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(71) Applicant: **MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.**
1006, Oaza Kadoma
Kadoma-shi,
Osaka-fu, 571 (JP)

(72) Inventor: **Fukui, Yasuo**
207, Gurandohaimu-Fujita,
16-16, Suehiro-cho
Kadoma-shi,
Osaka 571 (JP)
Inventor: **Matsuo, Hiroyuki**
414-2-2-510, Oaza-Uchiage
Neyagawa-shi,
Osaka 572 (JP)
Inventor: **Imai, Akihiro**
136-27, Takayama-cho
Ikoma-shi,
Nara 630-01 (JP)
Inventor: **Taguchi, Nobuyoshi**
3-5-5, Shikanodaihigashi
Ikoma-shi,
Nara 630-01 (JP)

(74) Representative: **VOSSIUS & PARTNER**
Siebertstrasse 4
D-81675 München (DE)

(54) Thermal transfer printing method using an intermediate transfer member.

(57) A thermal transfer printing method including

providing a color developing layer supplying member (1) including a substrate (3) disposed thereon with a recording layer (2) having a color developing property, an intermediate transfer member (4) comprising a substrate (6) disposed thereon with a macromolecular layer (5) having rubber elasticity and stickiness, an ink sheet (7) comprising a substrate (9) disposed thereon with an ink material layer (8) containing dyestuffs, and a color receiving sheet (12),

transferring the recording layer (2) of the color developing layer supplying member (1) onto the macromolecular layer (5) of the intermediate transfer member (4),

laminating the recording layer (2) disposed on the macromolecular layer (5) on top of the ink sheet (7) to transfer the dyestuffs from the ink material layer (8) by heat, and

tranferring the dyed recording layer (2) onto the color receiving sheet (12).

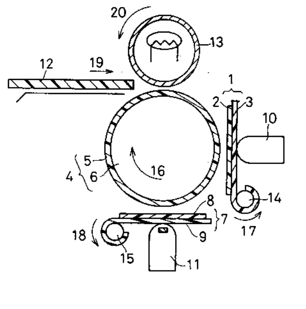

FIG. 1

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This invention relates to a thermal transfer printing method. In particular, this invention relates to a method of printing by using a recording means such as a thermal head together with an ink material containing coloring material made of dyestuff.

A well-known thermal transfer printing method in recent years is to record through sublimation and diffusion of dyestuffs i.e. coloring materials. According to this method, a recording can be obtained by using an ink sheet comprising a heat-resisting substrate such as polyethelene terephthalate (PET), condenser paper or the like which is disposed on the surface with an ink material layer made of dyestuffs and a binder material with a thickness of about 1 μm to transfer the dyestuffs directly on a recording medium having a color developing property by a recording head.

In the following, the above-mentioned conventional thermal transfer printing method is explained with reference to the structure and the operation.

First, an ink sheet comprising a heat-resisting substrate and an ink material layer made of dyestuffs and a binder material is placed between a thermal head and a platen and press-welded together with a color receiving sheet such as a recording paper. Next, a signal coming from a recording signal source heats the thermal head and raises a temperature of the ink material selectively. When the ink sheet is separated from the color receiving sheet, a part of the dye contained in the ink material layer is transferred onto the color receiving sheet. A transferred image is obtained in this way.

However, the above-mentioned conventional structure has the problem that a transferred amount of the dye differs greatly according to the surface material of the color receiving sheet. In other words, since the dye is transferred onto the color receiving sheet by raising the temperature of the ink material layer and causing sublimation and diffusion of the coloring material made of dyestuffs, the recording is only possible when the surface material of the color receiving sheet has a color developing property. Furthermore, the transferred amount of the dye is dependent upon the color developing property of the surface material of the color receiving sheet. For example, when ordinary paper is used as the color receiving sheet, the recorded image can be scarcely obtained by the transfer of the dyestuffs, since there is hardly any color developing property on the surface.

Furthermore, the above-mentioned conventional structure has the drawback that quality of the recorded image differs greatly according to the surface condition of the color receiving sheet. In other words, differences in the contact condition between the color receiving sheet and the ink material layer appears as different recording densities, and thus, uniformity in the recorded pictorial image is dependent upon the smoothing property of the color receiving sheet on the surface. For example, if there is an extreme unevenness in the surface of the color receiving sheet, the color receiving sheet causes a contact failure with the ink material layer so that a uniform recorded image can not be obtained.

It is an objective of this invention to solve the above-noted problems in the conventional system by providing a thermal transfer printing method which enables obtaining excellent pictorial image quality in a transfer recording of dyestuffs, regardless of the type (i.e., surface material, surface condition) of color receiving sheet.

In order to accomplish this and other objects and advantages, a thermal transfer printing method of this invention includes a color developing layer supplying member comprising a substrate disposed thereon with a recording layer having a color developing property, an intermediate transfer member comprising a substrate disposed thereon with a macromolecular layer having rubber elasticity and stickiness, an ink sheet comprising a substrate disposed thereon with an ink material layer containing dyestuffs, and a color receiving sheet. This method comprises the steps of: first, transferring the recording layer of the color developing layer supplying member onto the macromolecular layer of the intermediate transfer member, next, laminating this recording layer disposed on the macromolecular layer on top of the ink sheet to transfer the dyestuffs from the ink material layer by heat, and then, transferring the dyed recording layer onto the color receiving sheet.

It is preferable that the macromolecular material having rubber elasticity and stickiness comprises a macromolecular material having rubber elasticity and a macromolecular material having stickiness.

It is also preferable that the macromolecular material having rubber elasticity includes a silicone material having rubber elasticity.

Furthermore, it is preferable that the macromolecular material having stickiness includes a silicone material having stickiness.

It is preferable that the silicone material having stickiness comprises a silicone adhesive material containing silicone crude rubber and silicone resin.

Furthermore, it is preferable that the step of laminating the recording layer on top of the macromolecular layer to transfer the dyestuffs from the ink material layer by heat is followed by the step of separating the recording layer from the ink sheet when the temperature of the recording layer has become lower than the glass transfer point of the recording layer.

In addition, it is preferable that the step of transferring the dyed recording layer onto the color receiving sheet is followed by the step of separating the color receiving sheet when the temperature of the recording layer has become lower than the flow softening point of the recording layer.

It is also preferable that the color developing layer supplying member comprises the substrate disposed thereon with the recording layer having a color developing property via a release layer.

According to the above-mentioned embodiment of the invention, first, a recording layer of a color developing layer supplying member is transferred onto a macromolecular layer of an intermediate transfer member. Next, the recording layer of the color developing layer supplying member sticks to the macromolecular layer when pressed against the macromolecular layer due to the stickiness. Then, a boundary face between the substrate material of the color developing layer supplying member and the recording layer becomes a separating face, and the recording layer is separated from the color developing layer supplying member to be transferred onto the macromolecular layer.

Next, dyestuffs are transferred from an ink material layer by heat onto the recording layer which was transferred on the macromolecular layer. At this moment, the recording layer is held stably on the macromolecular layer due to the stickiness of this macromolecular layer. Furthermore, the macromolecular layer has rubber elasticity which enables a uniform contact between a thermal head, an ink sheet, and the recording layer disposed on the intermediate transfer member. As a result, a high-quality primary recorded image is formed stably on the recording layer.

Then, a color receiving sheet is pressed against the recording layer disposed on the macromolecular layer and provided with so much heat that the recording layer softens and is transferred onto the color receiving sheet. At this time, since the macromolecular layer has rubber elasticity, the macromolecular layer deforms itself elastically after the unevenness of the color receiving sheet, and the recording layer fills the hollow-shaped parts of the color receiving sheet. As a result, the recording layer as well as the primary recorded image are excellently fixed on the surface of the color receiving sheet as soon as they are transferred thereon, even if the surface of the color receiving sheet is uneven due to fibers etc.

According to the embodiment of this invention, the macromolecular material having rubber elasticity and stickiness comprises the macromolecular material having rubber elasticity and the macromolecular material having stickiness. Thus, the rubber elasticity and the stickiness can be determined separately to achieve the best results. Therefore, it is possible to form the macromolecular layer which models after the unevenness in the surface of the color receiving sheet without damaging the stickiness. Accordingly, various kinds of color receiving sheets can be used for the recording.

Furthermore, since the macromolecular material having rubber elasticity includes a silicone material having rubber elasticity, it is possible to attain excellent rubber elasticity and to obtain an intermediate transfer member which is subjected to less thermal degradation.

In addition, since the macromolecular material having stickiness includes a silicone material having stickiness, it is possible to attain excellent stickiness and to obtain an intermediate transfer member which is subjected to less thermal degradation.

Moreover, since the silicone material having stickiness comprises a silicone adhesive material including silicone crude rubber and silicone resin, it is possible to control the adhesive property and to attain sufficient cohesion as well as excellent stickiness.

It is preferable that the ink sheet is separated from the recording layer when the temperature of the recording layer has become lower than a glass transition point of the thermoplastic resin contained in the recording layer. In this way, the recording layer is held even more stably on the macromolecular layer.

It is also preferable that the recording layer is transferred onto the color receiving sheet by separating the color receiving sheet when the temperature of the recording layer has become lower than the flow softening point (flow starting point) of the thermoplastic resin contained in the recording layer. In this way, the recording layer as well as the primary recorded image can be transferred excellently onto the surface of the color receiving sheet.

Furthermore, it is preferable that the color developing layer supplying member comprises the substrate disposed thereon with the recording layer having a color developing property via a release layer which is disposed to separate the recording layer. Accordingly, the recording layer can be transferred excellently onto the macromolecular layer disposed on the intermediate transfer member.

As described above, this invention relates to a transfer printing method by heat of dyestuffs. According to this method, an image is formed on a recording layer having color developing properties, and the recording layer is transferred further onto the color receiving layer. This method enables high-quality recording by using color receiving sheets which were not recorded uniformly by the conventional method due to the unevenness in the surface. Additionally, any color receiving sheet having transferable properties is capable of receiving the recorded image. Moreover, special paper such as coated paper having color developing properties is not needed as the color receiving sheet. In principle, any kind of recording paper including plain paper can be used for the recording. This invention can attain a recorded image of excellent pictorial quality by using dyestuffs as the coloring material, regardless of the type of color receiving sheet.

FIG. 1 is a schematic diagram showing the thermal transfer printing method in an embodiment of this invention.

