

[54] **DRY MAGNETIC COPYING PROCESS**

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[58] Field of Search... **346/74 MT, 74 MP; 117/234,
117/239**

[56]

References Cited

UNITED STATES PATENTS

3,698,005	10/1972	Nacci et al.....	346/74 MT
3,555,556	1/1971	Nacci.....	346/74 MT
3,555,557	1/1971	Nacci.....	346/74 MT

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[57]

ABSTRACT

The use of a recording member comprising a transparent support, a stratum of magnetic material and a thin coating of polysilicic acid, in combination with a dry toner powder, preferably one comprising a plurality of toner particles each of which contains at least one ferromagnetic particle, a binder and a cationic surfactant, renders a dry magnetic copying process feasible.

14 Claims, 2 Drawing Figures

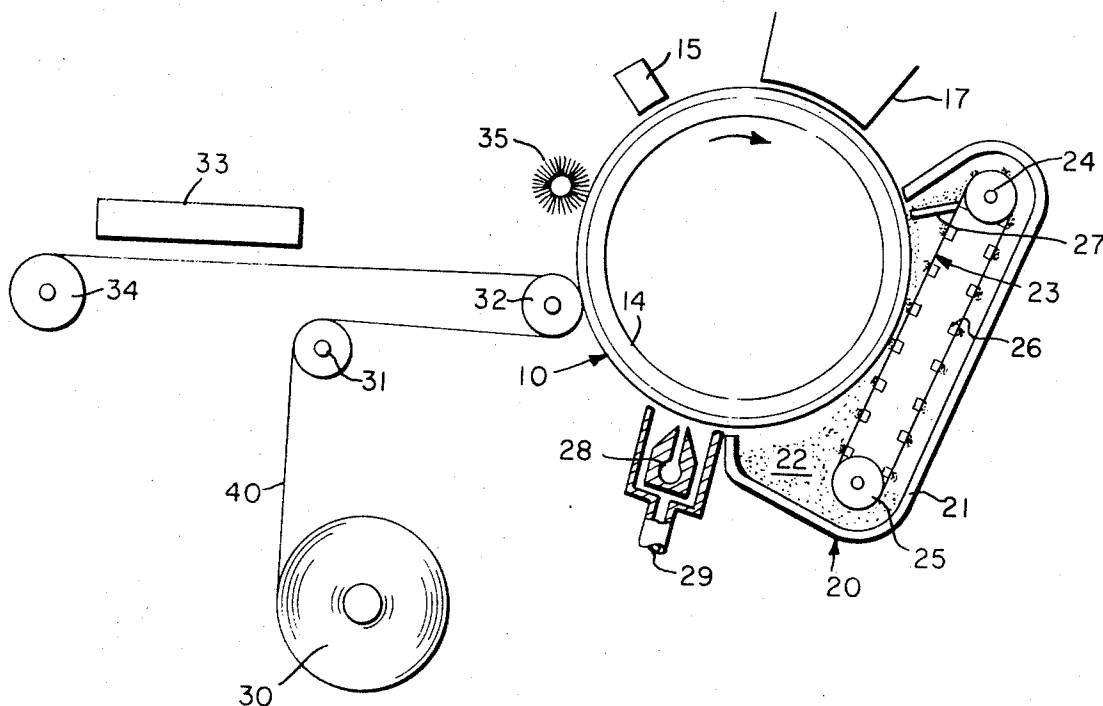


FIG. 1

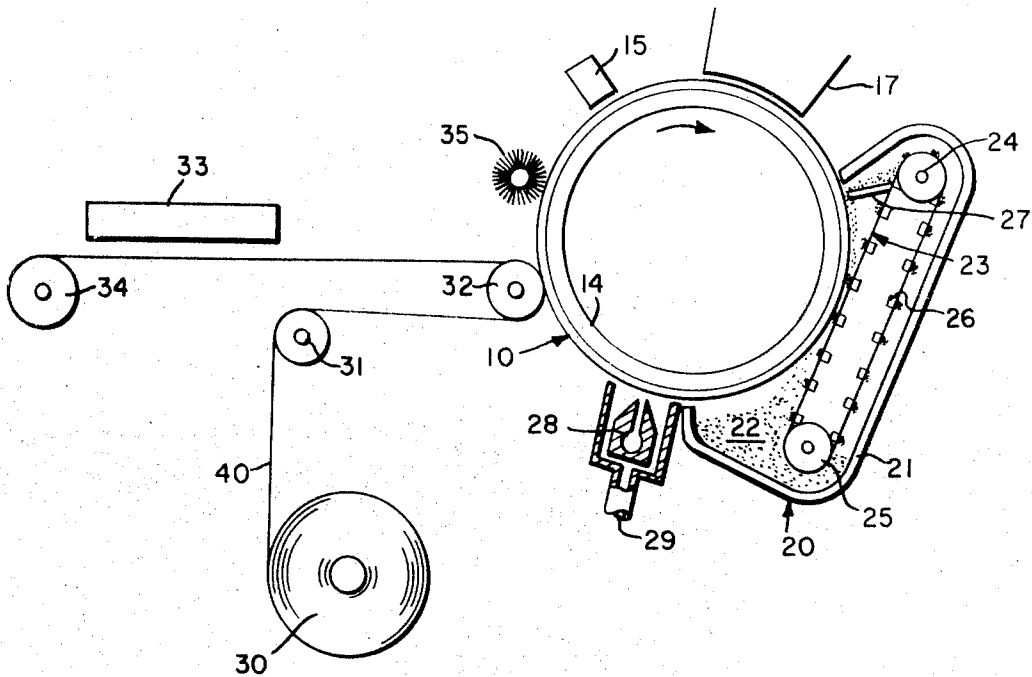
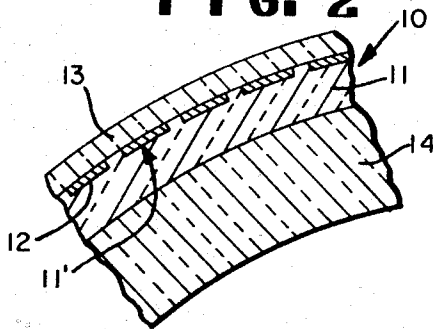


FIG. 2



DRY MAGNETIC COPYING PROCESS

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of U.S. application Ser. No. 37,706 filed on May 15, 1970 now U.S. Pat. No. 3,698,005.

BACKGROUND OF THE INVENTION

This invention relates to magnetic copying. More specifically, it relates to a dry magnetic copying process; and in particular, to the use of an improved magnetic recording member and an improved toner composition to make the dry magnetic copying process feasible.

The most common form of copying process in use today is the electrostatic process, but recent work indicates that magnetic copying processes may rival their earlier developed electrostatic counterparts. In the context of this invention, magnetic copying is defined as magnetic imaging of a record member followed by decoration of the magnetic image with a toner powder. One particularly useful magnetic copying process, thermomagnetic copying, is disclosed in a number of co-pending applications filed by one of the inventors of the present process. The thermomagnetic copying process itself is described in U.S. Pat. No. 3,555,556, which deals with a direct copying process, and U.S. Pat. No. 3,555,557, which deals with a reflex copying process. Specialized recording members for use in the thermomagnetic copying process are described in U.S. application Ser. No. 853,634, filed on Aug. 28, 1969, now abandoned, relating to a non-patterned magnet recording member, U.S. Pat. No. 3,554,798 relating to a patterned recording member, and U.S. Pat. No. 3,522,090, relating to a patterned recording member with a reflective coating; all of which deal with a recording member useful in the reflex recording process. The disclosure in the above specifications is hereby incorporated by reference into this specification.

