United States Patent [19]

Takiguchi

[11] **3,904,786**

[45] **Sept. 9, 1975**

[54] **PROCESS FOR FIXING IMAGES BY CONTACT HEATING IN A DUPLICATOR**

[75] Inventor: **Koichi Takiguchi,** Ebina, Japan

[73] Assignee: **Fuji Xerox Co., Ltd.,** Tokyo, Japan

[22] Filed: **Nov. 6, 1973**

[21] Appl. No.: **413,320**

[30] **Foreign Application Priority Data**

Nov. 30, 1972 Japan 47-119380

[52] **U.S. Cl.** **427/194;** 101/DIG. 13; 427/22; 427/195

[51] **Int. Cl.**[2] **B32B 27/08;** B44C 1/28

[58] **Field of Search** 101/467, 470, 471; 117/1.7, 17.5, 21

[56] **References Cited**

UNITED STATES PATENTS

3,060,051	10/1962	Johnson et al.	117/17.5
3,268,351	8/1966	Van Dorn	117/21
3,332,347	7/1967	Gundlach et al.	101/470 X
3,669,707	6/1972	Donnelly et al.	117/21
3,682,738	8/1972	Smith	117/21 X
3,770,346	11/1973	Jordan	117/21 X

OTHER PUBLICATIONS

IBM Technical Disclosure Bulletin, Vol. 14, No. 4, page 1159, Sept. 1971.

IBM Technical Disclosure Bulletin, Vol. 14, No. 4, page 1158, Sept. 1971.

Primary Examiner—Clyde I. Coughenour

Attorney, Agent, or Firm—Gerald J. Ferguson, Jr.; Joseph J. Baker

[57] **ABSTRACT**

A process for fixing images by contact heating in a duplicator comprising passing a thermoplastic resin powder image formed on a support between at least two heating rollers disposed in proximity to each other; heating the roller as disposed on the image side of the support to a temperature less than the temperature of the roller disposed on the side opposite the image side so that a temperature gradient is produced in the thermoplastic resin powder image to prevent said thermoplastic resin powder image from adhering to the roller disposed on the image side.

