

March 10, 1964

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3,124,483

APPARATUS FOR TRANSFERRING POWDER IMAGES AND METHOD THEREFOR

Original Filed May 12, 1958

3 Sheets-Sheet 1

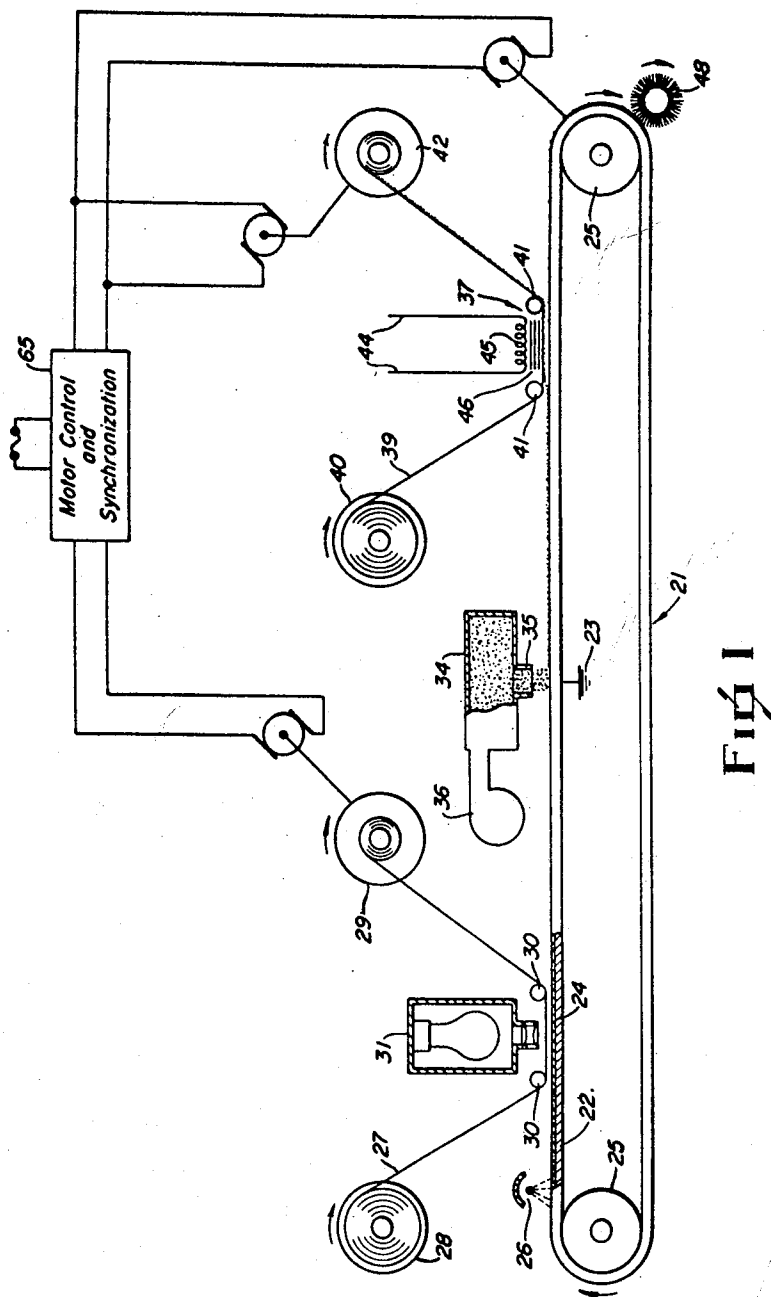


Fig. 1

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3 Sheets-Sheet 2

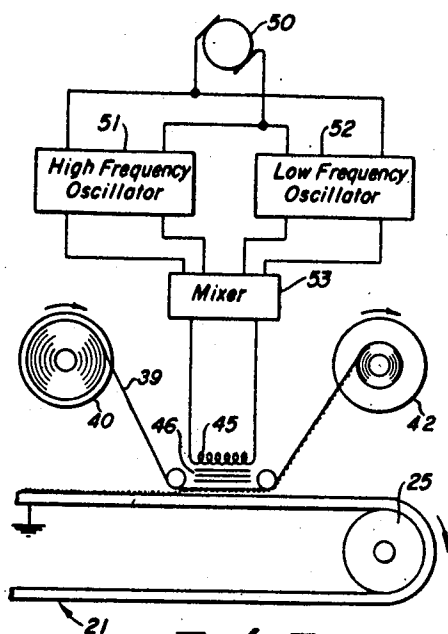


Fig 2

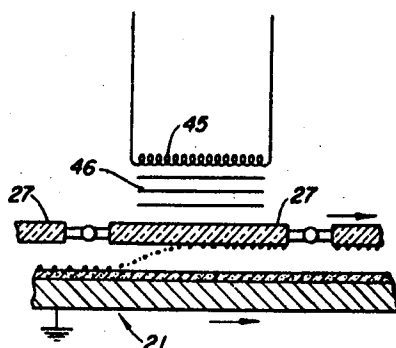


Fig 3

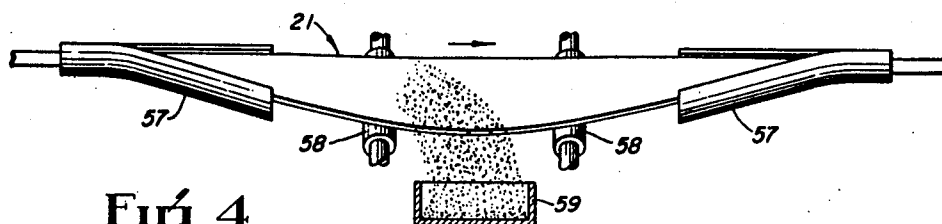


Fig 4

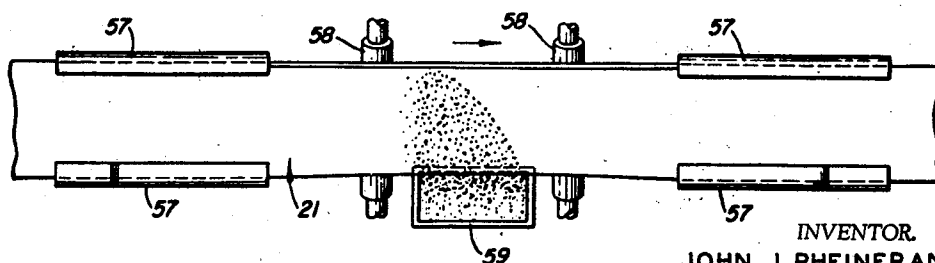


Fig 5

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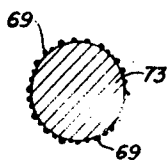
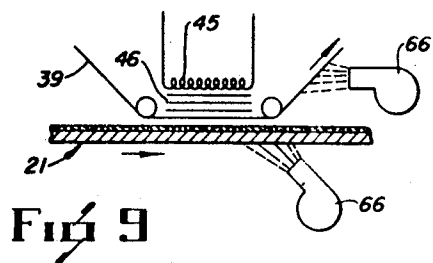
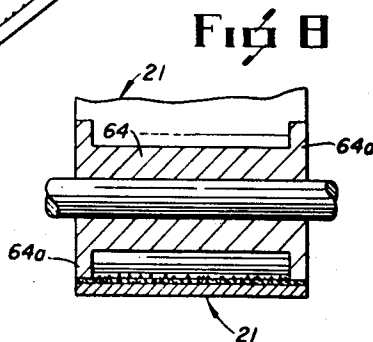
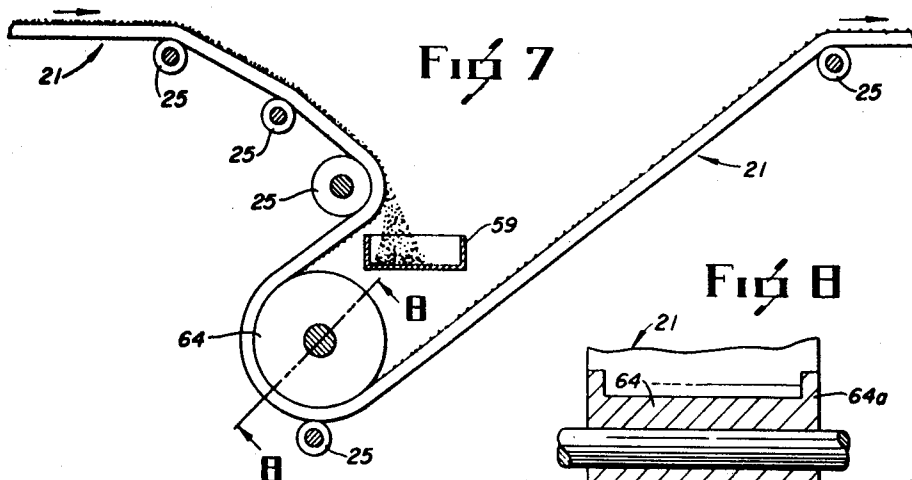
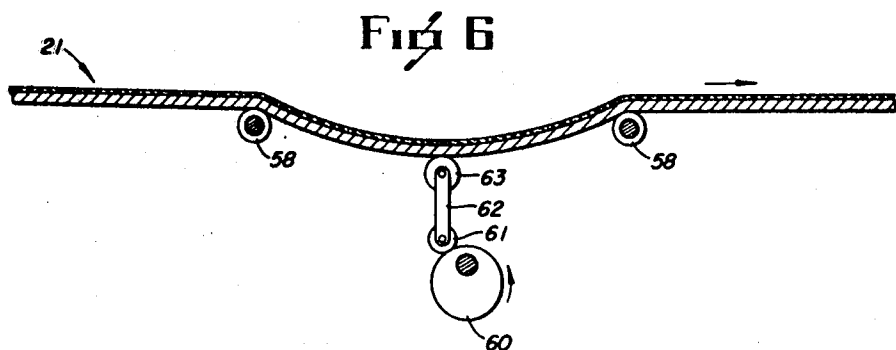
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APPARATUS FOR TRANSFERRING POWDER IMAGES AND METHOD THEREFOR

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3 Sheets-Sheet 3



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3,124,483

APPARATUS FOR TRANSFERRING POWDER IMAGES AND METHOD THEREFOR

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Original application May 12, 1958, Ser. No. 734,683. Divided and this application Feb. 12, 1962, Ser. No. 172,694

3 Claims. (Cl. 118—637)

The present invention relates in general to the art of electrophotography or xerography, which is the art of taking pictures and developing them utilizing electrical forces rather than chemical solutions. In particular, the present invention relates to new and novel compositions, articles, apparatus and methods or processes utilizing the field of electric photography and its related branches.