While widely used, the electrostatic copying process suffers from a number of deficiencies, the most important of which are the difficulties encountered in copying large black areas, and the fact that the document to be copied must be reimaged every time a copy is made. Both of these deficiencies can be overcome in the electrostatic process, but only by extensive and costly modification to the basic system. The magnetic copying process does not suffer from these difficulties; in fact, two advantages of the magnetic copying process are that it can intelligibly copy large black areas and that it can make multiple copies without reimaging. Magnetic copying does, however, suffer from difficulties of its own. The basic problem relates to the fact that electrostatic forces are stronger than magnetic forces. Since most magnetic toner particles are attracted by both electrostatic and magnetic fields, any electrostatic fields which are built up on the magnetic recording member will tend to overpower the magnetic field which forms the magnetic image, at least insofar as their effect on the toner particles is concerned, and the background region, i.e., that portion of the magnetic recording member other than that containing the magnetic image, will attract enough toner particles to render any copy unattractive if not unintelligible. Static fields usually build up at a sufficiently slow rate so that at least one clear copy can be made, but unless some

mechanism is provided to dissipate the static charge, after a few copies have been made the static field becomes large enough to cause difficulty.

There are a number of solutions to this problem. One is to limit the process to a copying process utilizing a highly conductive coating that can be grounded to provide a conductive path for the static charge to leak off the recording member. Static build up over the entire surface of a recording member having such a surface can then be kept to a minimum. Grounding the surface, however, does not provide completely clean copies, since some of the dry toner particles may stick to even the most conductive coating; but the copy usually is acceptable. In some instances, the decorated magnetic image is read out by illumination from behind. Such a process does require a transparent recording member. To be transparent, such a member must contain regions which do not contain magnetic particles. This in turn usually means that a non-continuous magnetic surface must be used. Static charges which build up on such surfaces cannot be easily dissipated by grounding the magnetic member, because each portion of the surface is not necessarily contiguous with the neighboring portions, and no continuous conductive path is formed. The approved solution to static build-up in such copying processes, therefore, is to use an aqueous copying process. A water-wet surface is not as prone to static build-up as is a dry surface, but the use of a wet toner introduces a number of difficulties; primarily it is expensive, due to the time and power required to remove water from the toner to provide a dry copy. While the wet copying process is easily operable, in view of the above-mentioned difficulties, there is still need for a development which will render a dry magnetic copying process feasible.

The object of this invention is to provide a dry magnetic copying process which will produce completely clean copies.

The object of the present invention is accomplished by a dry magnetic copying process comprising the steps of:

- a. forming a magnetic image on a polysilicic acid coated magnetic recording member by magnetizing said recording member;
- b. decorating said magnetic image to make it visible by depositing a toner powder which is susceptible to magnetic fields on the polysilicic acid coated surface of said recording member; and
- c. reading out the visible magnetic image.

This process utilizes an improved magnetic recording member comprising a support, a stratum of particulate hard magnetic material disposed on or near the surface of the support, and a thin substantially continuous coating of polysilicic acid disposed on the surface of the magnetic stratum. The improvement achieved by this recording member is particularly outstanding when the stratum of magnetic material comprises a plurality of discrete areas of particulate magnetic material, because, without such a recording member, only a few clean copies can be made with such a surface. The improved recording member is also useful, however, when the stratum of magnetic material is in the form of a continuous layer, because the number of clean copies that can be made in this case is significantly increased.

The improved recording member is effective by and of itself, when used with any conventional toner material susceptible to electromagnetic fields, but the re-

sults in both the case of the discrete magnetic areas and the case of the continuous magnetic layer are particularly outstanding when a preferred toner powder is used, preferably one wherein each toner particle comprises ferromagnetic particles, a binder and a cationic surfactant.