FIG. 2 (a) - (c) are schematic views showing the operation in a first embodiment of this invention shown in FIG. 1.

FIG. 3 is a cross-sectional view showing the fixation condition of a recording layer for explaining the operation in an embodiment of this invention.

FIG. 4 is a schematic diagram showing another embodiment of the thermal transfer printing method in a second embodiment of this invention.

FIG. 5 is a schematic diagram showing another embodiment of the thermal transfer printing method in a third embodiment of this invention.

FIG. 6 is a schematic diagram showing another embodiment of the thermal transfer printing method in a fourth embodiment of this invention.

A thermal transfer printing method of this invention will be described by referring to the following illustrative examples and attached figures.

FIG. 1 is a schematic diagram showing a thermal transfer printing method in an embodiment of this invention. Referring to FIG. 1, reference numeral 4 denotes an intermediate transfer member; 1, a color developing layer supplying sheet; 7, an ink sheet; 10, a pressurizer; 11, a thermal head; 13, a heating roller; 12, a color receiving sheet. Intermediate transfer member 4 comprises a roller-type substrate 6 disposed thereon with a macromolecular layer 5. Dye supplying sheet 1 comprises a sheet-type substrate 3 having heat resistance disposed thereon with a recording layer 2. Ink sheet 7 comprises a sheet-type substrate 9 having heat resistance disposed thereon with an ink material layer 8. This method further comprises pressurizer 10, thermal head 11, and heating roller 13.

The operation of the thermal transfer printing method as described above will be explained with reference to FIG. 2 (a) - (c).

FIG. 2 (a) to FIG. 2 (c) are schematic views showing the operation of the thermal transfer printing method in FIG. 1.

First, as shown in FIG. 2 (a), recording layer 2 of color developing layer supplying member 1 is pressed against macromolecular layer 5 disposed on intermediate transfer member 4 by pressurizer 10, and then, intermediate transfer member 4 is rotated in the direction indicated by arrow 16. Through the rotation of intermediate transfer member 4, color developing layer supplying member 1 is wound by a supplying member winding roller 14.

At this time, recording layer 2 sticks to macromolecular layer 5 due to the stickiness of macromolecular layer 5. A boundary face between substrate 3 of color developing layer supplying member 1 and recording layer 2 becomes a separating face, and recording layer 2 is separated from substrate 3 to be transferred onto macromolecular layer 5. Therefore, only substrate 3 is wound in the direction indicated by arrow 17 by supplying member winding roller 14.

Next, as shown in FIG. 2 (b), recording layer 2 which was transferred onto macromolecular layer 5 is press-welded against ink sheet 7 by means of thermal head 11. In this state, a recording signal is given from recording signal source 21 to thermal head 11 in order to heat thermal head 11 selectively. At least a part of the dye in ink material layer 8 is transferred onto the surface of recording layer 2 to form a primary recorded image 22 which corresponds to the recording signal. As intermediate transfer member 4 rotates in the direction indicated by arrow 16, ink sheet 7 is wound by ink sheet winding roller 15 in the direction indicated by arrow 18.

At this moment, recording layer 2 is held stably on macromolecular layer 5 due to the stickiness of macromolecular layer 5. Therefore, even if shear force is given upon recording layer 2 due to melting of ink material layer 8 with recording layer 2 or due to fluctuation in travelling speeds of intermediate transfer member 4 or ink sheet 7, recording layer 2 does not separate from or slip on macromolecular layer 5. Furthermore, since the macromolecular layer has rubber elasticity, the macromolecular layer deforms itself elastically after the unevenness in the surface of ink sheet 7 and thermal head 11, which enables a uniform contact between thermal head 11, ink sheet 7, and recording layer 2 disposed on macromolecular layer 5. As a result, high-quality primary recorded image 22 can be formed stably on recording layer 2.

Then, as shown in FIG. 2 (c), color receiving sheet 12 is pressed against intermediate transfer member 4 by means of heating roller 13. Heating roller 13 is rotated in the direction indicated by arrow 20, and then, color receiving sheet 12 is heated by heating roller 13, thereby adhering recording layer 2 on the surface of color receiving sheet 12. Accordingly, when color receiving sheet 12 is separated from intermediate transfer member 4, a pressurized part of recording layer 2 is transferred onto color receiving sheet 12 side to form a transfer image 23 on the surface of color receiving sheet 12 from primary recorded image 22. Color receiving sheet 12 moves forward through the rotation of heating roller 13 and intermediate transfer member 4 in the direction indicated by arrow 19.

At this time, since macromolecular layer 5 has rubber elasticity, macromolecular layer 5 deforms itself elastically based on the unevenness in the surface of color receiving sheet 12 due to fibers etc., and recording layer 2 fills the hollow-shaped parts of color receiving sheet 12. If more pressure is provided, softened macromolecular layer 5 intrudes further into the hollow-shaped parts on the surface of color receiving sheet 12, and recording layer 2 is pressed into the inside of even finer fibers. As soon as the adhesive strength of recording layer 2 against color receiving sheet 12 becomes stronger than the sticky strength of recording layer 2 against macromolecular layer 5, color receiving sheet 12 is separated from intermediate transfer member 4, and thus, softened recording layer 2 is released from macromolecular layer 5 to be transferred onto color receiving sheet 12. Therefore, recording layer 2 and primary recorded image 22 can be fixed satisfactorily on the surface of color receiving sheet 12 as soon as they are transferred thereon at the softening temperature of recording layer 2. Since transfer image 23 is a reverse image of primary recorded image 22, recording signal source 21 usually sends a signal which records the reverse image of transfer image 23 at thermal head 11.

In order to color recorded images, four elementary colors consisting of three elementary colors of cyan dye, magenta dye, yellow dye and black are used respectively as ink material layer 8. Each ink material layer 8 is disposed on substrate 9 in the above-listed face order to form ink sheet 7. Then, they are transferred one over another in this order onto recording layer 2 of macromolecular layer 5.

FIG. 3 is a cross-sectional view showing the state in which transfer image 23 of FIG. 2 (a) to (c) is fixed satisfactorily on color receiving sheet 12 having an uneven surface. The transfer mechanism of the recording layer is explained with reference to FIG. 3.

As shown in FIG. 2 (c), recording layer 2 adheres to the surface of color receiving sheet 12 through the pressure and heat provided on color receiving sheet 12 by heating roller 13. Although color receiving sheet 12 has an uneven surface due to fibers etc., macromolecular layer 5 models after the surface unevenness of color receiving sheet 12 so that recording layer 2 is filled into the hollow-shaped parts of color receiving sheet 12. If more pressure is provided, softened macromolecular layer 5 intrudes further into the hollow-shaped parts, and recording layer 2 is pressed into the inside of even finer fibers. Accordingly, as shown in FIG. 3, the surface condition of recording layer 2 reproduces the rough unevenness which is the same as the initial surface of the color receiving sheet.

Generally, gloss and writability of a color receiving sheet is determined by the unevenness in the surface of the color receiving sheet. As shown in FIG. 3, when recording layer 2 models after the rough unevenness of color receiving sheet 12, the surface of recording layer 2 becomes the same as the initial surface of color receiving sheet 12 so that letters can be written down with a pencil on recording layer 2. Furthermore, since recording layer 2 is strongly fixed to color receiving sheet 12, the fixation of the recorded image improves even more.

FIG. 4 is a schematic diagram showing another embodiment of the thermal transfer printing method of this invention. FIG. 4 differs from the embodiment in FIG. 1 in the use of a recording sheet 24 which combines color developing layer supplying member 1 and ink sheet 7 of FIG. 1. Furthermore, pressurizer 10 in FIG. 1 is eliminated, and instead, thermal head 11 is used here. Recording sheet 24 comprises a sheet-type substrate 25 having heat resistance on which recording layer 2 and ink material layer 8 are disposed.

The operation of the second embodiment as described above is explained in the following with reference to FIG. 4.

First, FIG. 4 shows that recording layer 2 of recording sheet 24 is pressed against macromolecular layer 5 disposed on intermediate transfer member 4 by means of thermal head 11. Then, intermediate transfer member 4 is rotated in the direction indicated by arrow 16. Through the rotation of intermediate transfer member 4, recording sheet 24 is wound by a recording sheet winding roller 26.

At this time, recording layer 2 sticks to macromolecular layer 5 due to the stickiness of macromolecular layer 5, as in the case with FIG. 2 (a). The boundary face between substrate 25 of recording sheet 24 and recording layer 2 becomes a separating face, and recording layer 2 is separated from substrate 25 to be transferred onto macromolecular layer 5. In this instance, it is possible to heat thermal head 11 selectively to improve the adhesion of recording layer 2 with macromolecular layer 5 and to also prevent bubbles or the like from forming between recording layer 2 and macromolecular layer 5.

Next, FIG. 4 shows that recording sheet 24 is wound in the direction indicated by arrow 18, and ink material layer 8 is conveyed to the place of thermal head 11. Then, at least a part of the dye in ink material layer 8 is transferred onto the surface of recording layer 2, as in FIG. 2 (b). Recording layer 2 which was transferred onto macromolecular layer 5 is press-welded against recording sheet 24 by means of thermal head 11. In this state, a recording signal is provided from recording signal source 21 to thermal head 11 in order to heat thermal head 11 selectively. Then, at least a part of the dye in ink material layer 8 is transferred onto the surface of recording layer 2 to form primary recorded image 22 which corresponds to the recording signal. As intermediate transfer member 4 rotates in the direction indicated by arrow 16, recording sheet 24 is wound by recording sheet winding roller 26 in the direction indicated by arrow 18.

Then, FIG. 4 shows that color receiving sheet 12 is pressed against intermediate transfer member 4 by means of heating roller 13, as in FIG. 2 (c), and heating roller 13 is rotated. After that, color receiving sheet 12 is heated by heating roller 13, thereby adhering recording layer 2 to the surface of color receiving sheet 12. Therefore, when color receiving sheet 12 is separated from intermediate transfer member 4, the pressurized part of recording layer 2 is transferred onto color receiving sheet 12.

As described above, the embodiment of FIG. 4 can simplify the apparatus design of the first embodiment shown in FIG. 1.

FIG. 5 is a schematic diagram showing another embodiment of the thermal transfer printing method of this invention. FIG. 5 differs from the embodiment in FIG. 4 in that a sheet separating roller 27 is disposed to separate recording sheet 24 from intermediate transfer member 14 in a position away from the edge part of thermal head 11.

