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(54) Thermal transfer recording system.

(57) An ink sheet used has a base film, a layer formed over the base film and more containing a coloring agent, and another layer formed over the first mentioned layer and containing a wax material as a chief component. A thermal head used includes a part glaze layer formed therein. The ink can easily penetrate into recesses in the surface of the recording sheet. As a result, a recording sheet of paper having a low-smoothness surface can be color printed very efficiently.

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BACKGROUND OF THE INVENTION

Field of the Invention:

The present invention relates to a thermal transfer type recording device suitable for use in printers, facsimile machines and so on and particularly to such a recording device for printing a colored or half-tone image on a sheet of paper having low smoothness.

Description of the Related Art:

Fig. 5 shows the printing section of a typical thermal-transfer type recording device constructed in accordance with the prior art. The printing section comprises a thermal head for heating an ink sheet 4. The thermal head includes a convex part glaze 2 formed therein at the tip end and a recessed heating resistor 3 formed in the apex of the part glaze 2. The ink sheet 4 consists of a base film 5 and an ink layer 6. Reference numeral 7 denotes a recording sheet of paper. Reference numeral 8 designates a platen roller for pinching the ink and recording sheets 4, 7 between the platen roller 8 and the thermal head 1 under pressure. The ink layer 6 is formed of a mixture consisting of a coloring agent (e.g. pigment or dye) and a binder (e.g. wax).

On printing, the ink layer 6 is partially heated so as to adhere to the recording sheet 7 by the thermal head 1. Since the adhered ink immediately solidifies, only the solidified ink parts in a desired pattern to be transferred remain on the recording sheet 7 when the ink sheet 4 is separated from the recording sheet 7.

If a recording sheet of paper having a low-smoothness surface is printed by the aforementioned thermal-transfer type recording device of the prior art, the ink is not brought into contact with recesses in the recording sheet surface and so is not transferred to the recording sheet surface very efficiently. This raises a problem that the printed portion is partially left white which degrades the quality of print. In order to overcome such a problem, the prior art has two proposed approaches: One of these approaches is to use a high-viscosity ink containing a resin-based binder. Before the ink solidifies, the ink sheet 4 is separated from the recording sheet 7 to transfer the ink to the recording sheet 7 in the form of a bridge over a recess in the recording sheet surface. However, the first approach can be realized only in a serial printer with the thermal head 1 being very rapidly moved, rather than a line printer.

The second approach is described in "NIKKEI ELECTRONICS", No. 535, September 2, 1991, pp.163. The second approach utilizes a thick-film thermal head including a protruding heating resistor with a convex part glaze which would be used only in the thin-film thermal head. The convex part glaze of the heating resistor is formed with two steps and the ink in the ink sheet has a reduced melting viscosity. Thus, the ink can easily enter the recesses in the low-smoothness surface of any recording sheet. However, the second approach can sufficiently perform its function only in the monochrome printer.

Fig. 6 is a graph showing variations in color strength and melting viscosity (easy transfer) relative to rate of coloring agent in the ink. It will be apparent from Fig. 6 that as the color strength increases, the melting viscosity increases or the transfer becomes more difficult. The color printing requires a reduction in the melting viscosity to facilitate the transfer since it is difficult to transfer the ink to the ordinary paper, as described. However, the color strength will then be reduced.

In the color recording process, three color inks, yellow, magenta and cyan, are superimposed one above another. When the third cyan color, for example, is to be printed, the apparent irregularity in the surface of the recording sheet will increase since the thickness of the irregular surface of the recording sheet is increased by those of the other color inks of yellow and magenta previously printed thereon. It is therefore difficult to perform color printing on the ordinary paper, compared to the monochrome print.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a thermal-transfer type recording device which can efficiently perform color printing on a sheet of paper having a low-smoothness surface.

To this end, the present invention provides a thermal-transfer type recording device using ink sheet, which is carrying an ink of higher viscosity at a position adjacent to the base film and is also carrying an ink of lower viscosity at another position remote from the base film, this recording device further comprising a thermal head including a part glaze with a convex heating resistor.

The thermal-transfer type recording device of the present invention can facilitate causing the ink to enter the low-smoothness surface of the recording sheet. Therefore, the recesses in the low-smoothness surface of the recording sheet can be filled with the ink to facilitate the transfer of ink.