Coatings of polysilicic acid on the surface of magnetic recording members are known to the art. The disclosure, however, has been limited to magnetic recording tapes for use with electromagnetic read-out devices, such as that disclosed in U.S. Pat. No. 3,476,595. Such coatings have generally been used to impart a durable and non-abrasive coating to the tape to protect both the tape and the tape heads, with which the tapes are used, from wear. The use of such a coating in a magnetic copying device where toner is to be attracted to the magnetic recording member and then transferred to a copy member is nowhere disclosed; nor is such a use suggested by the art. The problem presented to the present inventors was to decrease the amount of toner retained in the background area of the magnetic recording member while not significantly decreasing the amount of toner attracted to the magnetic image. The obvious way to accomplish this is to provide a continuous, conductive, and, hopefully, transparent coating on the recording member. This obvious solution naturally leads one away from the idea of coating the surface of the recording member with polysilicic acid, since putting such a material which is generally believed to be a non-conductor over a conductive magnetic stratum would be expected to increase the static charge build up. We have found that the basic problem is not so much the fact that toner particles are attracted to the background by static charges, but that under normal circumstances toner particles attracted by the static charge stick to the surface. The solution to the problem is to find a material which will increase the conductivity of the surface, or at least not reduce the conductivity substantially, and will also facilitate release of the toner particles from the record member. In practice it doesn't matter how many toner particles are attracted to the background of the record member by static charges so long as this static charge dissipates before any attempt is made to read the image or to transfer it to another surface, and so long as, when the charge does dissipate, the particles do not stick to the background surface so tightly that they cannot be removed without removing the particles decorating the magnetic images as well.

This combination of conductivity and non-stick properties appears to be critical. While it does not appear to be possible to find a highly conductive coating with good non-stick properties, especially one that is transparent, which is an important factor if the reflex process is used, we have found that a thin coating of polysilicic acid over the magnetic surface of the recording member produces the desired result even though one would expect the non-conductive nature of the polysilicic acid to overpower whatever gain might be realized from its non-stick properties. It does not appear that the coating of polysilicic acid increases the conductivity of the surface, at least by an amount which would account for the marked improvement of the recording member, but, by the same token, it does not appear to decrease the conductivity of the surface to the point where static charge will not dissipate in times reasonable with respect to copying machine speeds; a charge

decay constant of less than 1 second for the entire structure seems acceptable in such circumstances. In addition to its reasonably neutral electrical properties, however, the coating of polysilicic acid has non-stick properties which will allow toner particles, no longer held to the surface by static charge, to be easily removed from the surface without removing those toner particles held to the surface by the magnetic fields. While we expect that all coatings of polysilicic acid will work in this context, it has been found that a preferred coating is formed by the process of first hydrolyzing tetraalkyl orthosilicate in an alcohol to form polysilicic acid, then diluting the polysilicic acid so formed with an alcohol, and, finally applying the dilute solution of polysilicic acid in alcohol to the surface of the support and allowing the coating to form on the surface by evaporation of the alcohol. The coating can be applied using a swab, doctor knife or by spraying, or by any convenient, conventional means known to those skilled in the art. The reason why the coating so formed should produce a recording member that in turn produces particularly clean copies is not well understood at present. It is believed that the coating so formed may contain an abnormal concentration of hydroxyl groups which are particularly useful in dissipating the static charges.

The polysilicic acid coating must be substantially continuous and it must be thin. If the coating is not continuous, cracks will form where static build up can occur and where toner particles can be trapped. Since thin coatings of polysilicic acid have a tendency to be brittle and to craze, this presents a substantial problem. It may be that the preferred process for applying coatings of polysilicic acid, discussed above, produces a more durable, crack-free coating, and that this is the reason for its superior performance. In any event, when the coated record member begins to deteriorate, i.e., the copies made from it become less clear, the record member can be rejuvenated by applying another coating of polysilicic acid to the surface. The coating must be a thin coating so that the separation between the magnetic surface and the toner particles deposited on the surface of the polysilicic acid layer, does not become too large. If the separation becomes too large, the strength of the magnetic field, which decreases with distance, will decrease to the point where toner particles cannot be attracted by the magnetic field. For this reason the thickness of the coating should be kept below about 1.5 microns, with the preferred range between 0.1 and 1.0 micron. The following specific procedure for preparing the polysilicic acid coating has been found to produce acceptable results. A silicic acid solution is prepared by hydrolysis of tetraethyl orthosilicate in ethanol to form a 15 percent solution calculated as SiO_2 in the following manner:

100 gm tetraethyl orthosilicate is mixed with
47 gm 2 B alcohol, and
45 gm 0.1N HCl

The contents are combined and vigorously shaken until the solution becomes homogeneous, and allowed to stand 8 to 16 hours at room temperature to permit the solution to hydrolyze and form polysilicic acid. Storage for a longer duration must be under refrigeration for the solution continues to increase in viscosity forming a gel and eventually hardening. A more stable solution at room temperature is made from the above by addition of more 2B alcohol until dilute 5 percent polysilicic acid solution is obtained. This is applied to the re-

cording member using a doctor knife or by swabbing the surface of the recording member with cheesecloth containing the solution. The addition of 0.1 to 5.0 percent by weight of a silicone used as an anti-silking agent to the polysilicic acid solution improves the coating laid down by reducing the propensity for the coating to crack as it dries. Such a silicone sold under the designation L-520 by the Union Carbide Corporation has been used successfully. Higher concentration solutions can be used for thicker coatings and, likewise, more dilute solutions for thinner coatings. Coatings above 1.5 microns thickness not only tend to attenuate the magnetic attraction of the magnetic particles but also tend to crack and spall as the hardness increases with age.

The recording member discussed above will produce acceptable copies when used with conventional toner powders which are susceptible to magnetic forces. We have discovered, however, that the best copies are produced when a preferred toner powder is used in conjunction with the improved recording member discussed above.

The preferred toner powder comprises a plurality of toner particles and a dispersing or free flow agent. The toner particles, themselves, comprise at least one ferromagnetic particle, a binder, and a cationic surfactant. Each toner particle is substantially spherical and each has a diameter preferably between 2 and 15 microns. If the toner particles are much smaller, non-magnetic attractive forces become troublesome; if they are much larger, the particles become too heavy to be attracted or held by the magnetic fields.

The ferromagnetic particles can comprise a single type of particle or a mixture of particles. Preferably these particles are selected from the group consisting of Fe_3O_4 , Fe and combinations thereof, but any reasonably ferromagnetic particles will work. A suitable Fe_3O_4 is sold by the Columbian Carbon Company under the trade name "Mapico." A suitable iron is a carbonyl iron, GS-6, sold by General Aniline and Film Corporation. In this context, considerations other than the ferromagnetic nature of the particles may become important; i.e., the extent to which the particles lead to a blacker toner powder and consequently to a more readable image. The size of the ferromagnetic particles is preferably such that several can be contained in each toner particle.

The binder is used to hold the individual toner particles together and to bind the toner powder to the transfer paper if a fusing step is used. As such, almost any binder can be used. Since we are concerned with the elimination of static build up, however, some care must be used in choosing the binder. The binder must be one that has a slight propensity for static build up. If the binder has a high propensity for static build up, the advantage of using the improved recording member, discussed above, and the cationic surfactant, discussed below, can be completely overcome. Subject to the condition that they be relatively static free, however, many binders known to those skilled in the art can be used. Binders selected from the group consisting of carnauba wax, ethylene/vinyl acetate copolymers, and aliphatic polyamides have been found to fulfill the above condition and work well.

The toner particles also contain a cationic surfactant. The function of the cationic surfactant in the system is not well understood at present. It is believed that in the production of the toner particles, at least a portion of

the cationic surfactant becomes localized on the surface of each toner particle to produce exposed ionic groups, and that the charge of these exposed groups attracts dipolar water molecules from the atmosphere.

The presence of the water on the surface of the toner particles will decrease the static propensity of the particles, unless this effect is overpowered by a highly static-prone binder, and a preferred combination of a toner powder and a recording member with low static charge build up is achieved. It is believed that all cationic surfactants will work in this context. One such composition of this type, dimethyldistearylammonium chloride, sold by General Mills, Inc. under the trade name "Aliquat," has been found to be particularly useful for this purpose.

