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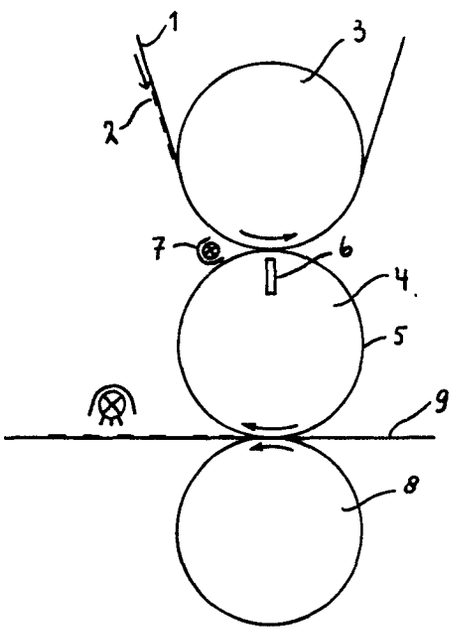
(54) Process for magnetically transferring a powder image.

(57) Process for transferring a powder image which has been formed with permanently magnetizable developing powder, which process comprises the steps of magnetically transferring the powder image (2) to an intermediate receiving member (4) having a uniform magnetic permeability over its whole surface and comprising magnetizable material having no remanent magnetism and subsequently transferring the powder image from the intermediate receiving material (9). The transfer of the powder image (2) to the intermediate receiving member (4) is effected by magnetizing the powder image (2) and contacting it with the intermediate receiving member (4). In a specific embodiment of the invention, the powder image (2) is magnetized while it is in contact with the surface of the intermediate receiving member (4). The intermediate receiving member (4) preferably has a relative magnetic permeability of at least 2.



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PROCESS FOR MAGNETICALLY TRANSFERRING A POWDER IMAGE

The invention relates to a process for magnetically transferring a powder image formed with the aid of permanently magnetizable powder.

According to the process of the so-called indirect electrophotographic copying system, such as this has been applied in practice, a latent electrostatic image is formed in a photoconductive material and this image is developed with a developing powder, after which the powder image obtained is transferred to a receiving material, mostly consisting of plain paper, on which it is fixed. After the transfer of the powder image the photoconductive material is cleaned and used for a next copying run.

The transfer of the powder image to the receiving material is mostly effected under influence of an electric field, which is generated between the photoconductive material and the receiving material. This electric transfer has the disadvantage, that blurred images occur, because powder particles are dispersed as a result of electric discharges which continuously take place in the transfer zone. A further objection of the electric transfer is, that with regard to the transfer efficiency and the quality of the transferred image the results obtained with it are dependent on the atmospheric conditions and the electric properties of the developing powder and the receiving material.

In order that a powder image can be transferred independently of the atmospheric conditions and the electric properties of developing powder and receiving material, it has already been proposed to use a magnetically attractable developing powder for the development of the electrostatic image and to transfer the powder

image under influence of the magnetic field of a permanent magnet or electro magnet installed behind the receiving material. However, also with this magnetic transfer method blurred images occur, because during the ejection of the receiving material out of the transfer zone particles of developing powder move over the receiving material under influence of the magnetic field.

These blurred images can be prevented by simultaneously transferring the powder image magnetically, and fixing it with the aid of heat, as described in the U.S. patent specifications 3 093 039 and 3 106 479. However, an objection of these processes is, that the heat-fixation of the powder image is carried out while the image is still in contact with or in the very neighbourhood of the photoconductive material, so that it can happen that melted or softened particles of developing powder permanently deposit on the photoconductive material and consequently this material can no more be reused. An objection of the process according to U.S. patent specification 3 093 039, in which transfer and fixing of the powder image take place simultaneously under influence of a high frequency magnetic field, moreover is that a very great quantity of energy is required in order to reach the desired fixing of the image.

An objection of the process according to U.S. patent specification 3 106 479, in which a heating element is installed in the transfer zone and in the very neighbourhood of the photoconductive material, is that also the photoconductive material is heated considerably, by which its photo-electric properties quickly decrease and only a relatively limited number of copies can be made with it.

