating amount of all the coat layers is 3 g/m^2 or less. Although the total coating amount of all the coat layers is desirably set as small as possible in order to reduce the heat capacity of the ribbon, disadvantages such as insufficient print density will result when such amount is too small. For this reason the lower limit of such amount is preferably about 0.5 g/m^2.

Another way to decrease the heat capacity of the coat layers is to reduce the amount of paraffin wax generally used as a heat-meltable vehicle of the coat layers. Paraffin wax has a relatively large heat of melting when compared to other waxes such as ester wax or heat-meltable resins for use as the heat-meltable vehicle and, hence, it is preferable that the amount of paraffin wax to be used is set as small as possible. Specifically, the proportion of paraffin wax to the overall heat-meltable vehicle of all the coat layers is preferably set within the range of about 0 % to 50 % by weight.

Herein, the proportion (% by weight) of paraffin wax to the overall heat-meltable vehicle of all the coat layers can be determined by the following formula (I):

$$\frac{\text{Sum of the weights of respective paraffin wax components of all the coat layers } (g/m^2)}{\text{Sum of the weights of the respective heat-meltable vehicle components of all the coat layers } (g/m^2)} \times 100 \quad (I)$$

(2) Providing a thin foundation

It is preferable to make a foundation thin so as to decrease the heat capacity of the foundation. The use of a foundation of 3.5 μm or less is particularly preferable. However, the foundation made too thin will exhibit an undesirably decreased mechanical strength. For this reason the lower limit of the thickness of the foundation is about 1.5 μm.

An example of a basic constitution of such ink ribbon comprises a foundation and one heat-meltable ink layer formed on one side of the foundation. As required, a release layer may be provided between the foundation and the heat-meltable ink layer, or a top coat layer may be provided on the heat-meltable ink layer. Preferably, a stick-preventive layer is provided on the other side of the foundation.

The heat-meltable ink layer comprises a coloring agent and a heat-meltable vehicle. The heat-meltable vehicle comprises, for example, a wax and/or a heat-meltable resin.

Examples of the aforesaid wax include natural waxes such as haze wax, bees wax, carnauba wax, candelilla wax, montan wax and ceresine wax; petroleum waxes such as paraffin wax and microcrystalline wax; synthetic waxes such as oxidized wax, ester wax, polyethylene wax, Fischer-Tropsch wax and α-olefin-maleic anhydride copolymer wax; higher fatty acids such as myristic acid, palmitic acid, stearic acid and behenic acid; higher aliphatic alcohols such as stearyl alcohol and docosanol; esters such as higher fatty acid monoglycerides, sucrose fatty acid esters and sorbitan fatty acid esters; and amides and bisamides such as stearic acid amide and oleic acid amide. These waxes may be used either alone or in combination.

Examples of the aforesaid heat-meltable resin (including elastomer) include olefin copolymer resins such as ethylene-vinyl acetate copolymer and ethylene-acrylic ester copolymer, polyamide resins, polyester resins, epoxy resins, polyurethane resins, acrylic resins, vinyl chloride resins, cellulosic resins, vinyl alcohol resins, petroleum resins, phenolic resins, styrene resins, vinyl acetate resins, natural rubber, styrene-butadiene rubber, isoprene rubber, chloroprene rubber, polyisobutylene and polybutene. These heat-meltable resins may be used either alone or in combination.

In the case of the ink layer exhibiting bridging characteristics, it preferably contains about 60 % to 90 % by weight of the heat-meltable resin and about 0 % to 30 % by weight of the wax.

Usable as the aforesaid coloring agent are any coloring agents conventionally used in a heat-meltable ink of this type. Examples of such coloring agents include various inorganic or organic pigments or dyes as well as carbon black. The content of the coloring agent in the ink layer is usually about 10 % to about 50 % by weight. In the case of the ink layer exhibiting bridging characteristics, the content of the coloring agent in the ink layer is preferably about 10 % to about 40 % by weight.

The melting or softening point of the heat-meltable ink layer is preferably within the range of about 60° to 120°C in view of the storage property and transfer sensitivity of the ink ribbon.

The coating amount of the heat-meltable ink layer is preferably within the range of about 0.5 to 3 g/m^2, preferably about 0.5 to 2 g/m^2 so as to decrease the heat capacity of the ink ribbon.

The aforesaid release layer is preferably a heat-meltable layer comprising a wax as the major component. Examples of the wax for use in the release layer include polyethylene wax, α-olefin wax, Fischer-Tropsch wax, paraffin wax, microcrystalline wax, candelilla wax and carnauba wax. The release layer may be incorporated with a small amount of a heat-meltable resin such as ethylene-vinyl acetate copolymer so as to have improved adhesion to the foundation.