Brief Description of the Drawings

Fig. 1 is a view showing the printing part of a thermal-transfer type recording device which is one embodiment of the present invention.

Fig. 2 is a graph illustrating the improved quality of print in the first embodiment of the present invention.

Fig. 3 is a fragmentary cross-section of an ink sheet constructed in accordance with the second embodiment of the present invention.

Fig. 4 is a schematic view showing a printing part constructed in accordance with the third embodiment of the present invention.

Fig. 5 is a schematic cross-section of a printing part constructed in accordance with the prior art.

Fig. 6 is a graph showing the characteristics of the conventional inks.

Fig. 7 is a schematic view showing the entire arrangement of a thermal-transfer type recording device.

Detailed Description of the Preferred Embodiments

Embodiment 1

Referring first to Fig. 1, there is shown a thermal head 1 comprising a part glaze 2 and a heating resistor 3 of ruthenium tetroxide having a width of 0.12 mm and a height of 5 μm. Fig. 1 also shows an ink sheet 4 comprising a base film of polyethylene having a thickness of 4.5μ, a coloring agent layer consisting of a binder and a coloring agent of 40% by weight mixed with the binder, the coloring agent layer having a thickness of 2 μm, and a wax layer 10 mostly formed by a wax of low melting viscosity and having a thickness of 1 μm. An ink layer 6 is formed by the layers 9 and 10. Thus, the ink sheet 4 comprises the ink layer 6 formed on the base film 5 by the coloring agent layer 9 and wax layer 10. The coloring agent used in this embodiment contains phthalocyanine blue as cyan, rhodamine lake T as magenta and benzine yellow G as yellow. The wax comprises carnauba wax and microcrystalline wax.

The ink sheet 4 is moved to the thermal head 1 by a feed means 11 which is mounted in the recording device. The feed means 11 may be of any suitable form well known in the art, for example, roller means.

On operation, the heating resistor 3 is first energized in respone to print data supplied from any suitable means (not shown). The heating value of the heating resistor 3 is 0.3 mJ/dot. Heat is transmitted from the heating resistor 3 through the base film 5 to the ink layer 6 in which the coloring agent and wax layers 9 and 10 will be fused. The molten wax easily enters and fills recesses in the recording sheet 7 since the melting viscosity of the wax is low. Particularly, when the thermal head 1 having the part glaze 2 and the heating resistor 3 protruding therefrom is used, a force urging the wax layer 10 against the recording sheet 7 is locally increased to facilitate the filling of the recesses in the recording sheet 7 with the molten wax. After the ink has solidified, the ink sheet 4 is separated from the recording sheet 7 while leaving the wax layer 10 with the coloring agent layer 9 on the surface of the recording sheet 7 in the desired pattern. The portion thus transferred is maintained increased in color tone to provide a color printed material.

Fig. 2 shows the improved quality of print. It will be apparent from Fig. 2 that the rate of transfer as well as the rate of dot reproducibility become maximum when the thermal head of the present invention having the thick-film part glaze (with the convex heating resistor) is used with the aforementioned composition of ink as in the first embodiment.

It has also been found that even if a thermal head having a thin-film part glaze with a concave heating resistor 3 was used, color images could be printed without any practical inconvenience.

Embodiment 2

Fig. 3 shows an ink sheet 4 which is another embodiment of the present invention. The ink sheet 4 includes an ink layer 6 which functions in a combination of a coloring agent layer 9 with a wax layer 10 as in the first embodiment. The graph on the right side of Fig. 3 shows the proportion of the coloring agent to the wax component in the ink layer 6 by weight. The coloring agent increases more than the wax toward the base film 5 while the wax gradually increases more than the coloring agent in the opposite direction. The printing can be carried out substantially in the same manner as in the first embodiment. More particularly, the side of the ink layer 6 adjacent to the recording sheet functions to fill the recesses in the surface of the recording sheet while the other side of the ink layer 6 adjacent to the base film 5 functions to maintain the color tone.

Embodiment 3

Fig. 4 shows a further ink sheet 4 which comprises a coloring agent layer 9 consisting of a binder of polyester resin and a coloring agent dispersed in the binder. However, such a coloring agent layer is less fused by heat from the thermal head. Using only the coloring agent layer, the transfer cannot be carried out very well. In order to overcome such a problem, the ink sheet 4 also comprises a wax layer 10 that can easily be fused by heat from the thermal head.