In the Dutch patent application 7209652, with reference to Fig. 8, a process for the formation of a latent magnetic image is described, which starts from a powder image formed electrophotographically with the aid of magnetically attractable developing powder on a photoconductive material. According to this process a uniform layer of permanently magnetizable material, which layer has been magnetized according to a fine linear pattern, is brought into contact with the image-carrying surface of the photoconductive material and the magnetized layer is demagnetized in those portions which are not in contact with the powder image, with the aid of a magnetic erasing

head which is installed behind the photoconductive material. During the formation of the latent magnetic image a part of the magnetically attractable developing powder is transferred to this magnetic image. However, the quantity of transferred developing powder is small, so that the process described cannot be applied without more as transfer method in an indirect electrophotographic copying system. A further objection of this process is, that for magnetizing the permanently magnetizable layer a wide magnet head must be used, which must have been manufactured with great precision, in order to obtain a magnetic field of uniform strength over its full working width.

The object of the invention is to provide for an improved process for the transfer of a powder image which has been formed with the aid of a permanently magnetizable powder, in which process the powder image is magnetically transferred to a first receiving support and from the first receiving support direct or indirect to the final receiving support. This process is characterized in that the powder image is transferred to a first receiving support which possesses an almost uniform magnetic permeability over its whole surface and which contains magnetizable material which is not remanently magnetic, and in that the transfer of the powder image to the first receiving support is effected by magnetizing the powder image and by bringing it into contact with the first receiving support.

The process according to the invention differs from the magnetic transfer methods known up to now, in that a high transfer efficiency is achieved and in that sharp images are obtained, without necessity to fix the powder image in some way ore other on the receiving support simultaneously with the magnetic transfer. In this way the objections of the processes, as described in above-mentioned U.S. patent 3 093 039 and 3 106 479, are prevented in the process according to the invention.

The first receiving support applied in the process according to the invention has a uniform or almost uniform permeability over its whole surface, and contains magnetizable material which has no remanent mangetism. A uniform or almost uniform magnetic permeability over the whole surface of the first receiving support is necessary to prevent, that powder particles transferred to the first receiving

support are moved over the surface of the support and thus disturb the image. The magnetizable material in the first receiving support preferably is a non-remanently magnetic, ferro- or ferrimagnetic material which has a relative magnetic permeability of at least 5. Materials with a lower relative permeability, for instance between 2 and 5, can also be used but as a rule a sufficiently high transfer efficiency can only be obtained on these materials, when during the transfer of the powder image a magnetic auxiliary field is generated and/or the powder image to be transferred is strongly magnetized. Magnetizable materials with a relative permeability lower than 2 can usually not be used, because on these too low transfer efficiencies are obtained. The first receiving support may fully consist of the magnetizable material, but it may also consist of a lowly magnetizable or non-magnetizable support on which a layer of the magnetizable material has been applied. Examples of suitable first receiving supports are supports which consist of iron, cobalt, nickel, soft magnetic alloys of cobalt and nickel or of nickel, copper and iron, as well as supports which consist of copper, glass, aluminium, paper or plastic, on which a layer of magnetizable material, for instance consisting of any of the above-mentioned metals or metal alloys, or of a fine dispersion of magnetizable powder in a filmforming binding agent, has been applied with or without the aid of one or more adhesive layers. Further the first receiving support may also consist of a self supporting plastic film in which magnetizable powder is finely dispersed. If the first receiving support contains the magnetizable material in the form of a dispersion in a filmforming binding agent, the magnetizable material should have been dispersed uniformly in the binding agent, in order to obtain a uniform or almost uniform magnetic permeability over the whole surface of the first receiving support.

The particle size of the magnetizable material preferably is smaller than 1 micrometre, because with such particles the most uniform layers are obtained. The weight ratio between magnetizable material and filmforming binding agent may amount to 3 : 1 to 10 : 1 and preferably is 5 : 1 to 8 : 1. The transfer of the powder image, formed with the aid of permanently magnetizable powder, to the first receiving support takes place by magnetizing the powder image and by

bringing it into contact with the first receiving support. The magnetizing of the powder image may be effected, before the image is brought into contact with the first receiving support, but it is simpler to magnetize the image while it is in contact with the first receiving support. With this last method the powder image is brought into contact with the first receiving support and a magnetic field is generated in the contact zone, between the first receiving support an the material carrying the powder image, which magnetic field is sufficiently strong to magnetize the powder image. When seperating the first receiving support from the other support, the magnetized powder is kept to the first receiving support by influence.

The powder image can be magnetized before it is brought into contact with the first receiving support by conveying the material carrying the powder image through a magnetic field of sufficient strength. However, this usually makes it recommendable to takes measures in order to prevent, that during the introduction in and the ejection out of the magnetizing zone the powder particles can be moved under influence of the external magnetic field, and thus cause image interferences. Movement of the powder particles can for instance be prevented by pressing the powder image in and near the magnetizing zone against a diamagnetic material.