The operation of the third embodiment as described above is explained in the following with reference to FIG. 5.

First, as in FIG. 4, FIG. 5 shows that recording layer 2 of recording sheet 24 is pressed against macromolecular layer 5 disposed on intermediate transfer member 4 by means of thermal head 11. Intermediate transfer member 4 is then rotated in the direction indicated by arrow 16. Through the rotation of intermediate transfer member 4, recording sheet 24 is wound by a recording sheet winding roller 26.

At this time, recording layer 2 sticks to macromolecular layer 5 due to the stickiness of macromolecular layer 5, as in the case with FIG. 4. The boundary face between substrate 25 of recording sheet 24 and recording layer 2 becomes a separating face, and recording layer 2 is separated from substrate 25 to be transferred onto macromolecular layer 5. In this instance, it is possible to heat thermal head 11 selectively.

Next, FIG. 5 shows that intermediate transfer member 4 and recording sheet 24 are press-welded by thermal head 11, and in this state thermal head 11 is heated selectively through a signal provided by recording signal source 27. A least a part of the dye in ink material layer 8 is transferred onto the surface of recording layer 2 disposed on intermediate transfer member 4 to form primary recorded image 22 which corresponds to the recording signal. Through the rotation of intermediate transfer member 4, recording sheet 24 and intermediate transfer member 4 are conveyed without being separated. After that, recording sheet 24 is separated from intermediate transfer member 4 by recording sheet separating roller 27 and is wound by recording sheet winding roller 26.

At this time, the recording sheet separating roller 27 serves to separate recording sheet 24 from intermediate transfer member 4 in the position away from the edge of thermal head 11. Therefore, when ink material layer 8 is separated from recording layer 2 disposed on macromolecular layer 5, the temperature of recording layer 2 has nothing to do with the heat reserve condition of thermal head 11 so that the temperature can be set lower than the glass transition point of the thermoplastic resin contained in recording layer 2.

Then, FIG. 5 shows that color receiving sheet 12 is pressed against intermediate transfer member 4 by means of heating roller 13, and heating roller 13 is rotated, as in FIG. 2 (c). When color receiving sheet 12 is heated by heating roller 13, recording layer 2 adheres to the surface of color receiving sheet 12. Therefore, when color receiving sheet 12 is separated from intermediate transfer member 4, the pressurized part of recording layer 2 is transferred onto color receiving sheet 12.

In the case of the second embodiment shown in FIG. 4, recording sheet 24 is separated from intermediate transfer member 4 at the edge of thermal head 11. Therefore, when ink material layer 8 is separated from recording layer 2, the temperature of recording layer 2 changes according to the heat reserve condition of thermal head 11. In other words, provided that the heat reserve of thermal head 11 is small, the temperature of recording layer 2 is low in the separation process of ink material layer 8 from recording layer 2. On the other hand, the temperature of recording layer 2 is high in the separating process of ink material layer 8 from recording layer 2, provided that the heat reserve of thermal head 11 is large.

The degree of stability with which recording layer 2 is held on macromolecular layer 5 due to the stickiness of macromolecular layer 5 changes according to the temperature of recording layer 2, i.e.

whether it is higher or lower than the glass transition point of thermoplastic resin contained in recording layer 2. If the temperature of recording layer 2 is lower than the glass transition point of thermoplastic resin contained in recording layer 2, recording layer 2 is in a state of extremely high cohesion so that it is held with sufficient stability on macromolecular layer 5 due to the stickiness of macromolecular layer 5. On the other hand, if the temperature of recording layer 2 is higher than the glass transition point of the thermoplastic resin contained in recording layer 2, softened recording layer 2 may deform by the shear force imposed upon recording layer 2 due to the melting of ink material layer 8 with recording layer 2 or due to a fluctuation in travelling speeds of intermediate transfer member 4 or recording sheet 24. In some cases, it becomes impossible to hold recording layer 2 on macromolecular layer 5 through the stickiness of macromolecular layer so that recording layer 2 may separate from or slip on macromolecular layer 5.

Therefore, according to the embodiment shown in FIG. 4, when the heat reserve of thermal head 11 is large, the temperature of recording layer 2 becomes higher than the glass transition point of thermoplastic resin contained in recording layer 2 in the separation process of ink material layer 8 from recording layer 2. In some cases, it becomes impossible to hold recording layer 2 on macromolecular layer 5 through the stickiness of macromolecular layer. This is the same with the first embodiment shown in FIG. 1.

Then, as shown in the embodiment of FIG. 5, recording sheet separating roller 27 serves to separate recording sheet 24 from intermediate transfer member 4 in a position away from the edge part of thermal head 11. Therefore, when ink material layer 8 is separated from recording layer 2 disposed on macromolecular layer 5, the temperature of recording layer 2 has nothing to do with the heat reserve condition of thermal head 11 so that the temperature can be set lower than the glass transition point of the thermoplastic resin contained in recording layer 2.

As described above, the embodiment of FIG. 5 can be used to hold recording layer 2 on macromolecular layer 5 even more stably. In addition, the dye of ink material layer 8 can be transferred onto recording layer 2 by heat with sufficient stability.

FIG. 6 is a schematic diagram showing another embodiment of the thermal transfer printing method of this invention. FIG. 6 differs from the embodiment in FIG. 1 in that a color receiving sheet separating roller 28 is disposed to separate color receiving sheet 12 from intermediate transfer member 14 in a position away from heating roller 13.

The operation of the fourth embodiment as described above is explained in the following with reference to FIG. 6.

First, as in FIG. 2 (a), FIG. 6 shows that recording layer 2 of color developing layer supplying member 1 is pressed against macromolecular layer 5 disposed on intermediate transfer member 4 by means of pressurizer 10, and intermediate transfer member 4 is then rotated in the direction indicated by arrow 16. Through the rotation of intermediate transfer member 4, color developing layer supplying member 1 is wound by supplying member winding roller 14.

At this time, recording layer 2 sticks to macromolecular layer 5 due to the stickiness of macromolecular layer 5. The boundary face between substrate 3 of color developing layer supplying member 1 and recording layer 2 becomes a separating face, and recording layer 2 is separated from substrate 3 to be transferred onto macromolecular layer 5. Therefore, only substrate 3 is wound by supplying member winding roller 14.

Next, FIG. 6 shows that ink sheet 7 is press-welded against recording layer 2 which was transferred on macromolecular layer 5 by means of thermal head 11, as in FIG. 2 (b). In this state, thermal head 11 is heated selectively, and at least a part of the dye in ink material layer 8 is transferred onto the surface of recording layer 2 to form primary recorded image 22 which corresponds to the recording signal. As intermediate transfer member 4 rotates in the direction indicated by arrow 16, ink sheet 7 is wound by ink sheet winding roller 15.

Then, color receiving sheet 12 is pressed against intermediate transfer member 4 by means of heating roller 13, and heating roller 13 is then rotated in the direction indicated by arrow 20. When color receiving sheet 12 is heated by heating roller 13, recording layer 2 adheres to the surface of color receiving sheet 12. Color receiving sheet 12 and intermediate transfer member 4 are conveyed through the rotation of intermediate transfer member 4 in the direction indicated by arrow 16 without being separated. After that, color receiving sheet 12 is separated from intermediate transfer member 4 by color receiving sheet separating roller 28, and in this way, a pressurized part of recording layer 2 is transferred onto color receiving sheet 12.

By disposing color receiving sheet separating roller 28, color receiving sheet 12 is separated from intermediate transfer member 4 in a position away from heating roller 13. Therefore, when color receiving sheet 12 is separated from intermediate transfer member 4, the temperature of recording layer 2 can be set lower than the flow softening point of the thermoplastic resin contained in recording layer 2, regardless of the temperature of heating roller 13.

In the embodiment shown in FIG. 1, color receiving sheet 12 is separated from intermediate transfer member 4 in the vicinity of heating roller 13 so that the temperature of recording layer 2 is approximately the same as the temperature of heating roller 13 when color receiving sheet 12 is separated from intermediate transfer member 4.

The degree of satisfaction with which recording layer 2 is transferred from macromolecular layer 5 onto color receiving sheet 12 changes according to the temperature of recording layer 2, i.e. whether it is higher or lower than the flow softening point (flow starting point) of the thermoplastic resin contained in recording layer 2. If the temperature of recording layer 2 is lower than the flow softening point of the thermoplastic resin contained in recording layer 2, recording layer 2 has high cohesion which enables excellent transfer from macromolecular layer 5 onto color receiving sheet 12. On the other hand, if the temperature of recording layer 2 is higher than the flow softening point of thermoplastic resin contained in recording layer 2, recording layer 2 shows cohesive failure which may lead to an incomplete transfer of recording layer 2 onto color receiving sheet 12 as a whole. This is due to the fact that the thermoplastic resin contained in recording layer 2 loses viscosity to such a degree that it can flow when heated higher than the flow softening point. Accordingly, recording layer 2 is divided into parts due to the force provided by both macromolecular layer 5 and color receiving sheet 12.

Therefore, according to the embodiment shown in FIG. 1, provided that the temperature of heating roller 13 fluctuates higher so that the temperature of recording layer 2 becomes higher than the flow softening point of thermoplastic resin contained in recording layer 2 in the separation process of color receiving sheet from intermediate transfer member 4, a satisfactory transfer may not be achieved in some cases. This is the same with the second embodiment shown in FIG. 4 and with the third embodiment shown in FIG. 5.

By disposing color receiving sheet separating roller 28, as shown in FIG. 6, color receiving sheet 12 is separated from intermediate transfer member 4 in a position away from heating roller 13. Therefore, when color receiving sheet 12 is separated from intermediate transfer member 4, the temperature of recording layer 2 can be set lower than the flow softening point of the thermoplastic resin contained in recording layer 2, regardless of the temperature of heating roller 13.

As described above, the embodiment shown in FIG. 6 does not cause cohesive failure of recording layer 2, and recording layer 2 and primary recorded image 22 can be transferred excellently onto the surface of color receiving sheet 12.

Furthermore, in FIG. 6, a separating nail can be disposed on the transfer image side of color receiving sheet 12 in order to separate color receiving sheet 12 easily from intermediate transfer member 4.

