Oct. 3, 1967 R. N. COOPER 3,345,294

DEVELOPER MIX FOR ELECTROSTATIC PRINTING

Filed April 28, 1964

FIG. 1

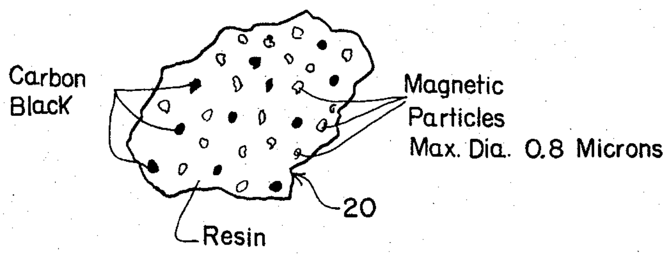


FIG. 2

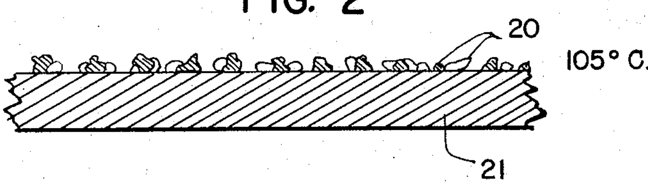


FIG. 3

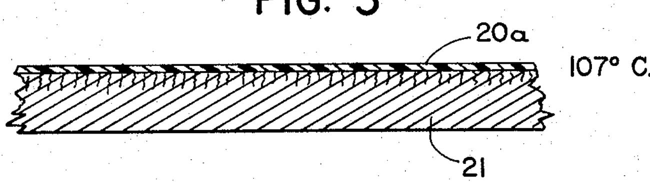
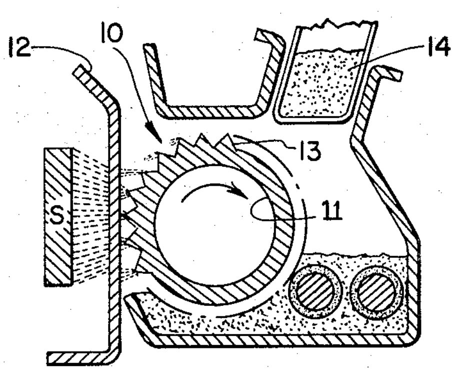


FIG. 4



Inventor
Robert N. Cooper
By
Wolfe, Hubbard, Voit & Osann.
Atty.

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DEVELOPER MIX FOR ELECTROSTATIC PRINTING

Robert N. Cooper, Chicago, Ill., assignor to American Photocopy Equipment Company, Evanston, Ill., a corporation of Illinois

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ABSTRACT OF THE DISCLOSURE

A developer mix for use in electrostatic printing to develop latent images, including charged and uncharged areas of an image-bearing sheet, said developer mix comprising the combination of separate granular magnetically attractable carrier particles and a developer powder comprising a coloring agent and a resin having a triboelectric relationship of opposite polarity with respect to said magnetically attractable granules, at least a major portion of said resin being composed of a polyamide resin having a sharp melting point within the range of about 70° C. to about 165° C. whereby developed images of substantially improved black density may be formed over extended operating periods.

The present invention relates to the field of electronic photography and, more particularly, to developing powders or toners for use in electrographic processes such as electrophotographic printing processes.

Electrophotographic processes are photographic processes for producing a visible record or reproduction by the use of electrical charges. Such processes are well known in the art and include the steps of converting a light image or electrical signal into an electrostatic charge pattern on an electrically insulating layer or sheet. This pattern is then developed by means of a developer powder or toner into a visible image, which is a reproduction of the original pattern.