The powder image can also be magnetized already during the image development by applying the magnetizable powder with the aid of magnetic means, for instance a known magnetic brush developing device, on the latent image to be developed.

The image transferred to the first receiving support is subsequently transferred in a known way direct or indirect to the final receiving support, which will mostly consist of plain paper. The direct transfer of the powder image to the final receiving support can for instance be effected in the way as described in the Dutch patent application 7209652 already mentioned, in which the final receiving support is pressed against the powder image and the image transferred as a result of the pressure-execution is subsequently fixed in a suitable way, for instance by heating, on the final receiving support. The indirect transfer of the powder image to the final receiving support can for instance be executed in the way

as described in British patent specification 1 245 426, in which the powder image is transferred under influence of pressure on a resilient medium and subsequently is transferred under influence of pressure and heat from the resilient medium to the final receiving support and is fixed at the same time.

The process according to the invention is especially attractive for application in so-called indirect electrophotographic copying systems in which for the development of the electrostatic image a permanently magnetizable developing powder, electrically conductive or not-conductive, is used. The reason of this is, that in comparison with known processes the process according to the invention has the great advantage, that a good transfer of the powder image is realized under conditions which are very favourable for the duration or life of the photoconductive medium which is usually very vulnerable. Besides the fact, that in the process according to the invention no heat has to be supplied to the powder image to be transferred, so that thermal charge of the photoconductive medium is prevented, only a slight contact-pressure between photoconductive medium and first receiving support is necessary, so that also the mechanical charge of the photoconductive surface is limited to a minimum. In last-mentioned respect the process according to the invention differs from the process as described in British patent specification 1 245 426 in a favourable way.

When applying the process according to the invention in the so-called indirect electrophotographic copying systems the transfer efficiency can even be increased by exposing away the electrostatic charges, which keep the powder image on the photoconductive medium, before or during the transfer.

The process according the invention can be applied for transferring powder images which have been formed with the aid of permanently magnetizable developing powders. Such permanently magnetizable developing powders are known. They usually consist of thermoplastic resin particles, in which permanently magnetizable powder, for instance a powder as mentioned on page 12 of the Dutch patent application 6806473, is finely devided in a quantity which mostly lies between 30 and 70 percents by weight. Further the resin

particles may also contain additions, such as colouring compounds or compounds which make the resin particles electrically conductive. These additions may have been finely divided in the resin particles or may have been deposited on the surface of the resin particles.

The invention is further explained in below example.

Example.

A photoconductive belt, manufactured as described in the example of British patent specification 1 408 252 was provided in a known way, by successively electrostatically charging and imagewise exposing, with a latent charge image and this charge image was developed according to the known magnetic brush method with a permanently magnetizable, one-component developing powder which had a particle size between 10 and 30 micrometres, a specific resistance of 3×10^8 ohm.cm and consisted of thermoplastic particles which contained 40 % by weight of epoxy resin and 60% by weight of permanently magnetizable γ-ferrioxide and which carried a layer of electrically conductive carbon on their surface. The developing powder was prepared according to the process as described in example 3 of the Dutch patent application 7508056. The image thus formed on the photoconductive belt was transferred according to the process of the invention to a receiving paper, by conveying the photoconductive belt through a transfer device having the installation as schematically represented in the figure.

In the transfer device the photoconductive belt 1, which carries the powder image 2 to be transferred, is conveyed over a supporting roller 3 and with slight contact-pressure is brought into contact with an image receiving roller 4, of which the sleeve 5 consists of copper on which on the outside a layer of nickel with a thickness of about 4 micrometres has been applied. The supporting roller 3 and the sleeve 5 are driven in the direction indicated by the arrows. Within the rotating sleeve 5 a stationary bar magnet 6 extending in axial direction is installed in such a way, that its magnet field is only effective in the nip between the roller 3 and the sleeve 5. The magnet field generated in the nip has a strength of about 24 kA/m. The magnet 6 achieves the magnetizing of the powder images conveyed into the nip between the roller 3 and the

sleeve 5 and further serves as auxiliary magnet for the transfer of the magnetized powder image to the magnetizable sleeve 5. For improving the transfer efficiency a lamp 7 is installed just before the nip between the roller 3 and the sleeve 5, which lamp exposes away the charge image still present on the photoconductive belt 1.