The free flow agent, usually present in quantities of 0.5 to 1.5 percent by weight, is used to keep the individual toner particles from sticking together and to increase the bulk of the toner powder. This facilitates an even deposition of toner particles over the recording member during the decorating step. Free flow, or dispersing agents, such as microfine silica and alumina will suffice. Fumed silica is sold by the Cabot Corp. under the trade name "Cab-O-Sil."

The relative concentration of the constituents of the individual toner particles can vary according to the needs of the particular system in which the toner powder is used. Preferably the toner particle will contain between 40 to 80 percent by weight of ferromagnetic particles, 30 to 60 percent by weight of binder and 5 to 15 percent by weight of cationic surfactant. The composition of the toner powder will vary with the process conditions, but the following specific toner formulation has been found to produce satisfactory quality copies over a wide range of process conditions.

CONSTITUENT	PERCENT
Carnauba wax	22.0
"Aliquat" 207	10.0
"Mapico" Black	33.5
GS-6 Carbonyl iron	33.5
"Cab-O-Sil" M-5	1.0

Toner compositions of the type discussed above are disclosed in U.S. Pat. No. 3,627,682 for Encapsulated Particulate Binary Magnetic Toners for Developing Images, filed on Oct. 16, 1968 by Joseph P. Hall Jr. and George J. Young, the disclosure of which is specifically incorporated into this application. The above-identified patent, however, deals primarily with the use of a binary mixture of hard and soft ferromagnetic particles to improve the printing characteristics of the magnetic toner. While for the reasons discussed in the Hall et al patent, a binary mixture of magnetic particles produces preferred toner compositions, for the purposes of the present invention it is the non-static properties of the compositions that are important, not the printing characteristics, so that a binary mixture of ferromagnetic particles is not essential. The non-static properties, and hence the particular usefulness of the specific mixture discussed above in the dry magnetic copying process of the present invention, therefore, is nowhere disclosed or suggested in the Hall et al patent.

BRIEF DESCRIPTION OF DRAWINGS

The magnetic copying process has been discussed in detail in the specifications referred to above, the disclosure of which has been specifically incorporated into

the present specification. A brief description of the detailed process is included below with reference to the following figures:

FIG. 1 is a schematic diagram of an apparatus useful in performing the magnetic copying process, and

FIG. 2 is an enlarged partial cross-sectional view of the recording member used in that apparatus.

DETAILED DESCRIPTION

The magnetic copying process is best practiced with an integrated apparatus of the type depicted schematically in FIG. 1. Referring to FIG. 1, the magnetic recording member 10 comprises a support 11, a stratum of magnetic material 12 having a thickness of 0.01 to 5 mils and a thin coating of polysilicic acid 13 disposed on the surface of the magnetic stratum. Referring to FIG. 2, for an enlarged view of the embodiment illustrated, the support 11 is in the form of a thin partially transparent film having a pattern of closely spaced grooves 11' filled with a thermomagnetic sensitive material which forms the magnetic stratum 12. The film, which can be made from any suitable material such as cellulose acetate or polycarbonates, is secured to the outer circumferential surface of a rotating transparent drum 14. The thermomagnetic material making up the magnetic stratum can be any suitable form of hard magnetic material. Particulate acicular chromium dioxide, with a maximum dimension of 0.01 to 10 microns, is a particularly useful material. The magnetic material can be arranged in any suitable pattern on the surface of the film or embedded in the film. If the image is to be read out by illumination from within, the recording member should preferably have a transmission of 5 to 95 percent, preferably 50 to 95 percent, to the exposing radiation. Precisely spaced grooves embedded in the film have been illustrated, but any other pattern such as dots will suffice; and, in the direct copy process, the magnetic stratum can be a continuous film. The spacing of the discrete areas will naturally depend on the use for which the member is intended, but normally a spacing of between one-fiftieth to one fifteen-hundredth of an inch is used.