The ink sheet 6 of Fig. 4 can be used substantially with such an advantage as in the first embodiment. More particularly, the molten wax layer 10

penetrates into the recesses in the recording sheet and functions as an adhesive layer between the coloring agent layer 9 and the surface of a recording sheet (not shown) after the molten wax has solidified. At this time, the coloring agent layer 9 will almost be not fused and will be transferred onto the recording sheet by the block-like parts of the coloring agent layer 9 being drawn by the wax layer 10.

Therefore, the size of each dot to be transferred is determined by the range of fusion in the wax layer 10, rather than that of the coloring agent layer 9. As shown in Fig. 4, accordingly, a dot 11 smaller than the heating resistor 3 can be formed on the recording sheet. Fig. 4 also shows a heating range by a broken line.

The third embodiment has such an advantage that the size of dots to be transferred can be varied by changing the degree of heating. This means that a half-tone print can be performed according to the third embodiment of the present invention.

The wax layer 10 of the present invention may contain any other suitable component such as adhesive, in addition to the wax component, without reducing the advantages thereof.

Furthermore, the wax layer 10 may be mixed with an undercooling substance such as ricinoleic amide. In such a case, the wax layer 6 is maintained in a molten state for a prolonged time period without solidifying. This provides the same effect as the melting viscosity being decreased. It is thus to be understood that the present invention is not limited to the previously described embodiments, but may be carried out with many modifications and changes by a person skilled in the art.

Fig. 7 shows a thermal-transfer type recording device to which the present invention can be applied. As shown in Fig. 7, an ink sheet 4 is unwound from a roller 21 and then moved to a roller 23 while passing between a thermal head 1 and a platen roller 8. The ink sheet 4 is then wound about the roller 23. The two rollers 21 and 23 are driven by a motor 24 while the thermal head 11 is driven by a motor 25. The motors 24 and 25 are powered by a power source 27 under control of a controller 29. Thus, a supply means 11 will be defined by the rollers 21 and 23, motor 24, power source 27 and controller 29. The thermal head 1 includes a part glaze layer as described. The ink sheet 4 may be any one of the ink sheets described in the previously described embodiments of the present invention. Consequently, the thermal-transfer type recording device can clearly print a recording sheet having a surface of low smoothness.

As will be apparent from the above description, the present invention uses an ink sheet having different functions separated in the direction of thickness of the ink sheet, that is, including a coloring component contained in the ink sheet on the side adjacent to the base film and a wax component of low melting viscosity mainly contained in the ink sheet on the opposite side adjacent to the recording sheet. The present invention also uses a thermal head having a part glaze for increasing a force urging the ink layer against the recording sheet. Therefore, the present invention can provide a thermal-transfer type color recording device which can print a recording sheet of low smoothness and maintain the color tone constant.

Claims

1. A thermal-transfer type recording device for transferring an ink from an ink sheet to a recording sheet by causing the ink sheet to contact the recording sheet and heating said ink sheet, said ink sheet including a base film to which the ink is applied, said ink containing a coloring agent and a binder as chief components, said recording device comprising:
   (a) means for supplying said ink sheet, the binder of said ink sheet carrying the layer of said ink, said ink layer having a higher melting viscosity on the side adjacent to said base film and a lower melting viscosity on the side brought into contact with said recording sheet, and
   (b) a thermal head for heating said ink sheet fed by said supplying means to transfer said ink to said recording sheet, said thermal head including a part glaze layer.

2. A thermal-transfer type recording device as defined in claim 1 wherein the ink layer in said ink sheet fed by said supplying means is gradually reduced in melting viscosity in a direction away from said base film.

3. A thermal-transfer type recording device for transferring an ink from an ink sheet to a recording sheet by causing the ink sheet to contact the recording sheet and heating said ink sheet, said ink sheet including a base film to which the ink is applied, said ink containing a coloring agent and a binder as chief components, said recording device comprising:
   (a) means for supplying said ink sheet, the binder of said ink sheet carrying the layer of said ink, said ink layer having a higher melting viscosity on the side adjacent to said base film and a lower melting viscosity on the side brought into contact with said recording sheet, said ink sheet further including an adhesive layer formed over said ink layer and having a melting temperature lower than that of said ink layer, said adhe-

sive layer being adapted to adhere said ink layer to said recording sheet under the molten state of said adhesive layer, and
(b) a thermal head for heating said ink sheet fed by said supplying means to transfer said ink to said recording sheet, said thermal head including a part glaze layer.