In a typical electrophotographic process, an electrophotographic recording element is prepared by coating the surface of a backing member such as paper with a photoconductive insulating material, that is, a material which is capable of receiving and holding an electrical charge but which when subjected to light of a selected wavelength, loses all or part of the charge in the areas which are exposed. An illustrative photoconductive material is zinc oxide, dispersed in an electrically insulating film-forming vehicle such as a silicone resin, and applied as a coating on a sheet of paper or like insulating material. To apply an electrical charge to such a sheet or recording element it is conventionally subjected to a high voltage corona discharge which produces an electrostatic charge on the element's surface. When a light image is focused on the charged surface, the portions irradiated by the light rays are discharged, leaving the remainder of the surface in a charged condition, or, in terms of the art, leaving an electrostatic image on the element. This image is rendered visible in any suitable manner, for example by applying a developer powder or toner which adheres electrostatically to the charged areas of the sheet. The powder image thus formed may be fixed directly to the photoconductive coating, for example by heating to fuse a thermoplastic resin incorporated in the powder. Such a process is known generically as an electronic photography process. A more detailed explanation of the process and its principles may be found in an article entitled "Electronic Photography" by M. L. Sugarman, Jr., M. B. Levine, and N. P. Steiner in I.R.E. Transactions on Industrial Electronics, Vol. PGIE–11, December 1959, pp. 26–34, inclusive.

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To develop a latent electrostatic image, the developer powder or toner must be applied to the charged exposed surface of the sheet. A typical development technique is described in U.S. Patent 2,874,063, issued Feb. 17, 1959 to H. G. Greig. Such a technique utilizes a "magnetic brush" made up of developer mix which includes magnetic carrier particles and a finely divided developer, all maintained in a loose mass by a magnetic field provided by a bar magnet, rotating magnetic brush or the like. The developer or toner particles are held in the brush by an electrical phenomenon referred to technically as a triboelectric effect. This effect occurs when the finely divided toner particles are mixed with the relatively coarser magnetic carrier particles. The surface characteristics of these materials being different, surface electrical charges of mutually opposite polarity are produced on the toner particles and the carrier particles. This results not only in a physical attractive force between the toner particles and the carrier so that the toner is held on or attached to the carrier particles, but also at the same time the toner particles are charged with an electrical charge opposite to the charge on the carrier particle. The carrier particles, being magnetic, adhere to the bar magnet, in the form of a brush-like mass. When this magnetic brush is swept across the surface of a sheet bearing an electrostatic image, however, the toner particles are attracted electrostatically to the image areas. This results in a development of the image on the sheet and thereby the formation of a powder image thereon which is a duplicate of the original.

It is a primary object of the present invention to provide an improved developer powder for use in electrostatic printing, which powder is capable of producing images of superior quality. Another object of the present invention is to provide such a developer powder which produces sharp, dark images having improved black density, even when used as a relatively small percentage of the total developer mix.

A further object of the invention is to provide an improved developer powder of the above type which produces copies of superior quality over extended operating periods. A related object is to provide such a developer powder which, when used in a magnetic brush technique, does not soften and "clump" on the brush at the normal operating temperature of the machine. Another related object of the invention is to provide such a developer powder which does not agglomerate at the normal operating temperature and which permits a maximum amount of powder to be attracted from the brush to the charged areas of the image-bearing sheet.

Still another object of the present invention is to provide a developer mix of the foregoing type which readily penetrates into the charged areas of the image-bearing sheet during the thermal fixing treatment thereby providing a smooth surface on the final copy and avoiding the irregular surface caused by raised images. In this connection, it is also an object to provide such a developer powder which produces substantially uniform black areas in the developed image, rather than the stippled effect achieved with certain developer powders of the prior art. Yet another object is to provide such a developer powder which is capable of carrying a relatively high percentage of coloring agent, and especially the ferromagnetic pigments which enhance the overall performance of the powder.

A still further object of the invention is to provide an improved developer powder which is capable of producing prints having cleaner backgrounds than heretofore obtainable. In this connection, it is an object to provide a developer powder which avoids the production of "fringes" which often mar the background of the print. Another object is to provide such a developer mix which substantially improves the background clean-up effect of a biasing technique whereby the paper is biased by the application of a voltage having the same polarity as the charge on the toner particles.

Other objects and advantages of the invention will become apparent upon reading the following description and appended claims and upon reference to the drawings in which:

FIGURE 1 is an enlarged view of a polyamide resin particle according to the present invention and showing the magnetic particles and carbon black entrained therein;

FIG. 2 is a schematic elevation showing a few resin particles, as illustrated in FIG. 1, on the surface of a sheet of copy paper prior to the fixing treatment;

FIG. 3 is a schematic elevation showing the copy sheet of FIG. 2 after subjection to a fixing treatment just a few degrees above the temperature of the particles in FIG. 2; and

FIG. 4 is a sectional elevation of a rotating magnetic brush formed by a developer mix embodying the present invention.