Drum 14 is driven (in the direction shown by the arrow) by a motor drive (not shown) which is provided with a commercially obtainable speed control unit. In operation, the magnetic portions of the recording member are imaged by some magnetizing means 17 such as a conventional magnetizing head or a variable character magnetic head.

The recording member containing the desired magnetic image is then decorated, or developed, by a toner powder contained in a suitable decorating means 20. In the particular embodiment illustrated, the decorating means is a cascade decorating means, located directly downstream of the magnetizing means, and comprising a hopper 21 encircling the lower portion of the drum and containing a supply of toner powder 22. Toner is conveyed to the recording member surface by a cascading device comprising a thin endless belt 23 trained around spaced rolls 24 and 25. The belt is activated by a motor drive (not shown), and contains means to raise toner powder from supply 22 to a position where it can cascade freely across the moving drum. One suitable way to transfer toner particles, is to provide permanent magnets 26, located on the back side of belt 23, to carry toner particles to a point where they can be stripped from the surface of belt 23 by a stationary doc-

tor blade 27, and cascade freely over the moving drum. Surplus toner falls back to the bottom of the hopper 21 for recirculation. While this is a convenient means for depositing toner powder on the recording member, any of the numerous decorating means known to those skilled in the art can be used.

The decorated recording member is then moved to a position provided with an air knife 28, used to remove excess toner powder, i.e., that toner powder sticking to the back-ground and not to the magnetic image. The pressure of the air stream that the air knife supplies must be adjusted to the point where only the excess toner and not the toner decorating the magnetic image is removed. Air supplied at a pressure of between 0.5 to 2.5 inches of water from an orifice held 1.0 inch from the surface of the recording member will fulfill these conditions. To reduce the amount of dust in the system, air knife 28 is surrounded by an exhaust duct 29 which draws the air and excess toner powder out of the system. The recording member, bearing the clean decorated magnetic image, is then moved to a point where the decorated image can be read out. In the system illustrated, the decorated image is transferred to a plain paper copy sheet, which in this case is depicted as a continuous web 40, fed from a supply roll 30, and moving on idler roll 31. Actual transfer of the image takes place in the nip between resilient pressure roll 32 and the recording member 10. Applied pressure against the drum may range from below 1 to above 50 pounds per linear inch (pli), however, the most efficient transfer occurs at the upper pressure range, since about 90 percent of the toner is transferred at 50 pli. The higher pressure ranges, however, have a destructive effect on the life of the recording member, so the low ranges may be preferred. In this context, electrostatic or magnetic forces may be used to assist in transfer of the toner powder to the paper. With such assistance, the transfer pressure can be decreased. Following transfer, the web containing the loose toner powder is conveyed to a fusing means 33 which thermally fixes the toner powder to the paper. The fusing means can be a bank of infrared heaters or any suitable device. The web is subsequently removed by a take up roll 34, or it may be forwarded to a cutter (not shown) and cut into sheets. A rotary bristle brush 35 is provided to remove any residual toner particles not transferred to the copy sheet. If multiple copies of the image on the recording member are to be produced, the drum 14 rotates to the decorating stage, without the intervening steps of cleaning, demagnetization and selective magnetization. If another image is to be copied, the recording member is cleaned by brush 35, demagnetized by means 15 which erases the old image, after which the recording member is ready to be imaged again.

Instead of the transfer device illustrated in FIG. 1, the toner powder could have been transferred to a transparent sheet and read out by projection. Similarly read-out of the image is possible, either directly from the recording member or by projection when a beam of light incident on the decorated magnetic recording member, either from behind or at a reflective angle to the decorated surface of the member, projects the visible image contained thereon, onto some copy member, such as a light sensitive paper or a screen, for either permanent or temporary recording.

The dry magnetic copying process has been illustrated using a copying device comprising a cylindrical

recording member with fairly specific structure. It is to be understood, however, that other embodiments, specifically direct imaging, using the record member and improved toner powder discussed above, can be used, depending on the results desired. The above discussion has been for the purpose of illustration and is not intended to limit the scope of this invention which is set forth in the following claims.