4. A thermal-transfer type recording device as defined in claim 3 wherein the ink layer of said ink sheet fed by said supplying means has a rate of coloring agent contained therein and a film thickness, all of which are larger than those of said adhesive layer.

5. A thermal-transfer type recording device as defined in claim 3 wherein the ink layer of said ink sheet fed by said supplying means will not fully be fused by heat from said thermal head and wherein the adhesive layer of said ink sheet fed by said supplying means contains a binder that can be fused by heat from said thermal head.

6. A thermal-transfer type recording device as defined in claim 3 wherein the ink layer of said ink sheet fed by said supplying means is fused by heat from said thermal head through a period of time that is smaller than that of said adhesive layer.

7. A thermal-transfer type recording device as defined in claim 3 wherein the adhesive layer of said ink sheet fed by said supplying means has an undercooling property.

8. A thermal-transfer type recording device as defined in claim 1 wherein the ink layer of said ink sheet fed by said supplying means is fused, on the side brought into contact with the recording sheet, by heat from said thermal head through a period of time that is smaller than that of said adhesive layer.

9. A thermal-transfer type recording device as defined in claim 1 wherein the ink layer of said ink sheet fed by said supplying means has an undercooling property on the side brought into contact with said recording sheet.

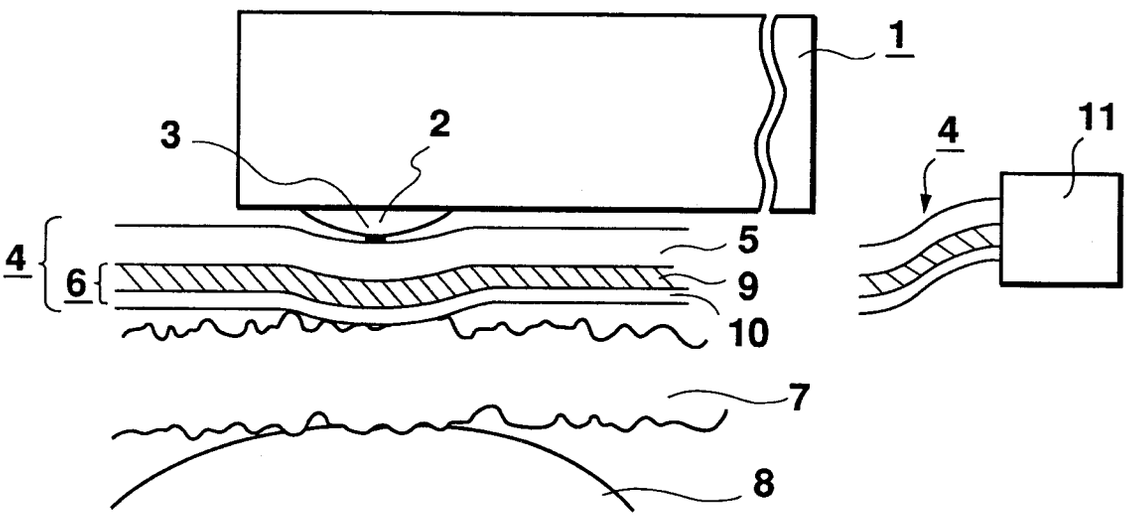

Fig. 1

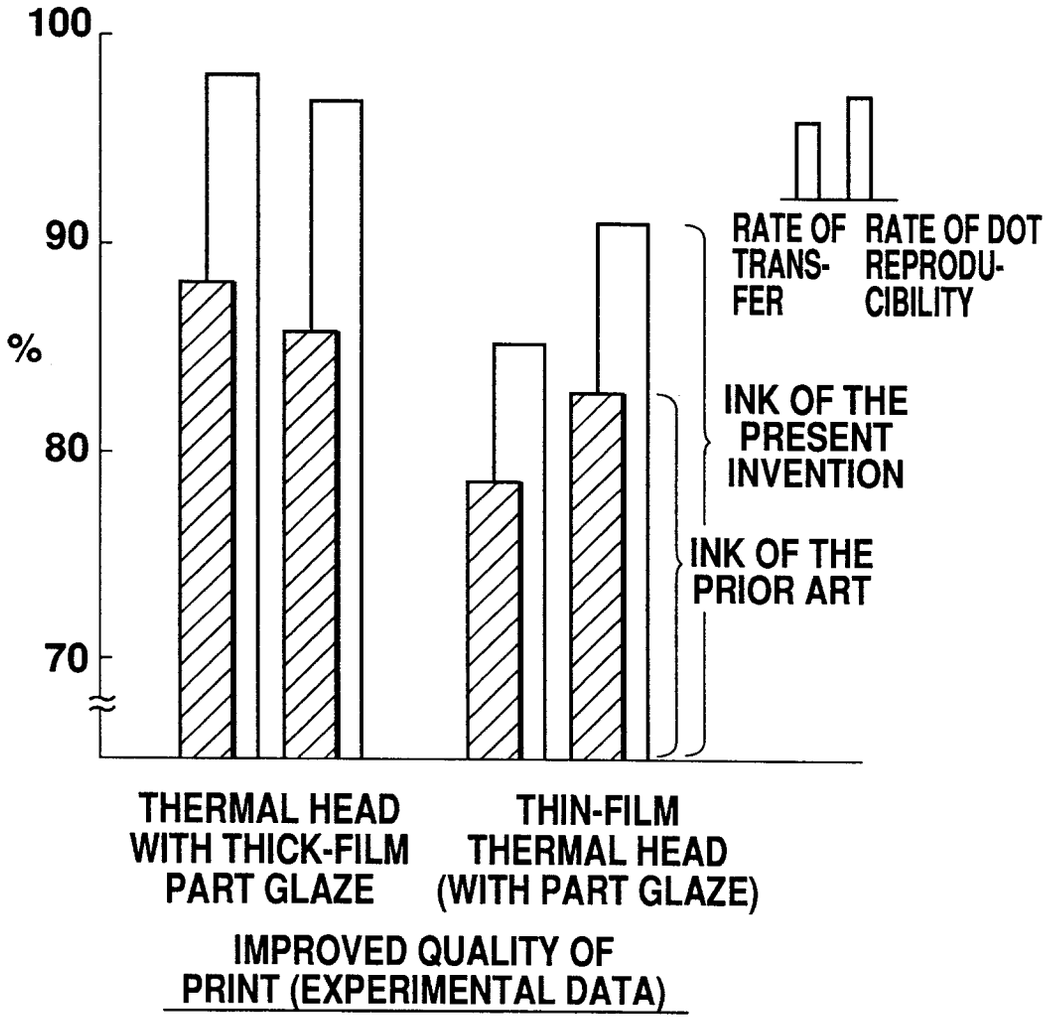
100
90
%
80
70
RATE OF TRANS-FER
RATE OF DOT REPRODU-CIBILITY
INK OF THE PRESENT INVENTION
INK OF THE PRIOR ART
THERMAL HEAD WITH THICK-FILM PART GLAZE
THIN-FILM THERMAL HEAD (WITH PART GLAZE)
IMPROVED QUALITY OF PRINT (EXPERIMENTAL DATA)

Fig. 2

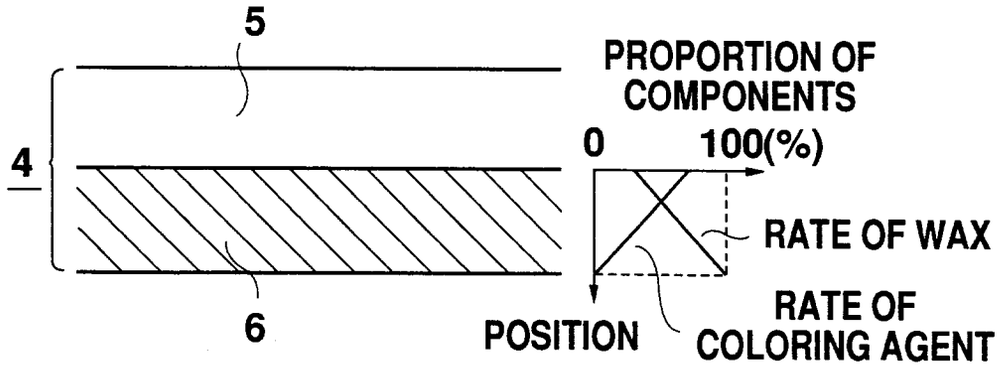
5
4
6
PROPORTION OF COMPONENTS
0
100(%)
RATE OF WAX
RATE OF COLORING AGENT
POSITION