While the invention will be described in connection with certain preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments but, on the contrary, it is intended to cover the various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

In a conventional elestrostatic printing process, a magnetic developer brush is formed by dipping a magnet into a developer mix comprising granular magnetic carrier particles and a developer powder. The magnetic carrier particles, such as iron, adhere to the magnet by magnetic attraction forming a brush-like mass, while the developer powder is held to the magnetic carrier particles by the triboelectric effect. Such a procedure is described in U.S. Patent No. 2,874,063. The magnetic brush thus formed can then be rubbed lightly across the surface of a copy sheet having a latent image thereon, so that the developer powder or toner is attracted to the charged areas of the paper to produce a direct powder image. This image may be fixed to the surface by any conventional means, such as by heating.

One illustrative developing unit utilizing a rotating magnetic brush is shown in FIG. 4. Such a unit is described and claimed in more detail in copending application Ser. No. 853,123, filed Nov. 16, 1959, now Patent No. 3,088,-386. Briefly, a rotating magnetic brush **10** is formed on a rotating cylinder **11**. A sheet, not shown, having a latent image thereon is passed between the brush **10** and a backing surface **12** so that the brush rubs over the surface to develop the image. The cylinder **11** is preferably a bar magnet and is provided with a plurality of ridges **13** which pick up individual brushes to enhance the development of the image. Toner powder is supplied from a suitable reservoir **14** to replenish the supply of toner used to develop the images.

The separate granular magnetically attractable carrier particles are preferably made of a ferromagnetic substance such as iron, magnetic iron oxide or magnetite, various magnetic metals and alloys, and the like. An illustrative carrier material is described in U.S. Patent No. 2,874,063 as consisting of "alcoholized iron," that is, iron particles which are free from grease and other alcohol-soluble impurities, and which are between about 0.001 and about 0.020 inch, and preferably between about 0.002 and about 0.008 inch, in their greatest dimension. While particles of iron have found predominant use, other magnetic substances such as nickel and nickel alloys or cobalt and cobalt alloys may well be used to advantage.

The coloring agent used in the developer powder may be any suitable pigment, dye, or stain which produces the desired color in the developed image. In most cases, it is desired to produce a black image, and the preferred coloring agent is carbon black. Other suitable coloring agents

may be used either singly or in combination with each other.

In accordance with the present invention, the resin portion of the developer powder is composed at least in major part of a polyamide resin. As used herein, the term "polyamide resin" refers to the polymerization product resulting from the reaction of a polyene fatty acid or the ester of a polyene fatty acid with ammonia and an amine selected from the group consisting of primary amines, secondary amines, and alkylamines. Particular polyamides of this type are described in more detail in U.S. Patent No. 2,379,413 to Bradley. In general, any polyamide resin produced by the reaction described above may be used in this invention, provided the melting point of the final resin composition is within the range of about 70° C. to about 165° C. Below 70° C., there is a danger of the resin being melted at the normal operating temperature of the machine, while temperatures above 165° C. cause charring of the coated copy sheets and may have a deleterious effect on certain vital parts of the copy machine. Examples of suitable polyamides are the Versamid 930, 940 and 950 resins of General Mills, Inc., and the Polymid 1155, 1144 and 1074 resins of the Lawter Chemical Company. It will be appreciated that polyamides having melting points outside the stated range may be used if they are combined with other polyamides so that the final resin composition has the desired melting point. Thus, the Versamid 100 resin, which has a melting point of 43–53° C., or the Versamid 900 resin, which has a melting point of 180–190° C., is not suitable by itself, but may be combined with other polyamides to produce a polyamide composition having a melting point within the range of 70° C. to 165° C.