According to the above-noted embodiment of this invention, a thermal transfer printing method includes a color developing layer supplying member comprising a substrate disposed thereon with a recording layer having color developing property, an intermediate transfer member comprising a substrate disposed thereon with a macromolecular layer having rubber elasticity and stickiness, an ink sheet comprising a substrate disposed thereon with an ink material layer containing dyestuffs, and a color receiving sheet. This method comprises the steps of: first, transferring the recording layer of the color developing layer supplying member onto the macromolecular layer of the intermediate transfer member, next, laminating the recording layer disposed on the macromolecular layer on top of the ink sheet to transfer the dyestuffs from the ink material layer by heat, and then, transferring this dyed recording layer onto the color receiving sheet. As a result, any color receiving sheet, if a recording layer shows a transferable property, can be used to record transfer images. With regard to the quality of the recorded image, this method enables a high-quality recording for color receiving sheets which could not conduct uniform recording by the conventional method due to surface unevenness. In addition, even if color receiving sheets with surface unevenness are used, letters can be written with a pencil etc. on the recording layer, and a recorded image can be obtained with satisfactory fixation.

The method of conducting the thermal transfer printing is not limited to the use of thermal head 11 as in the embodiment. The thermal transfer printing method can be also carried out by using an electric head or a light head instead of a thermal head.

Heating roller 13 is used in this transfer method, but other means which provide heat and pressure are also useful. Heating roller 13 is a roller having a heating part in the inside or around the roller. By controlling the amount of electricity provided to this heating part, the quantity of heat which is conveyed from the surface through heat conduction to the intermediate transfer member side can be controlled. As for the heating part, it is also possible to use a light source such as a halogen lamp having large radiation heat. Suitable materials for heating roller 13 include, for example, a rubber (rubber-coated) roller, plastic roller, or metallic roller. In addition, by using a thermal recording head such as a thermal head or electric head, it is possible to transfer only the necessary part of the recording layer (e.g. only the primary recorded image of the recording layer) onto the color receiving sheet.

Although it is omitted in FIGS. 1, 2, and 6, color developing layer supplying member 1 can also comprise a cassette with a supplying roller and a winding roller. This is also the same with ink sheet 7 and recording sheet 24.

It is not especially necessary to form recording sheet separating roller 27 as a roller as in the embodiment. The shape is not critical as long as it can separate the ink sheet. For example, a separating nail which is used for a fixing machine etc. can be used instead of roller, or an edge part of a thin plate or the like can be used as well. This is also the same with color receiving sheet separating roller 28 which is not necessarily formed as a roller as in the embodiment, but as long as it can separate the color receiving sheet, the structure does not play a roll.

It is particularly preferable that substrate 3 of color developing layer supplying member 1, substrate 9 of ink sheet 7, and substrate 25 of recording sheet 24 have a slipping layer or a heat-resisting and slipping layer at least on one side for attaining excellent travelling stability with the recording head etc. In addition, various kinds of macromolecular film can be used for substrate, substrate, and substrate. They may be disposed with a release layer (separating layer) according to the property of recording layer 2 on the side contacting recording layer 2. Materials suitable for the release layer include silicone resin, fluororesin, melamine resin, and wax materials or the like. It is preferable that an adhesive layer (anchor coat layer) is disposed according to the property of ink material layer 8 on the side contacting ink material layer 8.

For substrate, substrate, and substrate, various kinds of macromolecular film and those which are treated by surface coating can be used. Various kinds of macromolecular film include, for example, polyolefine type, polyamide type, polyester type, polyimide type, polyether type, cellulose type, polyparabanic acid type, polyoxadiazole type, polystyrene type, and fluorine type films. In particular, films such as polyethylene terephthalate (PET), polyethylene naphthalate, aromatic polyamide (aramide), triacetyl cellulose, polypropylene, and cellophane are useful. A suitable thickness of the macromolecular film is usually 3 μm to 100 μm, and more preferably from 3 to 30 μm. Various kinds of macromolecular film may be disposed on one side with a heat-resisting layer composed of thermosetting resin to reinforce heat resistance against thermal deformation of the film, or with an antistatic layer, or if necessary, with various kinds of coating layers.

Ink material layer 8 comprises at least dye and a binder material. The dye is not limited and can be any kind of dye which contains thermal transferable dyestuffs. Dyes such as a disperse dye, basic dye, color former or the like are useful. Furthermore, the binder material is not limited and can be various kinds of macromolecular materials and wax. Ink material layer 8 may comprise a multilayer. It is also possible that a slipping layer or different kinds of coating layers are disposed on ink material layer 8. In addition, ink material layer 8 may contain various kinds of additives such as silicone type materials or fluorine type materials.

Recording layer 2 is formed at least of a macromolecular material. Recording layer 2 needs to have a color developing property since ink material layer 8 contains dyestuffs in the coloring material. Therefore, it is suitable to choose macromolecular materials which can be dyed easily by disperse dyes etc. Examples include polyester, polyacetal type resin, acrylic type resin, urethane type resin, nylon type resin, polyvinyl acetate type resin, polyvinyl butyral. Polyester and polyvinyl butyral meet the requirements of a color developing property of dyestuffs and an adhesive property to paper.

Recording layer 2 is required to have an adhesive property with color receiving sheet 12 when transferred onto color receiving sheet 12. Therefore, it is preferable that the flow softening point of recording layer 2 is from 50 °C to 200 °C so that the recording layer softens rather easily through the heating provided from heating roller 13. Generally, the flow softening point of recording layer 2 is measured by a flow tester. Other than the above-mentioned macromolecular materials, materials comprising recording layer 2 can be, for example, hot melt materials such as waxes or resins which are used either individually or in a mixed form of several hot melt materials according to need. If recording layer 2 comprises one kind of the above-mentioned macromolecular materials alone, the flow softening point is value which indicates the property of the material. On the other hand, if recording layer 2 is formed by mixing several kinds of materials, the flow softening point is an amount which indicates both the flowability of recording layer 2 and the properties of the mixed materials. This is not the same with the glass transition point of recording layer 2. The glass transition point of the recording layer is usually measured by, e.g., a differential scanning calorimeter. If recording layer 2 comprises one kind of the above-mentioned macromolecular materials alone, the glass transition point indicates the property of the material, as with the flow softening point. On the other hand, if recording layer 2 is formed by mixing several kinds of materials, the glass transition point of each material comprising recording layer 2 can be observed, but a value which indicates the properties of the mixed materials can not be obtained. In this instance, the lowest glass transition point among the plurality of glass transition points can be used as the central value of the glass transition point for recording layer 2.

According to the thermal transfer printing method of this invention, recording layer 2 should have light permeability since an image is formed by the transfer of recording layer 2 onto the color receiving sheet. It is preferable to use hyaline macromolecular materials.

Recording layer 2 may include an additive to prevent itself from welding with ink material layer 8 by heat. Examples of the additive are various kinds of silicone compounds, fluorine compounds, fatty acid compounds, surface active agents, and particles.

The type of color receiving sheet 12 used is not limited in view of the material, paper quality or form. For example, woodfree paper, ordinary paper (for copy etc.), non-coated paper such as bond paper, coated paper, films such as polyethylene, polypropylene (PP), polyethylene terephthalate (PET) and aluminium foil, and synthetic paper mainly comprising PP, PET, and polyvinyl chloride, can be used either as a consecutive color receiving sheet or as a cut color receiving sheet.

In the embodiment mentioned above, recording layer 2 disposed on color developing layer supplying member 1 is applied on substrate 3 in advance, and substrate 3 is discarded after recording layer 2 is transferred onto intermediate transfer member 4. However, an endless substrate can be rotated to provide recording layers by the recording layer supplying means repeatedly.

Furthermore, substrate 6 and macromolecular layer 5 comprising intermediate transfer member 4 in the embodiment can be formed in such a way that the macromolecular layer is disposed directly on a drum-type substrate made of a metal or plastic material. This may also be comprised such that a sheet-type substrate made of plastic materials or the like which is disposed with a macromolecular layer is applied on a drum-type substrate. Instead of applying the macromolecular layer on the sheet-type substrate, it is also possible to apply a heat-resisting substrate in sheet-form having rubber elasticity and stickiness. By doing so, both the functions of the substrate and the macromolecular layer can be combined to reduce the thickness of the macromolecular layer. This heat-resisting substrate in sheet-form having rubber elasticity and stickiness can be e.g. fluorine type film or silicone type film added with an adhesive material. In particular, it is useful to use sheets which are composed of silicone rubber or fluorosilicone rubber added with a silicone adhesive material. Furthermore, instead of using a roller-type supporting material such as substrate 6, an endless belt-type supporting material be used as well.

Moreover, in the embodiment, intermediate transfer member 4 disposed with macromolecular layer 5 was used on the entire surface of substrate 6, but the intermediate transfer member can be comprised otherwise. It is also possible to use an intermediate transfer member comprising macromolecular layer 5 disposed only in the part needed for the recording on substrate 6. The intermediate transfer member can also be comprised such that macromolecular layer 5 is formed on the entire surface of substrate 6, and that the part of macromolecular layer 5 which is not used for recording is covered on the surface.

It is also possible that macromolecular layer 5 is made of a material having no light permeability. As a result, a permeation-type or reflection-type light sensor can be used as means to find the starting point of recording.

It is preferable that rubber elasticity of macromolecular layer 5 is high such that the elasticity does not change much even with pressure and heat. In particular, preferable materials are silicone materials having an advantage of high heat resistance which include elastomer-type, gel-type, and flexible resin-type silicone materials. By using elastomer-type silicone rubber, excellent rubber elasticity with high heat resistance, high weather resistance and high chemical resistance can be obtained. Examples of this silicone rubber are those which harden through condensation reaction, e.g. organopolysiloxane having several alkoxyl groups at the terminals which turns into a rubber elastic member through dealcohol condensation in the moisture contained in the air or organopolysiloxane having several acetoxyl groups at the terminals which turns into a rubber elastic member through deacetic acid condensation in the moisture contained in the air. In another example, an aliphatic unsaturated group such as a vinyl group combined with a silicone atom comprising organopolysiloxane and another organohydrogenpolysiloxane harden through addition reaction of a precious metal-type catalyst such as a platinum group compound catalyst. The latter hardens at low temperature and in a short time so that it is excellent silicone rubber having high productivity without creating any by-products in the hardening process. When this kind of silicone material is used to form soft macromolecular layer 5 which can be fixed on the surface unevenness of color receiving sheet 12, recording layer 2 is filled into the hollow-shaped parts of color receiving sheet 12. As a result of increased adhesive strength, the fixation can be improved.