Fig. 3

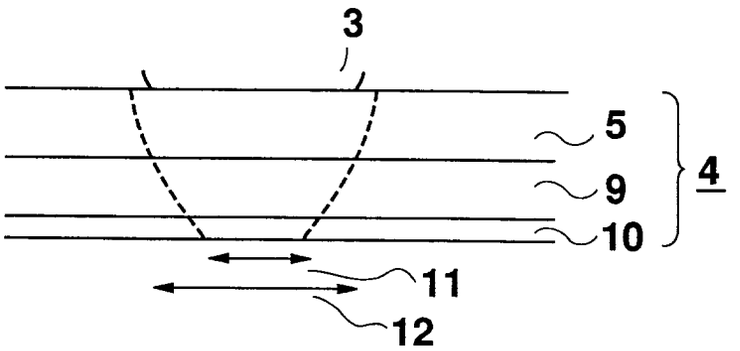

Fig. 4

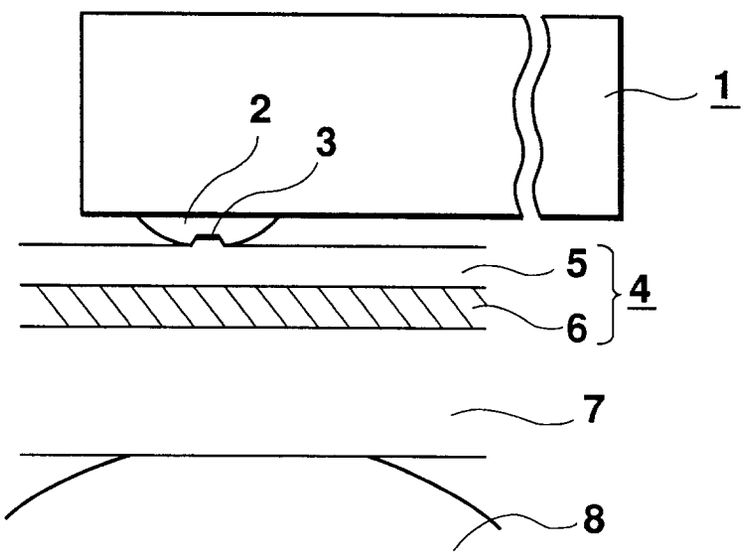

Fig. 5

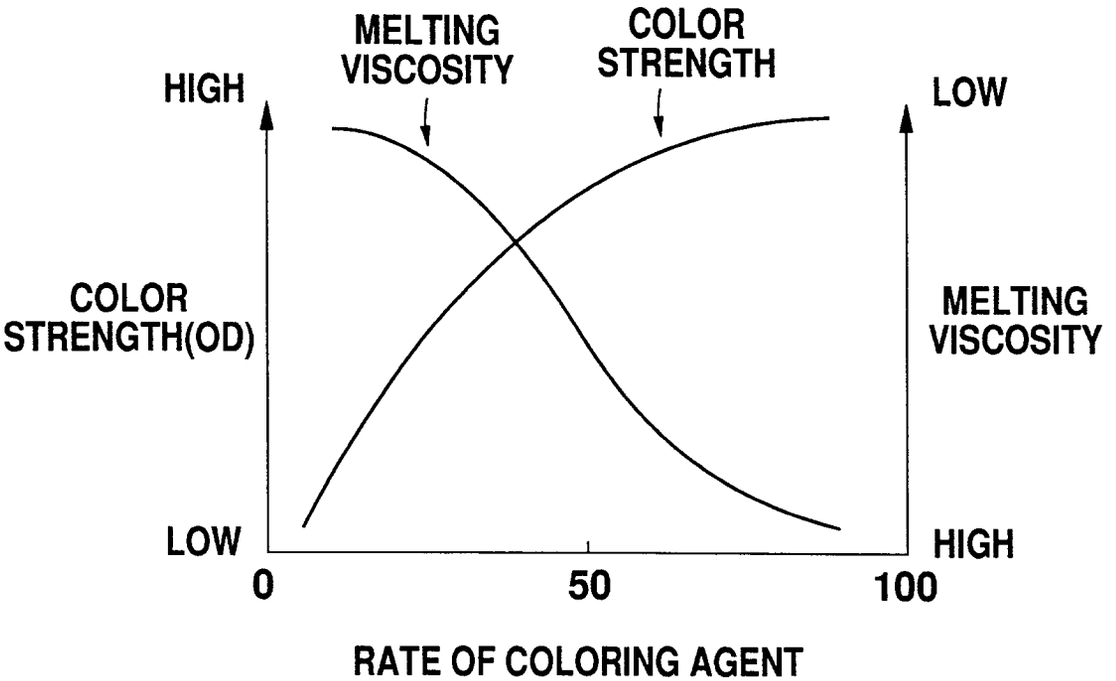
MELTING
VISCOSITY
COLOR
STRENGTH
HIGH
LOW
COLOR
STRENGTH(OD)
MELTING
VISCOSITY
LOW
HIGH
0
50
100
RATE OF COLORING AGENT