9 Claims, 3 Drawing Figures

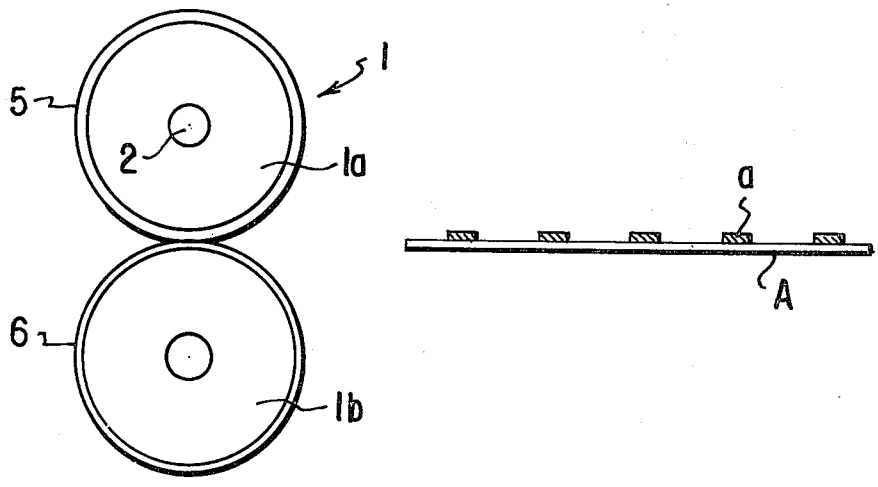


FIG. 1

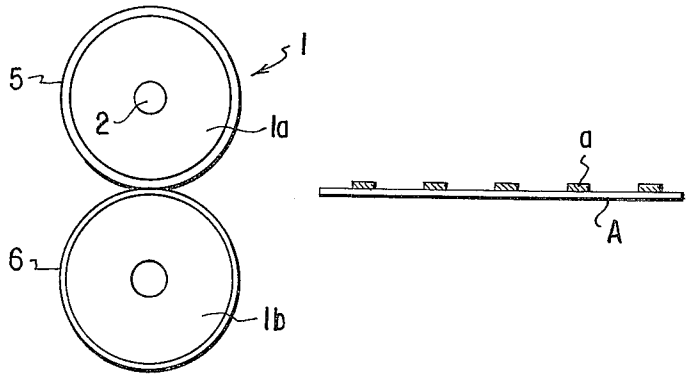


FIG. 2

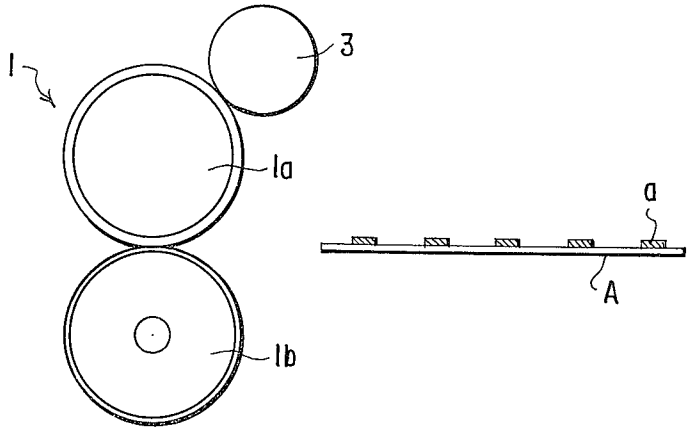
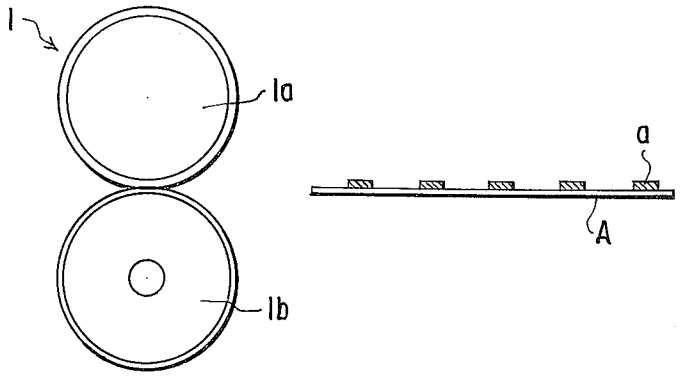


FIG. 3



PROCESS FOR FIXING IMAGES BY CONTACT HEATING IN A DUPLICATOR

BACKGROUND OF THE INVENTION

1. Field Of The Invention

The present invention relates to an image fixing process in a duplicator for permanently fixing a conventionally well known thermoplastic resin powder image (hereinafter referred to as a "toner image") formed on the surface of a support material and, more particularly, to a process for fixing a toner image loosely formed on a support such as an electrostatic recording paper or transfer paper (hereinafter referred to as a "support") by using heating rollers. 2. Description Of The Prior Art

In the process of electrostatic recording or electrophotography, processes for fixing toner images on a support are roughly classified into two groups; one using a solvent and the other heat. In many systems, the heating process is employed. The heating process can further be classified into several groups: i.e., processes utilizing the radiant heat of nichrome wire, infrared lamp, etc.; processes utilizing heat transfer by convection in an oven; processes utilizing contact heating by heated rollers; and like processes. The process of contact heating by heating rollers has the excellent feature that it requires comparatively low electric power and causes no danger of fire or scorch. Apparatus of this type may comprise a heating roller containing a heater therein and a pressure roller having coated on the surface thereof a heat resistant rubber, etc. When a support having formed on the surface thereof a toner image is passed between these rollers with the image side facing the heating roller, heat is directly conducted from the heating roller to the toner image to complete the fixing. The pressure roller presses the support against the heating roller from the rear so as to effect sufficient contact therebetween. The term " rear" as used hereinafter means the side opposite the toner image with respect to the support. Usually, a heating roller is coated with a release agent such as tetrafluoroethylene resin in order to make it difficult for the toner to adhere to the heating roller upon bringing them into contact with each other. However, when the toner is melted by the heat from the heating roller, toner particles at the contacted portion are melted which adhere to the roller. This phenomenon is called "offset". The thus offset toner particles are carried on the periphery of the rotating heating roller, and are applied or again offset to another portion of the support resulting in staining of the copy.

In another of the contact heating processes using a heating roller, image fixing is effected by heating from the rear of the support wherein no pressure roller is used and a heating roller is electrostatically brought into contact with the rear of the support having formed on the surface thereof the toner image. In this process, the problem of staining copies by the offset phenomenon can be avoided. However, there has been a problem — that is, since static electricity is employed to adhere the support to the heating roller, the contact force between the support and the heating roller becomes weak when the humidity is high. This results in insufficient heat conduction. Further, when using a support having a high moisture content, some portions of the toner image will not be fixed due to the rise of the support by aqueous vapor.