With regard to the rubber elasticity of macromolecular layer 5, excellent fixation can be attained with a rubber hardness from 10 to 70 degrees. In particular, if the rubber hardness is from 10 to 25 degrees, excellent fixation can be attained even though color receiving sheet 12 may have large surface unevenness.

When silicone materials are used for the macromolecular layer, it is suitable to use separating paper silicone which has low rubber hardness and hardens easily.

When an adhesive material is used as macromolecular layer 5 or for adding stickiness to macromolecular layer 5, an adhesive material of rubber type, acrylic type, and silicone type is useful. Examples of the rubber type adhesive material include a rubber component such as crude rubber, synthetic rubber, styrenebutadiene rubber, thermoplastic rubber, butyl rubber which has an adhesive additive resin such as rosin, rosin derivative, and turpentine resin. Examples of acrylic type adhesive material are materials composed mainly of 2-ethylhexylacrylate or n-butylacrylate which are copolymerized with either methylacrylate, ethylacrylate, methylmethacrylate, polyvinyl acetate, or acrylic acid, methacryl acid, acrylamide derivative, hydroxyethylacrylate, glysidylacrylate. Silicone adhesive materials have high cohesion and excellent adhesive characteristics. By using a silicone adhesive material having high cohesion, recording layer 2 which was transferred onto macromolecular layer 5 does not slip during the recording process and the storing process thereafter so that recording layer 2 is held stably on macromolecular layer 5. Silicone adhesive materials consist of silicone crude rubber which is a film forming material, silicone resin which is an adhesive substance, a filler, a plasticizer, and an additive. The silicone adhesive materials have high heat resistance and excellent adhesive characteristics which make them suitable for use as silicone materials having stickiness. The silicone crude rubber used includes dimethylsiloxane, diphenylsiloxane, methylvinylsiloxane, phenylmethylsiloxane, organopolysiloxane of a high polymerization degree containing a monomeric unit of a halogen thereof, or organopolysiloxane of a high polymerization degree thereof having a functional group such as a hydroxyl group at the terminal. Furthermore, the silicone resins include a diorganopolysiloxane having a methyl group, an ethyl group, a propyl group, a vinyl group, a phenyl group or any of these groups substituted with a halogen or the diorganopolysiloxane with a hydroxyl group or a trimethylsiloxane group at the terminal. Among the aforementioned silicone adhesive materials, there are those which harden through an addition reaction of a precious metal type catalyst such as platinum group compound catalyst added to an aliphatic unsaturated group such as vinyl group combined with a silicone atom comprising organopolysiloxane and to another organohydrogenpolysiloxane. These compounds harden at a low temperature and in a short time so that they are excellent silicone adhesive materials which have high productivity without creating any by-products in the hardening process. When using these silicone adhesive materials, their characteristics such as stickiness, cohesion, and adhesiveness can be easily changed by changing the proportion of silicone crude rubber and silicone resin, or by changing the type and amount of additives. In addition, by using a silicone adhesive material, stickiness as well as rubber elasticity can be obtained. In this case, macromolecular layer 5 can be comprised of just silicone adhesive material.

Furthermore, it is effective to add an additive to macromolecular layer 5 in order to enhance the mechanical strength, heat resistance, and also to control the surface characteristics. As the additive, inorganic fine particles such as silica, alumina, red oxide, titanium oxide and organic materials with comparatively low molecular weight e.g. silicone oil can be used.

It is preferable that macromolecular layer 5 is determined to be as thick as possible in order to deform itself sufficiently to the surface unevenness of color receiving sheet 12. Bond paper having rather rough surface has a depth of about 10 μm at the hollow-shaped part and about 25 μm at the deepest part. Therefore, a suitable thickness for macromolecular layer 5 which can be transferred onto color receiving sheet 12 having extremely rough surface is 10 μm or more, and more preferably 25 μm or more for obtaining satisfactory fixation. On the other hand, ordinary paper has shallower hollow-shaped parts on the surface than bond paper so that a thickness of about 10 μm for macromolecular layer 5 can attain sufficient fixation.

According to the embodiment of this invention, heating roller 13 serves to provide heat from the color receiving sheet 12 side when recording layer 2 is transferred onto color receiving sheet 12. It is also possible to dispose a heater inside of substrate 6 in order to heat from the substrate 6 side only. The heating may be conducted by heating from both the color receiving sheet 12 side and the substrate 6 side. In addition, if the material composing recording layer 2 can adhere to color receiving sheet 12 at room temperature, recording layer 2 can be transferred onto color receiving sheet 12 by pressure only so that the heating process is no longer necessary. In this case, the electric power consumed by the heater in heating roller 13 can be saved, thereby reducing the consumption of electric power used for the whole device.

As described above, the thermal transfer printing method of this invention can attain a uniform pictorial image by using different kinds of recording papers as the color receiving sheet, for example, ordinary paper, transparent film for OHP, bond paper with extremely rough surface, coated paper, and coated film. In particular, the high-quality pictorial image printing which was the characteristic of the conventional sublimation type recording and which was impossible to attain by using ordinary paper in the past, is attained by the method of this invention.

The embodiments of this invention will be described specifically in the following illustrative examples.

Example 1

An intermediate transfer member used here comprised a metallic roller of 30 mm in diameter which was applied with a mending tape (MD-12C, Nichiban Co., Ltd.) of 12 mm in width obtained on the market. The macromolecular layer was an acrylic adhesive material which was coated on the adhesive side of the mending tape. This adhesive material was flexible and had stickiness.

A color developing layer supplying member comprised a polyethylene terephthalate (PET) film of about 25 µm in thickness which had a recording layer of about 3 µm thereon formed by coating and drying a coating material containing polyvinyl butyral (BL-S, Sekisui Chemical Industrial Co., Ltd.) by means of a wire bar.

First, the color developing layer supplying member was applied to the intermediate transfer member such that the recording layer of the color developing layer supplying member was in contact with the macromolecular layer of the intermediate transfer member. When the PET-film of the color developing layer supplying member was separated from the intermediate transfer member, the recording layer was transferred onto the adhesive side of the mending tape which formed the macromolecular layer.

An ink sheet used for video printers (NV-MP1, Matsushita Electric Industrial Co., Ltd.) was used as the ink sheet. The ink sheet was placed on top of the intermediate transfer member such that a cyan dye layer is in contact with the recording layer disposed on the intermediate transfer member. Next, heat was provided partially from the opposite side of the dye layer of the ink sheet by means of a small heater which was heated to about 180 °C. When the color sheet was separated from the intermediate transfer member, the part of the recording layer which was heated by the heater had the migrated cyan dye thereon.

Then, this recording layer of the intermediate transfer member was placed on top of copy paper having a Becksmoothness of 35 seconds as a color receiving sheet, and heat was provided from the color receiving sheet side by using a small heater which was heated to about 180 °C. Next, the intermediate transfer member and the copy paper were cooled to room temperature. When the copy paper was separated from the intermediate transfer member, the heated part of the recording layer was transferred onto the copy paper.

As described above, the principle of this invention was confirmed by using an intermediate transfer member disposed with a macromolecular layer composed of an acrylic adhesive material of a mending tape obtained on the market, providing a recording layer made of polyvinyl butyral from a color developing layer supplying member onto the macromolecular layer having rubber elasticity and stickiness, transferring dyestuffs by heat onto the recording layer disposed on the intermediate transfer member, and transferring the dyed recording layer onto copy paper.

Example 2

An intermediate transfer member used here comprised a polyethylene terephthalate (PET) film of about 25 µm in thickness which had a macromolecular layer of about 10 µm in thickness thereon formed by coating a coating material containing a gel-type silicone potting material (SE1880, Toray Dowcorning Silicone, Ltd.) by means of a wire bar and by drying 30 minutes at 150 °C. This macromolecular layer was very flexible and had a sticky surface.

By using the same color developing layer supplying member as in Example 1, the color developing layer supplying member was applied to the intermediate transfer member such that the recording layer of the color receiving sheet supplying member was in contact with the macromolecular layer of the intermediate transfer member. When the PET-film of the color developing layer supplying member was separated from the intermediate transfer member, the recording layer was transferred onto the silicone potting material which formed the macromolecular layer.

Next, by applying the same ink sheet and the same procedure as in Example 1, the ink sheet was placed on top of the intermediate transfer member, and heat was provided partially from the opposite side of the dye layer of the ink sheet. As a result, the heated part of the recording layer had the migrated dye thereon.

Then, this recording layer of the intermediate transfer member was placed on top of copy paper having a Becksmoothness of 35 seconds as a color receiving sheet, and heat was provided as in Example 1. As a result, the recording layer was transferred onto the copy paper. It was easier to separate the copy paper from the intermediate transfer member than in Example 1.

Example 3

An intermediate transfer member was manufactured by first coating a dye which contained either separating paper silicone (SD7328, Toray Dowcorning Silicone, Ltd.) or silicone adhesive material (SD4570, Toray Dowcorning Silicone, Ltd.) and a catalyst (SRX212, Toray Dowcorning Silicone, Ltd.) as an additive on top of a polyethylene terephthalate (PET) film of about 25 µm in thickness by means of a wire bar. Next, the coating was dried 3 minutes at 130 °C to form a macromolecular layer of about 25 µm in thickness. Compounds of this macromolecular layer are shown below in a table. Five types of compounds were formed for the macromolecular layer which comprised the separating paper silicone only to the one made only of the silicone adhesive material. The macromolecular layers obtained in this manner were very flexible and had excellent rubber elasticity. Except the macromolecular layer comprising the separating paper silicone only, the other macromolecular layers showed stronger surface stickiness as the percentage content of the silicone adhesive material increased. However, only the macromolecular layer comprising the separating paper silicone had hardly any stickiness on the surface. The PET-films having these macro-molecular layers were applied to a rubber-coated metallic roller of 60 mm in diameter to form the intermediate transfer media.