In order to reduce the tendency of the developer powder or toner to adhere to the background of the print, either with or without the biased brush, and to increase the overall contrast between the image and the background, it is preferred to include a small amount of a finely divided magnetic substance in the powder. The magnetic substance may be magnetic iron oxide, ferrosoferric oxide powder, a magnetic metallic substance or alloy, or the like, and may be present in an amount as small as 1% by weight and preferably between about 5% and about 25% by weight of the developer powder. The particle size of the magnetic substance should not exceed about 1 to 2 microns in the greatest dimension, and should preferably be in the range of about 0.2 to 0.8 micron. The use of a magnetic substance, in small amounts and in the form of a finely divided powder intimately mixed and bonded with the toner so that it does not separate out when the toner is contacted with the carrier particles, has been found to be highly effective in preventing spurious deposits of toner on the background areas of the electrographic print. It will be appreciated that the Fe_3O_4 and other magnetic substances are good pigments by themselves, and in some cases may constitute the sole pigment or coloring agent in the toner.

To prepare a suitable toner, the polyamide resin is mixed thoroughly with the coloring agent and magnetic substance which have been previously reduced to an extremely finely divided powder form. For example, ferrosoferric oxide is available commercially in sizes of 100–500 millimicrons, while carbon black is available in particle sizes of 9–50 millimicrons. The resulting mixture is heated to about 180–200° C. to melt the polyamide resin and form a homogeneous melt which is stirred and then allowed to cool and harden. At this point the magnetic substance and carbon black are distributed thoroughly and uniformly throughout the resin. The hardened mixture is then broken up and ground to reduce the material to a particular size of substantially about 5–20 microns, and preferably about 10–15 microns in the greatest dimension. The resulting particles are diagrammatically illustrated in FIG. 1.

A developer mix embodying the invention is formed by mixing a finely divided toner such as one of the illustrative toners described above, together with relatively coarser magnetic carrier particles. The amount of toner or developer employed in the mix usually amounts to about 1% to about 15% by weight in the bin mix, with the higher end of the range being most useful with the biasing technique described above. In an illustrative mix, satisfactory results were achieved with 50 parts by weight of carrier and 1 part by weight of toner. The usual care must be taken, of course, to insure that the resin developer powder composition is sufficiently triboelectrically different, with respect to the magnetic carrier particles so that when the two are mixed, the developer powder acquires a charge. While the small amount of ferrosoferric oxide which the toner contains gives it a slight magnetic attraction to the iron carrier and to the magnetic brush core or other carrier element, this magnetic attraction is insufficient to interfere with the development of negative images. Accordingly, a direct powder image may be developed from a negatively charged electrostatic image, according to the above described procedure. Although normally black images may be formed, the image may be any color compatible with the background. The magnetic component in the toner may serve to dilute or enhance the overall color of the toner. Black magnetic materials such as ferrosoferric oxide are admirably suited for black toners. Even toners which are relatively invisible under normal lighting conditions but which are detectable under fluorescent light, ultraviolet light, infrared light or other detecting systems such as X-rays, magnetic sensing devices and the like may be utilized in accordance with this invention. In those areas in which the charge has been dissipated by exposure to light, the slight magnetic attraction between the developer powder and the magnetic carrier is sufficient to prevent the adherence of the developer to the background.

It has been unexpectedly discovered that when the polyamide resins are used in the developer powder according to this invention, the resulting developed image has an improved black density which is vastly superior to the images produced by the conventional developer powders used heretofore. Although the explanation of this surprising result is not completely understood, it is believed to be attributable to a combination of properties of the polyamide resin. Thus, for example, the polyamide resin has an extremely sharp melting point. An electrostatic copying machine normally operates at a temperature of about 130° F. and, as a result of this relatively high temperature, the resin in the developer mix often tends to soften and cause the developer powder to agglomerate, thereby increasing its particle size and reducing black lay-down. In addition, the softened resin often causes the developer mix to pack into the grooves in the magnetic brush; this is commonly referred to as "clumping" on the brush and prevents the brush from picking up the maximum amount of toner. The polyamides, however, have a sharp melting point and consequently are not softened by the normal operating temperature of the machine. For example, the preferred polyamide developer powders melt at about 107 C.±0.5 C., and exhibit practically no softening at temperatures as close as one or two degrees below this point.