What is claimed is:

1. A dry magnetic copying process comprising the steps of:

- a. forming a magnetic image on a polysilicic acid coated magnetic recording member;
- b. decorating said magnetic image to make it visible by depositing a toner powder which is susceptible to magnetic fields on the polysilicic acid coated surface of said recording member; and
- c. reading out the visible magnetic image.

2. A dry magnetic copying process comprising the steps of:

- a. forming a magnetic image on a polysilicic acid coated magnetic recording member by magnetizing said recording member;
- b. decorating said magnetic image to make it visible by depositing a toner powder which is susceptible to magnetic fields on the polysilicic acid coated surface of said recording member; and
- c. reading out the visible magnetic image.

3. A dry magnetic copying process comprising the steps of:

- a. forming a magnetic image on a polysilicic acid coated magnetic recording member by demagnetizing said recording member and then bringing said demagnetized recording member into proximity with a magnetized member containing a magnetic image of sufficient strength to form said magnetic image on said recording member;
- b. decorating said magnetic image to make it visible by depositing a toner powder which is susceptible to magnetic fields on the polysilicic acid coated surface of said recording member; and
- c. reading out the visible magnetic image.

4. The process of claim 3 wherein the polysilicic acid coating on said magnetic recording member is 0.1 to 1.5 microns thick.

5. The process of claim 3 wherein the polysilicic acid coating on said magnetic recording member is formed by the hydrolysis of a tetraalkyl orthosilicate.

6. The process of claim 3 wherein the polysilicic acid coating on said magnetic recording member is formed by the hydrolysis of tetraethyl orthosilicate.

7. The process of claim 3 wherein the polysilicic acid coating on said magnetic recording member is formed by first hydrolyzing tetraethyl orthosilicate in an alco-

hol to form polysilicic acid, then diluting said polysilicic acid with an alcohol, and, finally, applying the dilute solution of polysilicic acid to said magnetic recording member and allowing a substantially continuous thin coating of polysilicic acid to form by evaporation of said alcohol.

8. The process of claim 3 wherein the polysilicic acid coating on said magnetic recording member is formed by diluting polysilicic acid with an alcohol, and applying the dilute solution of polysilicic acid to said magnetic recording member and allowing a substantially continuous thin coating of polysilicic acid to form by evaporation of said alcohol.

9. The process of claim 3 wherein the step of reading out the visible magnetic image comprises transferring said toner powder to a copy member and fusing said toner powder to said copy member.

10. The process of claim 3 wherein the step of reading out the visible magnetic image comprises projecting the visible magnetic image onto a copy member.

11. The process of claim 3 wherein the step of decorating said magnetic image comprises decorating said magnetic image with a dry toner powder composed of a free flow agent and a plurality of toner particles each comprising at least one ferromagnetic particle, a binder having slight propensity for electrostatic charge build up, and a cationic surfactant, said toner particles having a diameter of 2 to 15 microns.

12. The process of claim 11 wherein: said toner powder comprises 0.5 to 1.5 percent by weight of a free flow agent and 99.5 to 98.5 percent by weight of toner particles; and each of said toner particles comprises 40 to 60 percent by weight of at least one type of ferromagnetic particles, 20 to 60 percent by weight of a binder having slight propensity for electrostatic charge build up, and 5 to 15 percent by weight of a quaternary ammonium compound.

13. The process of claim 12 wherein: said binder is selected from the group consisting of carnauba wax, ethylene/vinyl acetate copolymers, and aliphatic polyamides; said ferromagnetic particles are selected from the group consisting of Fe_3O_4 , Fe and combinations thereof; said quaternary ammonium compound is dimethyldistearyl ammonium chloride; and said free flow agent is selected from the group consisting of microfine silica and microfine alumina.

14. The process of claim 12 wherein said binder is carnauba wax, said ferromagnetic particles are Fe_3O_4 , said quaternary ammonium compound is dimethyldistearyl ammonium chloride and said free flow agent is selected from the group consisting of microfine silica and microfine alumina.

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