Table

Sample No.	1	2	3	4	5
Weight parts of separating paper silicone (solid content)	10	7.5	5	2.5	0
Weight parts of silicone adhesive material (solid content)	0	2.5	5	7.5	10

In order to manufacture a color developing layer supplying member, a release layer of about 0.5 µm was formed by coating a coating material which contained separating paper silicone (SD7328, Toray Dowcorning Silicone, Ltd.) and a catalyst (SRX212, Toray Dowcorning Silicone, Ltd.) as an additive on top of a polyethylene terephthalate (PET) film of about 25 µm in thickness by means of a wire bar and then drying the coating material 3 minutes at 130 °C. On top of this release layer, a coating material containing polyvinyl butyral (BL-S, Sekisui Chemical Industrial Co., Ltd.) was coated and dried by means of a wire bar to form a recording layer of about 3 µm in thickness. This was used as the color developing layer supplying member.

An ink sheet was manufactured by using a PET-film of about 4 µm in thickness disposed with a heat-resisting and slipping layer on the bottom. First, by using a wire bar, the PET-film was coated with a coating material containing azo-type disperse dye, saturated polyester resin, and silicone-type mold release agent and then dried to form an ink material layer of about 1 µm in thickness.

First, a metallic roller of the intermediate transfer member was supported by an axe so that the intermediate transfer member could rotate. Next, the intermediate transfer members having five types of macromolecular layers with the compounds listed in the table were placed on top of the color developing layer supplying member respectively such that the recording layer side of the color developing layer supplying member was in contact with the macromolecular layer side of the intermediate transfer member. Then, a pressure of about 150 N was provided from the opposite side of the recording layer of the color developing layer supplying member by means of a metallic roller 30 mm in diameter, and the intermediate transfer member was rotated and was applied to the color developing layer supplying member. When the color developing layer supplying member was separated from the intermediate transfer member, the recording layers of the color developing layer supplying members were transferred onto the macro-molecular layers of the intermediate transfer media except the intermediate transfer member having the macromolecular layer comprising only the separating paper silicone. On the other hand, as for the intermediate transfer member which had the macromolecular layer comprising the separating paper silicone only, a part of the recording layer remained on the color developing layer supplying member without being transferred onto the macromolecular layer.

Next, five kinds of the intermediate transfer media having the transferred recording layers were placed respectively on top of the ink sheets such that the recording layer sides of the intermediate transfer members faced the ink material layers. Then, a pressure of about 50 N was provided by using a thermal head. The recording conditions were as follows. Recording speed: 8 ms/line, maximum recording pulse width: 4 ms, maximum recording energy: 7 J/cm^2.

After the recordings, the intermediate transfer members and the color sheets were cooled to room temperature. When the ink sheets were separated from the intermediate transfer members, the intermediate transfer media disposed with the macromolecular layers recorded the gradation patterns clearly on the recording layer except the one with the macromolecular layer comprising only the separating paper silicone. In particular, the dot reproductivity at the highlight parts was excellent which showed that the contact between the thermal head, the ink sheet, and the recording layer of the intermediate transfer member was satisfactory. Furthermore, the recording layer did not separate from the macromolecular layer, and the recording was conducted stably. As for the intermediate transfer member with the macromolecular layer comprising only the separating paper silicone, the recording was conducted satisfactorily at the highlight parts. However, the recording layer separated from the macromolecular layer at highly dense parts which showed that the macromolecular layer could not hold the recording layer sufficiently.

Next, after being recorded, five kinds of the intermediate transfer media disposed with the recording layers with the gradation patterns were placed respectively on top of copy paper with a Becksmoothness of 35 seconds as color receiving sheets, and pressure was provided by a heated metallic roller from the copy paper side. After that, the intermediate transfer members and the copy paper were taken out and cooled to room temperature, and the copy paper was separated from the intermediate transfer members. In this way, the recording layers were transferred onto the copy paper. The metallic roller had a diameter of about 30 mm and a temperature of about 100 ° C. In addition, the metallic roller had been loaded with about 150 N.

When the recording layers were transferred onto the copy paper, all of the five kinds of intermediate transfer member could be separated from the copy paper, with the result that high-quality pictorial images of uniformly formed dots from low recording density to high recording density were obtained. In addition, the gloss of the recording layers was as good as the surface of the paper, and the images hardly showed a different impression. The surface of the recording layers had writability, and the fixation was also satisfactory. On the other hand, as the percentage content of the silicone adhesive material in the macromolecular layer increased, the force needed for separating the copy paper from the intermediate transfer members became stronger.

Example 4

An intermediate transfer member was manufactured by first coating a coating material which contained separating paper silicone (SD7328, Toray Dowcorning Silicone, Ltd.) and a silicone adhesive material (SD4570, Toray Dowcorning Silicone, Ltd.) in a ratio of 1/1 in solid content and also a catalyst (SRX212, Toray Dowcorning Silicone, Ltd.) as an additive on top of a polyimide film of about 25 μm in thickness by means of a wire bar. Then, the coating material was dried 3 minutes at 130 ° C to form a macromolecular layer of about 70 μm in thickness. This macromolecular layer was very flexible and had excellent rubber elasticity. The surface of the macromolecular layer had sufficient stickiness so that it stuck excellently to various materials such as metal, resin film etc. As in Example 3, the polyimide film disposed with this macromolecular layer was applied on a rubber-coated metallic roller to form the intermediate transfer member.

As for a base material for a recording sheet, a PET-film of about 4 μm in thickness was used which was disposed with a heat-resisting and slipping layer on the bottom. In order to manufacture a part of the recording layer in the recording sheet, a coating material which contained separating paper silicone (SD7328, Toray Dowcorning Silicone, Ltd.) and a catalyst (SRX212, Toray Dowcorning Silicone, Ltd.) as an additive was coated partially on top of the PET film as a release layer by means of a wire bar. Then, the coating material was dried 3 minutes at 130 ° C to form the release layer of about 0.5 μm in thickness. On top of this release layer, a coating material containing polyvinyl butyral (BL-S, Sekisui Chemical Industrial Co., Ltd.) was coated and dried by a wire bar to form the recording layer of about 3 μm in thickness. Next, an ink material layer of the recording sheet was manufactured by coating a coating material containing azo-type disperse dye, saturated polyester resin, and a silicone-type mold release agent on the part of the PET film where the release film was not disposed and drying the coating material to form an ink material layer of about 1 μm in thickness by a wire bar.

First, as in Example 3, the intermediate transfer member was supported and was applied to the part of recording layer in the recording sheet. When the recording sheet was separated from the intermediate transfer member, the recording layer of the recording sheet was transferred onto the macromolecular layer.

Next, by using part of the ink material layer in the recording sheet, the recording was conducted on the recording layer disposed on the intermediate transfer member by a thermal head, as in Example 3.

After the recording, the intermediate transfer member and the color sheet were cooled to room temperature. When the recording sheet was separated from the intermediate transfer member, the gradation patterns were clearly recorded on the recording layer. In particular, the dot reproductivity at highlight parts was excellent which showed that the contact between the thermal head, the recording sheet, and the recording layer of the intermediate transfer member was satisfactory. Furthermore, the recording layer did not separate from the macromolecular layer, and the recording was conducted stably.

Next, as in Example 3, the recording layer was transferred onto a color receiving sheet by placing the color receiving sheet on top of the recording layer, pressing a heated metallic roller, cooling them to room temperature, and separating the color receiving sheet from the intermediate transfer member. Three kinds of color receiving sheet were used here: bond paper with a Becksmoothness of 7 seconds, copy paper with a Becksmoothness of 35 seconds, and a PET-film 100 µm thick. The same procedure was repeated three times to transfer the recording layer onto three kinds of color receiving sheets.

All the transferred images obtained on the color receiving sheets were high-quality pictorial images, and the fixation was also satisfactory. On the other hand, the gloss of the recording layers improved in order of bond paper, copy paper, and PET-film which reflected the surface condition of each color receiving sheet well. As for the recording layer on the copy paper, this recording layer reproduced the surface condition of the paper even more true than the recording layer on the copy paper obtained in Example 3 so that a different impression of the image was even more reduced. In addition, the surface of the recording layers for bond paper and copy paper had sufficient writability.

Example 5

As in Example 4, an intermediate transfer member was formed by using a polyimide film which was disposed with a macromolecular layer containing separating paper silicone and a silicone adhesive material and applying it on a rubber-coated metallic roller.

Next, as in Example 4, a release film, a recording layer, and an ink material layer were formed on top of a PET-film to be used as a recording sheet.

First, as in Example 3, the intermediate transfer member was supported and was applied to the part of recording layer in the recording sheet. When the recording sheet was separated from the intermediate transfer member, the recording layer of the recording sheet was transferred onto the macromolecular layer.

Next, the ink sheet was placed on top such that the ink material layer side of the recording sheet faced the recording layer side of the intermediate transfer member. A pressure of about 50 N was provided by a thermal head. The recording conditions were as follows. Recording speed: 8 ms/line, maximum recording pulse width: 4 ms, maximum recording energy: 7 J/cm^2.

At this time, when the recording sheet was separated from the intermediate transfer member in a condition that the temperature of the recording layer was set at about 40 °C which was lower than the glass transition point of polyvinyl butyral used for the recording layer which was 54 °C, the gradation patterns were clearly recorded on the recording layer. The dot reproductivity was excellent at the highlight parts as in Example 4. Furthermore, the recording layer did not separate from the macromolecular layer, and the recording was conducted stably. The room temperature was about 28 °C.

On the other hand, when the recording sheet was separated from the intermediate transfer member in a condition that the temperature of the recording layer was set at about 70 °C which was higher than the glass transition point of polyvinyl butyral used for the recording layer which was 54 °C, the softened recording layer was deformed and raised up from the macromolecular layer due to welding with the recording sheet, or the recording layer was separated from the macromolecular layer and adhered to the recording sheet.

Example 6

As in Example 4, an intermediate transfer member was formed by using a polyimide film which was disposed with a macromolecular layer containing separating paper silicone and silicone adhesive material.

Next, as in Example 4, a release film, a recording layer, and an ink material layer were formed on top of a PET-film to be used as a recording sheet.

First, as in Example 3, the intermediate transfer member was supported and was applied to the recording layer part of the recording sheet. When the recording sheet was separated from the intermediate transfer member, the recording layer of the recording sheet was transferred onto the macromolecular layer.

Next, the ink sheet was place on top such that the ink material layer side of the recording sheet faced the recording layer side of the intermediate transfer member. A pressure of about 50 N was provided by a thermal head. The recording conditions were as follows. Recording speed: 8 ms/line, maximum recording pulse width: 4 ms, maximum recording energy: 7 J/cm^2.