In the case of the release layer being heat-meltable, the melting or softening point thereof is preferably within the range of about 60° to 120°C in view of the storage property and transfer sensitivity of the ink ribbon.

The coating amount of the release layer is preferably about 0.5 to about 1.5 g/m^2, more preferably about 0.5 to about 1.0 g/m^2 so as to decrease the heat capacity of the ink ribbon.

The aforesaid top coat layer may be of a constitution similar to that of the release layer. Preferably, the melting or softening point of the top coat layer ranges from about 60° to 120°C, and the coating amount thereof from about 0.5 to about 1.5 g/m^2, more preferably about 0.5 to about 1.0 g/m^2.

Usable as the foundation are polyester films such as polyethylene terephthalate films, polyethylene naphthalate film, polyarylate film and polybutylene terephthalate film, polycarbonate films, polyamide films, aramid films and other various plastic films commonly used for the foundation of an ink ribbon of this type. As described earlier, the thickness of the foundation is preferably within the range of about 1.5 to 3.5 μm.

On the back side (the side adapted to be brought into slide contact with the thermal head) of the foundation may be formed a conventionally known stick-preventive layer composed of one or more of various heat-resistant resins such as silcone resin, fluorine-containing resin, nitrocellulose resin, other resins modified with these heat-resistant resins including silicone-modified acrylic resins, and mixtures of the foregoing heat-resistant resins and lubricating agents. Preferably, the coating amount of the stick-preventive layer is set to the smallest possible as long as the stick-preventive layer serves the purpose, favorably within the range of about 0.01 to 1 g/m^2, more preferably about 0.01 to 0.5 g/m^2.

According to a preferred embodiment of the present invention, the thermal transfer ink ribbon has a construction wherein a heat-meltable release layer is provided on one side of a foundation, a heat-meltable ink layer exhibiting bridging characteristics is provided on the release layer, and a stick-preventive layer is provided on the other side of the foundation. In the embodiment, preferably, the release layer comprises a wax, the heat-meltable ink layer contains about 10 to 40 % by weight of a coloring agent, about 60 to 90 % by weight of a heat-meltable resin and about 0 to 30 % by weight of a wax, and the thickness of the foundation is about 1.5 to 3.5 μm, the coating amount of the release layer is about 0.5 to 1.0 g/m^2, the coating amount of the ink layer is about 0.5 to 2.0 g/m^2, the coating amount of the stick-preventive layer is about 0.01 to 0.5 g/m^2, and the total coating amount of the release layer, the ink layer and the stick-preventive layer is about 1 to 3 g/m^2. In this embodiment, the proportion of paraffin wax determined by formula (I) is preferably from about 0 to 50 % by weight.

The present invention will be described in more detail by way of examples thereof. It is to be understood that the present invention is not limited to these examples, and various changes and modifications may be made in the invention without departing from the spirit and scope thereof.

Examples 1 to 3 and Comparative Example

A polyethylene terephthalate (PET) film of the thickness appearing in Table 1 was used as having a stick-preventive layer of a silicone-modified acrylic resin layer in a coating amount of 0.3 g/m^2 on one side thereof. Onto the other side of the PET film was coated a coating liquid containing 10 parts (in weight part, hereinafter the same) of paraffin wax dissolved in 90 parts of toluene, followed by drying at 50 °C to form a release layer in a coating amount of 1 g/m^2. Note that Comparative Example was not provided with the release layer.

In turn, onto the release layer thus formed was coated a coating liquid containing 100 parts of the ink composition appearing in Table 1 which was dissolved or dispersed in a mixed solvent of 400 parts of toluene and 50 parts of methyl ethyl ketone, followed by drying at 50 °C to form an ink layer in the coating amount appearing in Table 1. Thus, thermal transfer ink ribbons were obtained.

The thermal transfer ink ribbons thus obtained were subjected to the following tests. The results of the tests are shown in Table 1.

(A) Heat capacity of ink ribbon

Each of the thermal transfer ink ribbons was measured for its heat capacity (J/m^2) using a differential scanning calorimeter (DSC 200, a product of Seiko Instruments Inc.).

(B) Density of printed image

Each of the thermal transfer ink ribbons was subjected to printing using a thermal transfer printer (PC-PR 150V, a product of NEC Corporation) under the following conditions, and the resulting printed image was measured for its reflection density (in terms of OD value).