The powder image transferred to the sleeve 5 is transferred in the nip between the sleeve 5 and the elastic pressure roller 8 under influence of pressure to a sheet of receiving paper 9 supplied from a stock pile. Finally the powder is fixed on the receiving paper by heat.

Thus sharp copies of very good quality are obtained. The transfer efficiency upon transferring the powder image to sleeve 5 was equal to the efficiency that was achieved with the usual electric transfer methods. Equally good results were obtained when instead of a layer of nickel the sleeve 5 was provided with a layer consisting of a fine dispersion of non-remanently magnetic γ-ferrioxide in epoxy resin in the volume ratio 1 : 1.

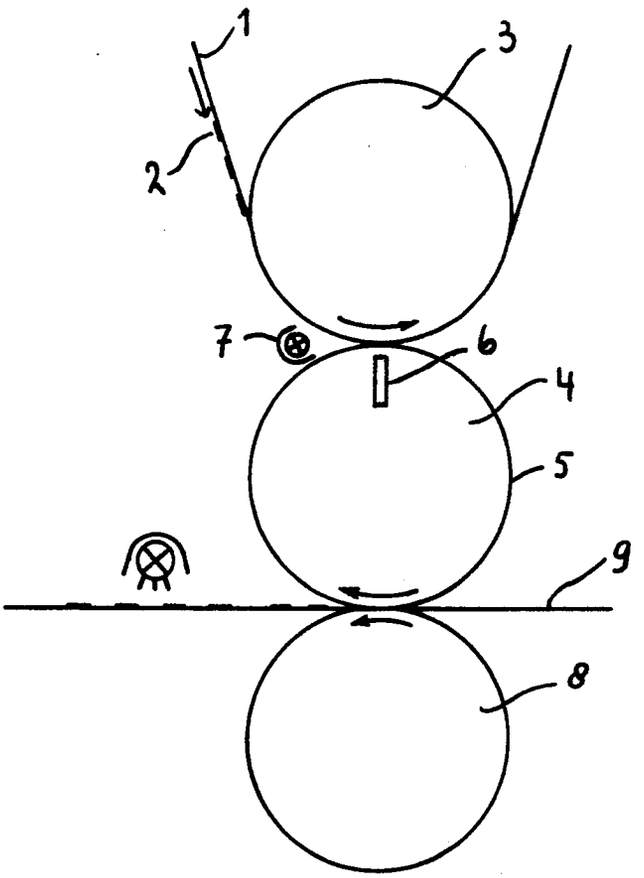
CLAIMS

1. Process for transferring a powder image, which has been formed with the aid of permanently magnetizable developing powder, in which process the powder image (2) is magnetically transferred to a first receiving support (4) and subsequently from the first receiving support direct or indirect to the final receiving support (9), c h a r a c t e r i z e d i n t h a t the powder image (2) is transferred to a first receiving support (4) which possesses a uniform or almost uniform magnetic permeability over its whole surface and which contains magnetizable material which is not remanently magnetizable, and in that the transfer of the powder image (2) to the first receiving support (4) is effected by magnetizing the powder image (2) and by bringing it into contact with the first receiving support (4).

2. Process according to claim 1, c h a r a c t e r i z e d i n t h a t the first receiving support (4) possesses a relative magnetic permeability at least 2.

3. Process according to any of the preceding claims, c h a r a c t e r i z e d i n t h a t the magnetizing of the powder image (2) is effected, while it is in contact with the first receiving support (4).

4. Electrophotographic process in which in a photoconductive material a latent electrostatic image is formed, this latent image is developed with a permanently magnetizable powder and the powder image (2) is magnetically transferred to a receiving support (4), c h a r a c t e r i z e d i n t h a t the transfer of the powder image (2) is effected according to the process of any of the preceding claims.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European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 78 200069

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A	US - A - 3 392 642 (H.GERMER) * Column 1, line 59 to column 2, line 22 *	1
A	US - A - 3 721 553 (E.C.GIAIMO Jr.) * Complete *	1
A	US - A - 3 530 794 (G.RITZERFELD) * Complete *	1
A	GB - A - 1 169 510 (STANDARD TELEPHONES AND CABLES) * Complete *	1

CLASSIFICATION OF THE APPLICATION (Int. Cl.²)

G 03 G 13/16

TECHNICAL FIELDS SEARCHED (Int.Cl.²)

G 03 G 13/16
G 03 G 15/16
G 03 G 19/00

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	5-10-1978	WEYLAND