After the recording, the intermediate transfer member and the recording sheet were cooled to room temperature. When the recording sheet was separated from the intermediate transfer member, the gradation patterns were clearly recorded on the recording layer.

Next, as in Example 4, copy paper was placed on top of the recording layer with the gradation patterns, and the recording layer was transferred onto the copy paper by means of a heated metallic roller.

At this time, when the copy paper was separated from the intermediate transfer member in a condition that the temperature of the recording layer was set at about 90 °C which was lower than the flow softening point of polyvinyl butyral used for the recording layer which was 110 °C, the recording layer was transferred excellently onto the copy paper. The transferred image obtained on the copy paper was a high-quality pictorial image of uniformly formed dots from low recording density to high recording dencity, as in Example 4. In addition, the gloss of the recording layer was as good as the surface of the paper, and the image hardly showed a different impression. The surface of the recording layer had writability, and the fixation was also satisfactory.

On the other hand, when the copy paper was separated from the intermediate transfer member in a condition that the temperature of the recording layer was set at about 160 °C which was higher than the flow softening point of polyvinyl butyral used for the recording layer which was 110 °C, the recording layer which softened so much that it could flow was divided in two parts when separated and remained partially on the macromolecular layer. As a result, the recording layer was not satisfactorily transferred onto the copy paper.

Example 7

An intermediate transfer member was manufactured by first coating a coating material which contained silicone adhesive material (SD4567, Toray Dowcorning Silicone, Ltd.) having an increased amount of silicone crude rubber and a hardening property to addition reaction and a catalyst (SRX212, Toray Dowcorning Silicone, Ltd.) as an additive on top of a polyimide film of about 50 μm in thickness by means of a wire bar. Then, the coating material was dried 3 minutes at 130 °C to form a macromolecular layer of about 70 μm in thickness. This macromolecular layer was very flexible and had excellent rubber elasticity. Furthermore, the surface of the macromolecular layer had sufficient stickiness as in the macromolecular layer formed in Example 4 so that it stuck excellently to various materials such as metal, resin film etc. On the other hand, the materials comprising the macromolecular layer reduced in comparison with Example 4 which made it easier to form the macromolecular layer. As in Example 3, the polyimide film having this macromolecular layer was applied on a rubber-coated metallic roller to form the intermediate transfer member.

Next, as in Example 4, a release film, a recording layer, and an ink material layer were formed on top of a PET-film to be used as a recording sheet.

First, as in Example 3, the intermediate transfer member was supported and was applied to the recording layer part of the recording sheet. When the recording sheet was separated from the intermediate transfer member, the recording layer of the recording sheet was transferred onto the macromolecular layer.

Next, the ink sheet was placed on top such that the ink material layer side of the recording sheet faced the recording layer side of the intermediate transfer member. A pressure of about 50 N was provided by a thermal head. The recording conditions were as follows. Recording speed: 8 ms/line, maximum recording pulse width: 4 ms, maximum recording energy: 7 J/cm^2.

After the recording, the intermediate transfer member and the recording sheet were cooled to room temperature. When the recording sheet was separated from the intermediate transfer member, the gradation patterns were clearly recorded on the recording layer. The dot reproductivity was excellent at the highlight parts, as in Example 4. Furthermore, the recording layer did not separate from the macromolecular layer, and the recording was conducted stably.

Next, as in Example 4, copy paper was placed on top of the recording layer with the gradation patterns, and the recording layer was transferred onto the copy paper by using a heated metallic roller. The metallic roller had been loaded with about 400 N.

The transferred image obtained on the copy paper in the manner described above was high-quality pictorial image of uniformly formed dots from low recording density to high recording density, as in Example 4. In addition, the gloss of the recording layer was as good as the surface of the paper, and the image hardly gave a different impression. The surface of the recording layer had writability, and the fixation was also satisfactory.

Claims

1. A thermal transfer printing method comprising
providing a color developing layer supplying member comprising a substrate disposed thereon with a recording layer having a color developing property, an intermediate transfer member comprising a substrate disposed thereon with a macromolecular layer having rubber elasticity and stickiness, an ink sheet comprising a substrate disposed thereon with an ink material layer containing dyestuffs, and a color receiving sheet,
transferring the recording layer of the color developing layer supplying member onto the macromolecular layer of the intermediate transfer member,
laminating the recording layer disposed on the macromolecular layer on top of the ink sheet to transfer the dyestuffs from the ink material layer by heat, and
tranferring the dyed recording layer onto the color receiving sheet.

2. The thermal transfer printing method as in claim 1, wherein said macromolecular material having rubber elasticity and stickiness comprises a macromolecular material having rubber elasticity and a macromolecular material having stickiness.

3. The thermal transfer printing method as in claim 1 or 2, wherein said macromolecular material having rubber elasticity comprises a silicone material having rubber elasticity.

4. The thermal transfer printing method as in any of claims 1 to 3, wherein said macromolecular material having stickiness comprises a silicone material having stickiness.

5. The thermal transfer printing method as in claim 4, wherein said silicone material having stickiness comprises a silicone adhesive material containing silicone crude rubber and silicone resin.

6. The thermal transfer printing method as in any of claims 1 to 5, wherein said step of laminating the recording layer on top of the macromolecular layer to transfer the dyestuffs from the ink material layer by heat further comprises separating the recording layer from the ink sheet when the temperature of the recording layer has become lower than the glass transition point of the recording layer.

7. The thermal transfer printing method as in any of claims 1 to 6, wherein said step of transferring the dyed recording layer onto the color receiving sheet further comprises separating the color receiving sheet when the temperature of the recording layer has become lower than the flow softening point of the recording layer.

8. The thermal transfer printing method as in any of claims 1 to 7, wherein said color developing layer supplying member comprises the substrate disposed thereon with the recording layer having a color developing property via a release layer which is disposed to separate the recording layer.

9. The thermal transfer printing method as in claim 8, wherein said release layer is at least one layer selected from the group consisting of silicone resin, fluororesin, melamine resin, and wax materials.

10. A thermal transfer printing method according to any of claims 1 to 9, wherein said macromolecular layer comprises a silicone material layer having rubber elasticity and stickiness.

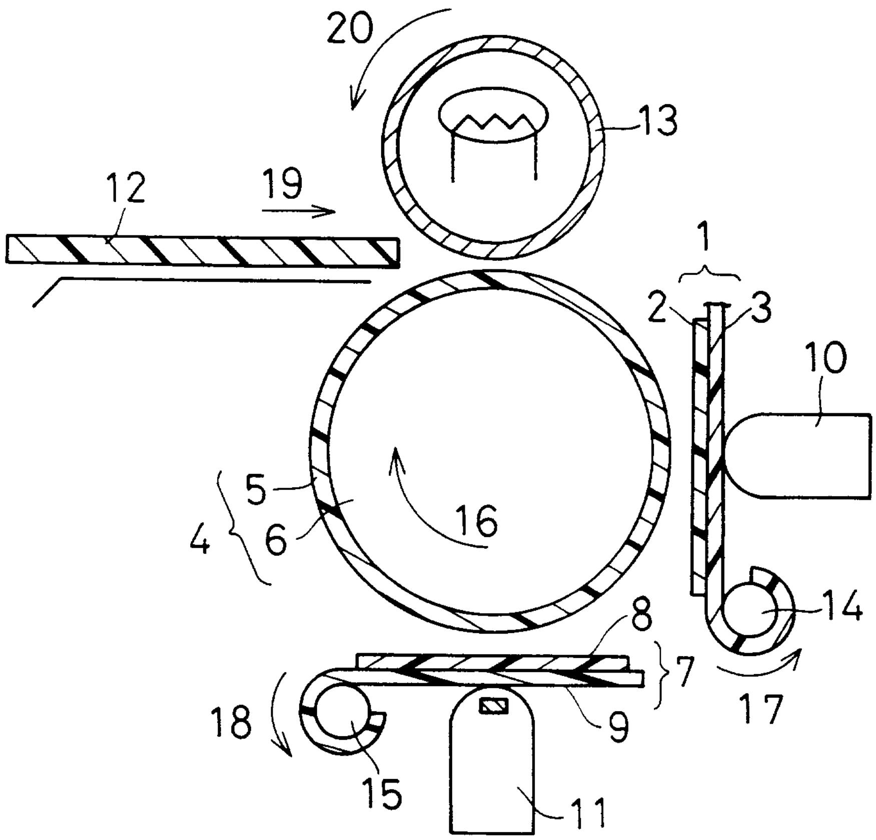


FIG. 1

FIG.2 (a)

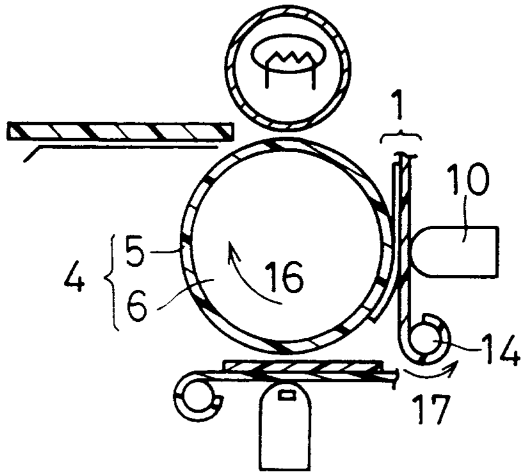


FIG.2 (b)