Printing energy:	0.20 W/dot
Printing speed:	100 cps
Receptor paper:	Woodfree paper having a Bekk smoothness of 50 seconds

Table 1

	Ex. 1	Ex. 2	Ex. 3	Com. Ex.
Coating amount of stick-preventive layer (g/m^2)	0.30	0.30	0.30	0.30
Thickness of PET (μ m)	3.5	2.5	2.5	3.5
Composition of release layer (% by weight)				
Paraffin wax	100	100	100	-
Coating amount of release layer (g/cm^2)	1	1	1	-
Composition of ink (% by weight)				
Ethylene-vinyl acetate copolymer	60	60	60	10
Carnauba wax	-	-	20	10
Paraffin wax	-	-	-	50
Petroleum resin	20	20	-	-
Carbon black	20	20	20	30
Softening point of ink layer (℃)	62	62	70	76
Coating amount of ink layer (g/m^2)	1.5	1.5	1.5	4
Proportion of paraffin wax determined by formula (I) (% by weight)	45.4	45.4	45.4	71.4
Heat capacity of ink ribbon (J/m^2)	1,131	858	1,003	1,902
Density of printed image (OD value)	1.6	1.8	1.3	0.5

As has been described, the thermal transfer ink ribbon of the present invention requires less printing energy and hence provides advantages in driving a printer with a battery. In addition, the thermal transfer ink ribbon of the present invention will contribute to printing at an increased speed.

In addition to the materials and ingredients used in the Examples, other materials and ingredients can be used in the Examples as set forth in the specification to obtain substantially the same results.

Claims

1. A thermal transfer ink ribbon comprising a foundation, and one or more coat layers provided on at least one side of the foundation and including at least one heat-meltable ink layer,

the ink layer having a melting or softening point of from about 60° to 120°C,

the ink ribbon requiring a heat quantity of not more than about 1,350 J/m^2 to raise the temperature thereof from 25° up to 120°C.

2. The thermal transfer ink ribbon of Claim 1, wherein said coat layers as a whole contain a paraffin wax in an amount of about 0 to 50 % by weight relative to the total amount of all heat-meltable vehicles contained therein.

3. The thermal transfer ink ribbon of Claim 1, wherein the total coating amount of all of said coat layers is about 0.5 to 3 g/m^2.

4. The thermal transfer ink ribbon of Claim 2, wherein the total coating amount of all of said coat layers is about 0.5 to 3 g/m^2.

5. The thermal transfer ink ribbon of Claim 1, wherein said foundation has a thickness of about 1.5 to 3.5 μm.

6. The thermal transfer ink ribbon of Claim 2, wherein said foundation has a thickness of about 1.5 to 3.5 μm.

7. The thermal transfer ink ribbon of Claim 3, wherein said foundation has a thickness of about 1.5 to 3.5 μm.

8. The thermal transfer ink ribbon of Claim 1, wherein the ink ribbon comprises a heat-meltable release layer provided on one side of the foundation, a heat-meltable ink layer provided on the release layer, and a stick-preventive layer provided on the other side of the foundation.

9. The thermal transfer ink ribbon of Claim 8, wherein the release layer comprises a wax, the heat-meltable ink layer contains about 10 to 40 % by weight of a coloring agent, about 60 to 90 % by weight of a heat-meltable resin and about 0 to 30 % by weight of a wax, and the thickness of the foundation is about 1.5 to 3.5 μm, the coating amount of the release layer is about 0.5 to 1.0 g/m^2, the coating amount of the ink layer is about 0.5 to 2.0 g/m^2, the coating amount of the stick-preventive layer is about 0.01 to 0.5 g/m^2, and the total coating amount of all of said coat layers is about 1 to 3 g/m^2.

10. The thermal transfer ink ribbon of Claim 9, wherein said coat layers as a whole contain a paraffin wax in an amount of about 0 to 50 % by weight relative to the total amount of all heat-meltable vehicles contained therein.

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EUROPEAN SEARCH REPORT

Application Number
EP 94 10 6706

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.5)
X	EP-A-0 342 980 (KONICA CORPORATION) * page 7, line 61 - page 8, line 20 * * page 9, line 26 - line 35 * * page 10, line 35 - page 11, line 20; example 9 *	1-10	B41M5/38
X	US-A-5 144 334 (A.SUZUKI ET AL.) * column 7, line 9 - line 25 * * column 8, line 49 - line 64; examples A1,B1-B4 *	1-10	
X	US-A-4 840 837 (N.TANAKA ET AL.) * claims 1-15; examples 1-9; table 1 *	1-10	
X	US-A-4 762 432 (S.UEYAMA ET AL.) * column 1, line 54 - column 2, line 20; claims 1-3; figure 2 *	1-10	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

B41M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	31 August 1994	Bacon, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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