Fig. 6

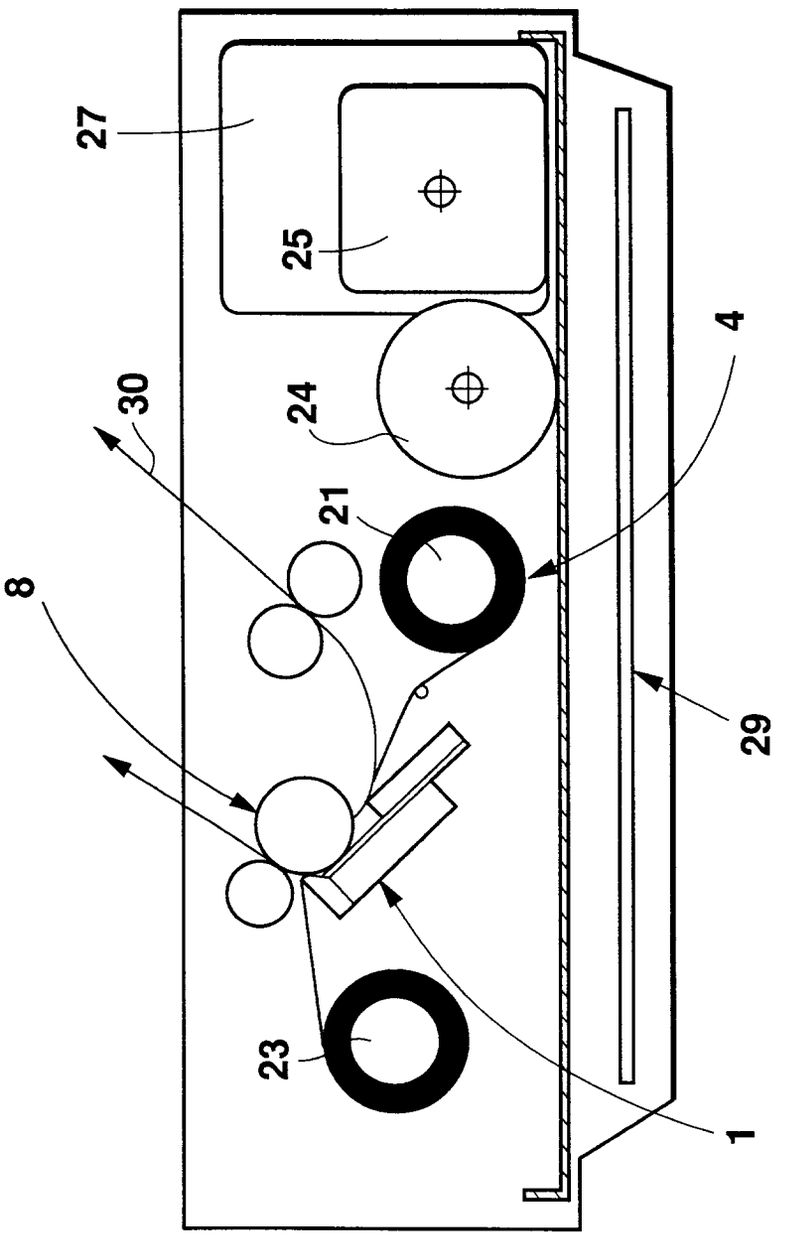

Fig. 7