Thus, referring to FIGS. 2 and 3, the particles **20** of developer powder which are deposited on the copy sheet **21** may be perfectly solid at 105° C., and then melt completely to form a smooth-flowing homogeneous liquid layer **20a** when the temperature is raised just a couple of degrees, to 107° C. for example. The polyamide resin exhibits a low surface tension just a degree or two above its melting point, so that the toner spreads evenly and penetrates into the image bearing portions of the copy sheet to a much greater degree than previous developer powders. This not only increases the black density of the developed image, but also provides a smooth surface on the final copy and avoids the irregular surface caused by raised images. Moreover, the excellent flow characteristics and low viscosity of the polyamide produces uniformly covered black areas in the developed image, rather than the stippled effect produced by developer mixes of the prior art.

Another important characteristic of the polyamide resins is their excellent affinity to negative electrostatic charges, which contributes to the deposition of a high concentration of toner over the charged areas which attract the developer powder. Also, the molten polyamide is capable of dispersing and carrying a substantially greater percentage of pigment than the conventional resins used heretofore, which further contributes to a high black density in the final developed image.

In addition to the improved black density, it has been found that the polyamide developer mixes of this invention practically eliminate the so-called "fringes" which often appear on copies made from conventional developer mixes, particularly when the copy paper has been allowed to dry out under low humidity storage conditions. The "fringes" are small dark areas which appear next to the edges of relatively large solid areas of the developed image. The polyamide mixes have been used to make copies under conditions identical to those which produced pronounced fringes with conventional developer mixes, and the resulting copies made from the polyamide mixes are completely free of fringes.

A further unexpected result which has been achieved with the polyamide developer mixes is that they produce surprisingly clean backgrounds when used with a biasing technique. This technique, which biases the copy paper by the application of a voltage having the same polarity as the charge on the toner particles to remove spurious toner deposits from the background areas, has been used heretofore with conventional developer mixes, but with only limited success. With the polyamide mixes of this invention, however, the biasing technique has been so effective that it has produced backgrounds substantially as clean as those of the originals. It will be recognized that the biasing voltage may be applied to the paper by a number of different methods, such as by corona discharge, by passing the paper between a pair of conductive rollers having a suitable voltage applied thereto (before and/or after development), or by applying a voltage to an insulated developer brush. Of course, in any of these methods the applied biasing voltage must have a polarity opposite to that of the charged areas of the copy sheet, i.e., the same as the charge of the toner particles.

In order to demonstrate the superior results produced by the polyamide developer mixes of the invention, two different copies were made from a standard reference original having a series of ten blocks of graduated black densities. The two copies were made under identical conditions in the same electrostatic copying machine, but with different developer powders having the following compositions in parts by weight:

	Powder A	Powder B
Carbon black	1.00	1.00
Fe_3O_4	4.50	4.50
Attaclay (Phillips Mineral & Chemical Corp.)	0.15	0.15
Polyamide resin (Versamid 940)	1.00	10.00
Styrene homologue resin (Piccolastic D100, Pennsylvania Industrial Chemical Co.)	5.50	----------
Coumarone-indene resin (Cumar V3, Allied Chemical Co.)	3.00	----------
Polyethylene	0.50	----------

Powder A is a conventional developed powder which is currently used on a large scale in commercial applications, while Powder B was formulated in accordance with the present invention. In each case, the developer powder constituted about 3½% by weight of the total developer mix, the balance being composed of conventional magnetic carrier particles. For the purpose of comparing the two copies, the ten graduated blocks on each copy were tested with a Welch "Densichron," which gives a numerical value to the amount of light reflected and, therefore, indicates the "black density" of the area tested. The higher the numerical value, the higher the black density. The results of these tests were as follows:

Block No.	Copy A	Copy B
1	0.95	1.46
2	0.92	1.40
3	0.82	1.36
4	0.74	1.32
5	0.68	1.25
6	0.58	0.85
7	0.36	0.48
8	0.17	0.19
9	0.10	0.16
10	0.09	0.13

As can be seen from the above data, the black density of Copy B, made with the polyamide developer powder of this invention, was considerably higher than the black density of Copy A for each block, including the lightest blocks in the series. Moreover, pronounced "fringes" appeared adjacent the edges of the darkest blocks on Copy A, whereas the corresponding areas of Copy B were completely clean and free of any such "fringes."