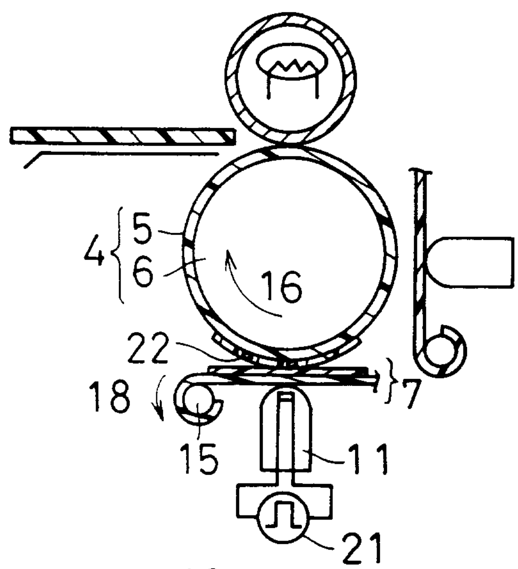
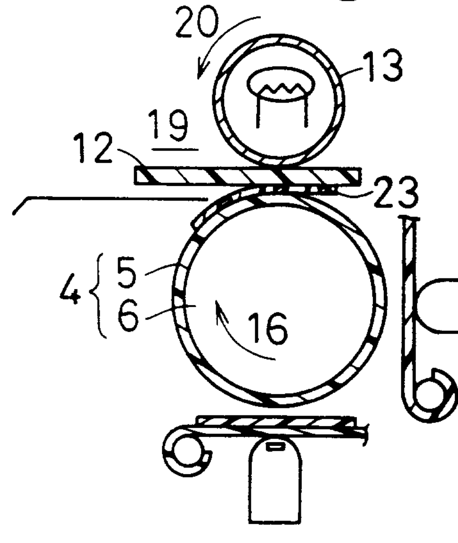


FIG.2 (c)



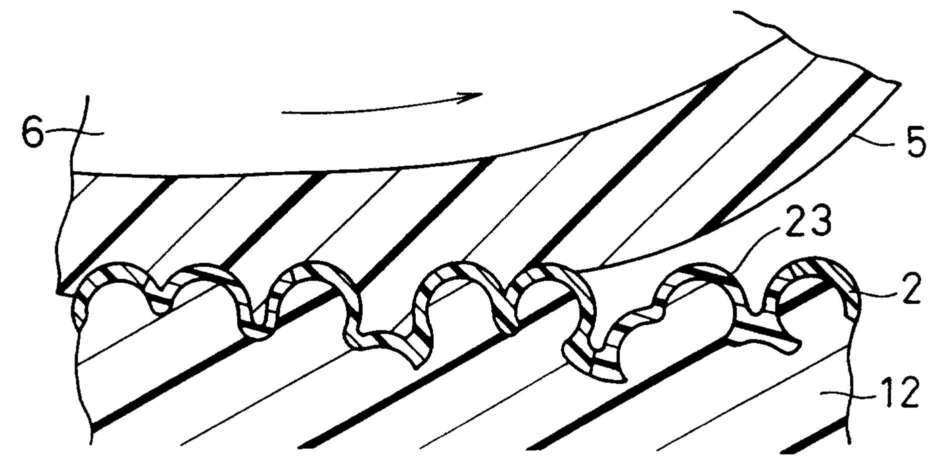


FIG. 3

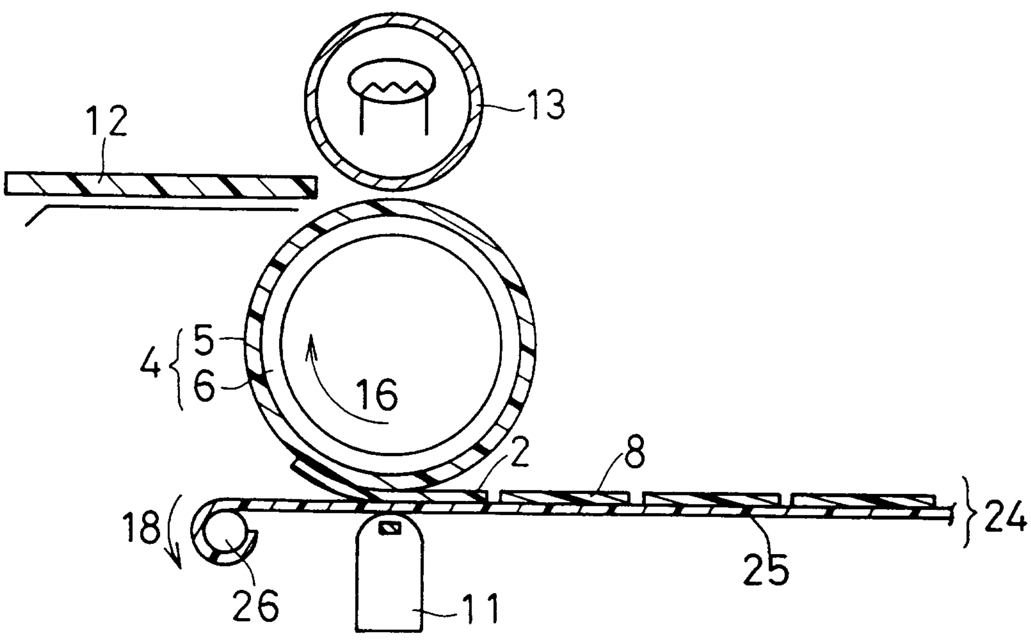


FIG. 4

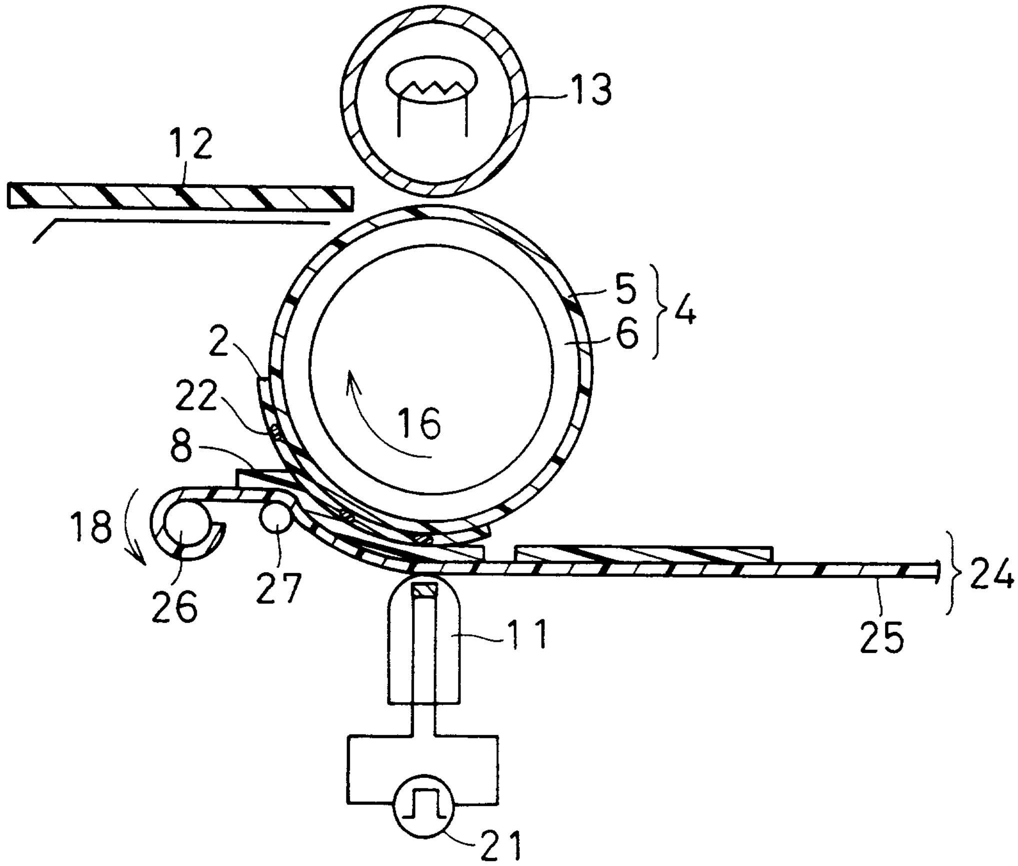


FIG. 5

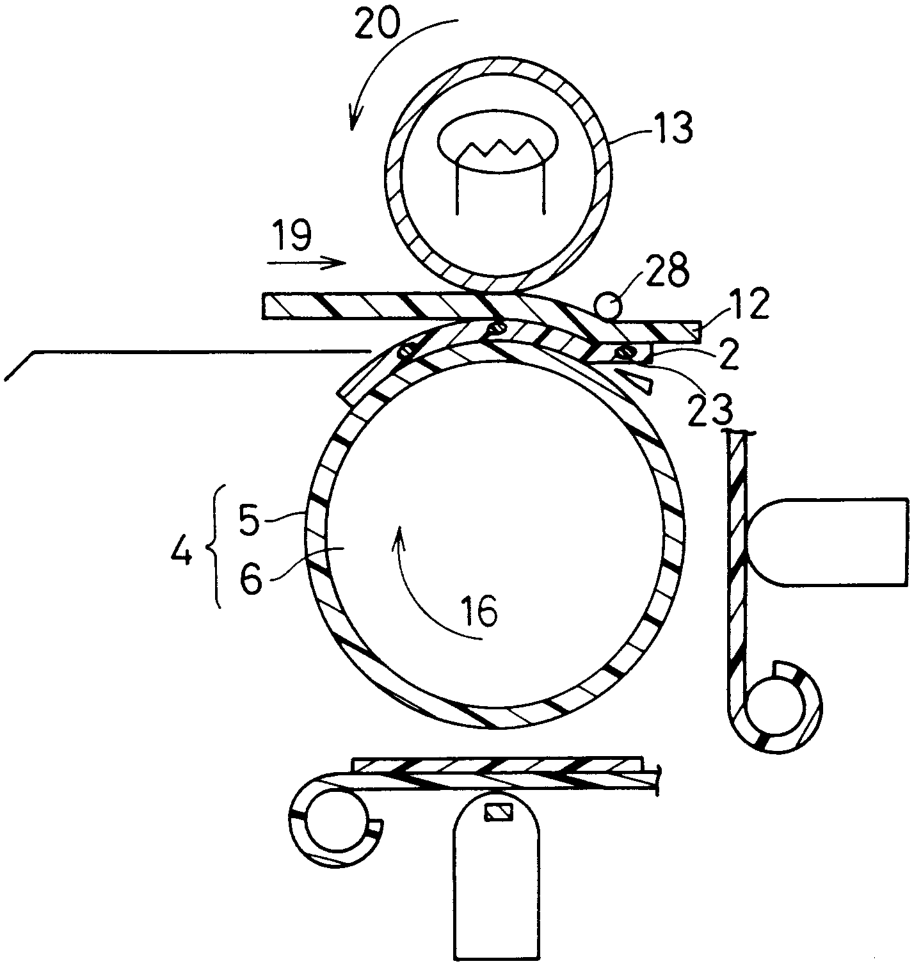


FIG. 6