SUMMARY OF THE INVENTION

A primary purpose of this invention is to eliminate the above-described problem of the prior art and to provide a process for image fixing by contact heating in a duplicator, where the probability of the toner image being offset to the heating roller is small and thus any reduction in image quality is small, and where the process is not influenced by environmental conditions such as temperature and humidity.

Other objects and advantages of this invention will become apparent upon reading the appended claims in conjunction with the following detailed description and the attached drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a diagrammatic illustration of an illustrative embodiment of the present invention.

FIGS. 2 and 3 are diagrammatic illustrations of other illustrative embodiments of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In each embodiment of the invention, a pair of heating rollers 1 as shown in FIGS. 1 to 3 is used. Image side roller 1*a* in FIG. 1 is heated from inside by heating element 2, image side roller 1*a* in FIG. 2 is heated by a heating roller disposed outside the roller 1*a*, and image side roller in FIG. 3 is heated by heat conducted from rear roller 1*b*. In each figure are also illustrated a support A and a toner image *a*.

In the course of studies on the fixing of images, the inventor has found that the offset phenomenon of toner particles to an image side roller 1*a* can almost be eliminated by raising the temperature of a rear roller 1*b* while maintaining the temperature of an image side roller less than that of the rear roller when feeding a toner image bearing support between the two adjacent rollers — that is, by producing a suitable temperature gradient in the toner layer. This phenomenon is considered to result from the fact that the temperature of the melted particles becomes different in the region between the image side roller and the support depending upon the location of the particles because of the temperature gradient. Thus, the adhesion force between the image side roller 1*a* and the toner a becomes less than that between toner particles or between toner and the support where the property of the material constituting the surface of the image side roller may also desirably affect the relative adhesion forces.

This invention utilizes the above-described phenomenon and, as a result of experiments, it has been found that an optimum temperature gradient can be produced in a toner layer by heating the rear roller 1*b* to a high enough temperature to melt the toner a through the support A and heating the image side roller 1*a* to a temperature less than that of the roller 1*b* but high enough to soften the toner a when in contact therewith.

In practice, the application of material having a good release property to the surface of the image side roller further increases the desirable effects. Furthermore, in order to prevent to some extent the toner image from being crushed by the rollers, it is desirable to use a material softer than metal on or near the surface of the roller on the image side.

Furthermore, means for cleaning the image side roller and the rear roller such as silicone oil-impregnated

felt processed with tetrafluoroethylene may be used. Such means (not shown) would be positioned in contact with the rollers. The combined use of such cleaning means and the fixing process of the invention can further increase the desirable results of the invention.

As is described above, according to the present invention, the offset phenomenon of a toner image to a heating roller can be prevented by a simple device with no reduction in image quality of the resulting copy, by producing a difference in temperature between at least two adjacent rollers so that the temperature of the roller on the image side is lower than that of the rear roller, so that a temperature gradient is produced in the toner image adhered to the support. In addition, the process of this invention is not influenced by outside temperature or humidity, and hence stable duplication can be maintained over a long period of time without having to vary the duplicating conditions depending upon environmental conditions.

Various experiments illustrating different aspects of the invention will now be described without in any way attempting to limit the scope thereof.

EXAMPLE 1

In heating rollers **1** of FIG. **1**, a roller **1***a* 30mm in diameter having a 5 mm coating **5** of rubber (JIS hardness: 60°) and an aluminum roller **16** 30 mm in diameter having a 100 μ coating **6** of tetrafluoroethylene resin were used.

As the toner, three toners, i.e., 914/**420** toner (hereinafter referred to as "toner A"), 720 toner (hereinafter referred to as "toner B") and 660 toner (hereinafter referred to as "toner C") (all being made by Fuji Xerox Co., Ltd.) were used. As the support, M2 paper (made by Fuji Xerox Co., Ltd. for use in the Xerox Corporation Copier) was used. All of these toners are powders of styrene copolymer in which carbon black is dispersed and they are differentiated by melt temperature and melt viscosity. Duplication was conducted at a line speed for both rollers **1***a* and **1***b* of 90 mm/second and a copying rate of 900 sheets/hour.

i. In the case of using toner A:

When the temperature of the rear roller **1***b* and the temperature of the image side roller **1***a* were maintained at 200°C and 160°C, respectively, excellent fixing could be achieved without the offset phenomenon and image detraction. However, when the temperature of the rear roller **1***b* was decreased to less than 180°C or when the temperature of the image side roller **1***a* was decreased to less than 140°C, offset of toner *a* to the image side roller **1***a* occurred, resulting in staining of support A. Also, when the temperature of the rear roller **1***b* was raised to above 260°C or when the temperature of the image side roller **1***a* was raised to above 200°C, the offset phenomenon took place. Temperature ranges to effect good fixing with toner A are 180° to 260°C and 150° to 195°C, with respect to the rear roller **1***b* and the image side roller **1***a*, respectively. However, it was necessary to adjust the temperature of the image side roller to a temperature lower than that of the rear roller **1***b* by greater than 10°C.

ii. In the case of using toner B:

The temperature of the rear roller **1***b* was adjusted to 190° – 270°C and the temperature of the image side roller **1***a* to 160° – 200°C, with the difference in temperature between rear roller **1***b* and image side roller **1***a* being greater than 10°C to thereby effect good fixing. At temperatures outside the above-specified ranges, the offset phenomenon occurred.

iii. In the case of using toner C:

The temperature of the rear roller **1***b* was asjusted to 155° – 220°C and the temperature of the image side roller **1***a* to 140° – 170°C, with the difference in temperature between rear roller **1***b* and image side roller **1***a* being greater than 10°C. Good fixing was thus achieved. At temperatures outside the above-specified ranges, the offset phenomenon occurred.

EXAMPLE 2

Referring to FIG. **2**, a copper roller **3** 25 mm in diameter containing at the center thereof a heater was used to heat image side roller **1***a*. At the same temperature ranges as in Example 1, similar good fixing was achieved.

EXAMPLE 3

Referring to FIG. **3**, when fixing was conducted at a line speed of rollers **1***a* and **1***b* of 90 mm/second and at a copying velocity of 900 sheets/hour using toner A while keeping the temperature of the rear roller **1***b* to 190 to 200°C, the image side roller **1***a* was maintained at about 160°C and good fixing was achieved.

EXAMPLE 4

Using the same heating rollers **1** as in Example 1, good fixing was achieved at a line speed of each of rollers **1***a* and **1***b* of 150 mm/second and at a copying rate of 1200 sheets/hour using toner A while maintaining rear roller **1***b* at 250°C and image side roller **1***a* at 200°C.

Additionally, in Examples 2 and 3, the same rear roller **1***b* as in Example 1 was used and, as the image side roller **1***a*, that used in Example 1 was used omitting heater **2** therefrom

Numerous modifications of the invention will become apparent to one of ordinary skill in the art upon reading the foregoing disclosure. During such a reading, it will be evident that this invention provides a unique fixing process using contact heating for accomplishing the objects and advantages hereinstated.

What is claimed is:

1. A process for fixing images by contact heating in a duplicator comprising

passing a thermoplastic resin powder image formed on a support between at least two heating rollers disposed in proximity to each other

heating the roller disposed on the image side of said support to a high enough temperature to soften said thermoplastic resin powder image when in contact therewith and heating the roller disposed on the side opposite the image side to a temperature high enough to melt said thermoplastic resin powder image through the support so that a temperature gradient is produced in said thermoplastic resin powder image to prevent said thermoplastic resin powder image from adhering to the roller disposed on the image side.

2. A process as in claim **1** where said roller disposed on the image side of said support is coated with a material which readily releases said thermoplastic resin powder from the coating.

3. A process as in claim **1** where roller disposed on the image side of said support is coated at or near the surface thereof with a material softer than metal.

4. A process as in claim 1 including cleaning the roller disposed on the image side of said support with a material which readily releases said thermoplastic resin powder from said last-mentioned roller.

5. A process as in claim 1 where heat is applied to both of said rollers.

6. A process as in claim 1 where heat is applied to said roller and is disposed on the side opposite the image side and said roller on the image side of said support being heated from the first-mentioned roller.

7. A process as in claim 1 where heat is applied to at least one of said rollers by a heating element centrally mounted with said one roller.

8. A process as in claim 1 where heat is applied to at least one of said rollers by a heating element contacting the periphery of said one roller.

9. A process as in claim 1 where the temperature difference between said rollers is at least 10°C.

* * * * *