In another example of the invention, two different copies were made from the same standard original described above and with the same developer mixes. In this case, however, both developer mixes had been stored at 130° F., which is the approximate temperature of the developer mix bin in a conventional photocopy machine during constant use, for a period of about 48 hours prior to making the copies. Also, the polyamide mix in this example contained only 2.0% by weight of the polyamide developer powder (Powder B), while the other mix contained 3.5% by weight developer powder (Powder A), with the balance of the mix in each case being composed of magnetic carrier particles. The ten graduated blocks on each copy were tested for black density with a Welch "Densichron," with the following results:

Block No.	Copy A	Copy B
1	0.38	0.84
2	0.35	0.82
3	0.34	0.77
4	0.31	0.69
5	0.33	0.63
6	0.29	0.59
7	0.26	0.45
8	0.06	0.18
9	0.06	0.08
10	0.00	0.08

As can be seen from the above data, the difference in the two powders after the 48-hour aging period was even greater than the initial difference. Thus, whereas the black density of Block No. 1 of Copy B was initially about 53% greater than the same block in Copy A, after the 48-hour aging it was about 121% greater. Similarly, the black density of Block No. 6 of Copy B was about 46% greater than Copy A before aging, and about 103% greater after aging. This superior stability of the developer powder of this invention is obviously of great importance from a commercial standpoint. Moreover, since the cost of the developer powder is substantially greater than that of the magnetic carrier particles, the lower percentage of developer powder permitted by the polyamide powder is also of considerable practical importance.

In a further example of the invention, four different copies were made from a single original for the purpose of comparing the effect of a biased brush (applied positive voltage) on prints made with the two different developer powders described in the example above. Thus, two prints were made with each powder, one print with each powder being made with a biased brush and the other being made with a non-biased brush. All four prints were then tested for background cleanliness by measuring white reflectance on a Welch densiometer, with the following results:

	Biased Brush	Non-biased Brush
Powder A	84	84
Powder B	86	84

As can be seen from the above figures, the biasing of the brush had practically no effect on the background of the print made with Powder A. In the case of Powder B, however, the biasing of the brush effected a considerable improvement in the background cleanliness.

It can be seen that this invention provides an improved developer powder which is capable of producing superior electrostatic prints characterized by sharp, dark images having improved black densities. Moreover, the developer powder does not soften and agglomerate at the normal operating temperature of a copy machine, nor does it "clump" on the magnetic bush. Consequently, a maximum amount of powder is attracted from the brush to the charged areas of the image-bearing sheet. The developer power also readily penetrates into the charged areas of the copy sheet during thermal fixing so as to provide a smooth surface on the final copy and thereby avoid the irregular surface caused by raised images. Furthermore, this invention produces cleaner backgrounds which are free of so-called "fringes" and can be used effectively with a biasing technique. Finally, the low viscosity index and excellent flow characteristics of the polyamide resin avoid the stippled effect in the black areas of the developed image, producing smooth uniformly covered black areas.

I claim as my invention:

1. A developer mix for use in electrostatic printing to develop latent images, including charged and uncharged areas of an image-bearing sheet, said developer mix comprising the combination of separate granular magnetically attractable carrier particles and a developer powder comprising a coloring agent and a resin having a triboelectric relationship of opposite polarity with respect to said magnetically attractable granules, at least a major portion of said resin being composed of a polyamide resin having a sharp melting point within the range of about 70° C. to about 165° C. whereby developed images of substantially improved black density may be formed over extended operating periods.

2. A developer mix for use in electrostatic printing to develop latent images, including charged and uncharged areas of an image-bearing sheet, said developer mix comprising the combination of separate granular magnetically attractable carrier particles and a developer powder comprising a coloring agent and a resin having a triboelectric relationship of opposite polarity with respect to said magnetically attractable granules, said resin consisting essentially of a single polyamide resin having a sharp melting point within the range of about 70° C. to about 165° C., said developer powder having a particle size between about 5 and about 20 microns in the greatest dimension.

3. A developer mix for use in electrostatic printing to develop latent images, including charged and uncharged areas of an image-bearing sheet, said developer mix comprising the combination of separate granular magnetically attractable carrier particles, and a developer powder comprising a coloring agent and a resin having a triboelectric relationship of opposite polarity with respect to said magnetically attractable granules, at least a major portion of said resin being composed of a polyamide resin having a sharp melting point within the range of about 70° C. to about 165° C. whereby developed images of substantially improved black density may be formed over extended operating periods, and a finely divided magnetic material intimately mixed and bonded together with said resin and coloring agent in an amount large enough to increase the tendency of said developer powder to adhere magnetically

to said carrier particles and small enough to avoid substantially interfering with the adherence of the developer powder to the charged areas of the image whereby the tendency of the developer powder to adhere to the uncharged areas is substantially reduced.

4. An electrostatic printing method comprising the steps of electrophotographically producing a latent electrostatic image, including charged and uncharged areas of an image-bearing sheet, moving across said latent image a mixture of separate granular magnetically attractable carrier particles and a developer powder comprising a coloring agent and a resin having a triboelectric relationship of opposite polarity with respect to said carrier particles, at least a major portion of said resin being composed of a polyamide resin having a sharp melting point within the range of about 70° C. to about 165° C., said developer powder being attracted to the charged areas of said image-bearing sheet so as to form a developed image with a relatively high black density, and heating the developer powder on said sheet to at least the melting of said resin to fix the developed image.

5. An electrostatic printing method comprising the steps of electrophotographically producing a latent electrostatic image, including charged and uncharged areas of an image-bearing sheet, moving across said latent image a mixture of separate granular magnetically attractable carrier particles, and a developer powder comprising a coloring agent and a resin having a triboelectric relationship of opposite polarity with respect to said magnetically attractable granules, said resin consisting essentially of a single polyamide resin formed by the reaction of a fatty acid with a member selected from the group consisting of alkylated amines, diamines, and polyamines, said resin having a sharp melting point within the range of about 70° C. to about 165° C., said developer powder having a particle size between about 5 and about 20 microns in the greatest dimension, said developer powder being attracted to the charged areas of said image-bearing sheet so as to form a developed image with a relatively high black density, and heating the developer powder on said sheet to at least the melting point of said resin to fix the developed image.

6. An electrostatic printing method comprising the steps of electrophotographically producing a latent electrostatic image, including charged and uncharged areas of an image-bearing sheet, moving across said latent image a mixture of separate granular magnetically attractable carrier particles, and a developer powder comprising a coloring agent and a resin having a triboelectric relationship of opposite polarity with respect to said magnetically attractable granules, at least a major portion of said resin being composed of a polyamide resin having a sharp

melting point within the range of about 70° C. to about 165° C. whereby the developed image is formed with a substantially improved black density, and a finely divided magnetic material intimately mixed and bonded together with said resin and coloring agent in an amount large enough to increase the tendency of said developer powder to adhere magnetically to said carrier particles and small enough to avoid substantially interfering with the adherence of the developer powder to the charged areas of the image whereby the tendency of the developer powder to adhere to the uncharged areas is substantially reduced, said developer powder being attracted to the charged areas of said image-bearing sheet so as to form a developed image with a relatively high black density, and heating the developer powder on said sheet to at least the melting point of said resin to fix the developed image.

7. An electrostatic printing method comprising the steps of electrophotographically producing a latent electrostatic image, including charged and uncharged areas of an image-bearing sheet, forming a magnetic brush of granular magnetically attractable carrier particles, applying to said magnetic brush a developer powder comprising a coloring agent and a resin having a triboelectric relationship of opposite polarity with respect to said carrier particles, at least a major portion of said resin being composed of a polyamide resin having a melting point within the range of about 70° C. to about 165° C., and moving said magnetic brush across said latent image while biasing said paper by applying a voltage thereto having the same polarity as the charge on the particles of developer powder so that said developer powder is attracted to the charged areas of said image-bearing sheet while maintaining the uncharged background areas substantially free of developer powder, and heating the developer powder on said sheet to at least the melting point of said resin to fix the developed image.

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NORMAN G. TORCHIN, *Primary Examiner.*

C. E. VAN HORN, *Assistant Examiner.*