FIG. 1 is a schematic view, partly in side elevation and partly in vertical section, of one form of apparatus for developing powder images and then effecting electromagnetic transfer thereof;

FIG. 2 is a schematic view of part of the arrangement of apparatus shown in FIG. 1 and showing means for effecting transfer of powder images by utilizing high and low frequency electromagnetic means;

FIG. 3 is a schematic view of an arrangement of apparatus for effecting transfer and fusion of images to glass surfaces;

FIG. 4 is a partial vertical sectional view of a portion of the endless conveyor or web showing means to bend it from its normal line of travel and thereby cause the powder-carrier composition to move across the surface of the web carrying the electrostatic image and thereby develop it;

FIG. 5 is a plan view of the arrangement of apparatus shown in FIG. 4;

FIG. 6 is a partial vertical sectional view, a portion in side elevation, of an arrangement of apparatus for moving or vertically reciprocating the web to agitate or cascade a developer composition across the surface thereof and thereby develop the electrostatic image;

FIG. 7 is another view, partly in side elevation, of means for changing the direction of the web and for causing the developer composition to cascade across the surface thereof to develop an electrostatic image into a powder image;

FIG. 8 is a view along line A—A of FIG. 7, showing the structure of the guide roll;

FIG. 9 is a view, in side elevation, of an arrangement of apparatus for fixing the transferred image and for maintaining the selenium layer at a low temperature to prevent its change into the hexagonal form;

FIG. 10 is a greatly enlarged cross-sectional view of electroscopic-magnetic toner particles of this invention; and

FIG. 11 is a cross-sectional view showing a developer carrier particle covered with electroscopic-magnetic toner particles.

Excellent reproductions of copy material can be obtained according to the present invention by utilizing the new and novel arrangement of apparatus disclosed in FIG. 1. In this apparatus the image bearing surface or electrophotographic member constitutes a continuous, flexible belt or web 21 comprising electrically conductive inner layer 22, such as a flexible copper strip, a flexible aluminum strip, aluminized or silvered plastic (such as polyethylene terephthalate, cellulose triacetate, or the like), flexible iron alloys having either magnetic or non-magnetic properties or other electrically conductive metallic or plastic foil or the like, contacting a suitable ground wire 23, and having a photoconductive insulating layer 24,

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for example, vitreous selenium or anthracene on at least one surface thereof. In addition, various alloys of selenium such as combinations thereof with arsenic or tellurium, may be used. Furthermore, in addition to uniform coatings of photoconductive insulating materials, the photoconductive insulating films may be formed by dispersing finely-divided photoconductive material in an electrically insulating resin binder as more fully described in U.S. 2,663,636 to A. E. Middleton. In addition to the materials specifically disclosed therein, other suitable photoconductive pigments known to those skilled in the art may be used such as zinc oxide, titanium dioxide, zinc-cadmium sulfide, indium trisulfide, gallium triselenide, tetragonal lead monoxide, mercuric sulfide, etc., either alone or in combination with each other or with suitable dye sensitizing agents. This image bearing member is positioned about driving rollers 25 positioned in a suitable frame (not shown) which carry and drive the continuous web and is constructed of such a size and shape that the flexible web easily bends around and is carried by such rollers without cracking or distortion of the light sensitive coating.

At one end of the web and slightly above the sensitive coating or layer, there is positioned electric charging apparatus 26, such as a corona discharge electrode, connected to a suitable source of electrical energy (not shown), for distributing an electric charge over the surface of the sensitive layer. Original or film strip 27 from supply reel 28 and collected on driver or take-up reel 29 is led between rollers 30 which hold it substantially firmly in close register with the charged web while light from a source 31 above the strip 27 and web 21 is focused on to the film causing portions of the sensitive layer struck by light, passing through the transparent section of the strip, to become electrically conductive, thereby discharging the electrical charges residing thereon and leaving the remainder as an electrostatic image of the original.

A source of developer is contained in supply box 34 which can be agitated to cause the developer to dust through opening 35 onto the traveling web containing the electrostatic image or it can be fitted with a blower 36 which will likewise agitate the powder and cause it to dust lightly onto the web where it is attracted to and held by the remaining electrostatic charges, thereby forming a powder image corresponding to the electrostatic image and the image on the original.

The transfer means generally designated 37 includes a transfer member 39, such as a strip or web of cellophane or paper, and is positioned beyond the developing means and adjacent the powder image on the traveling web and comprises a supply reel 40 containing the transfer material 39 which is led between a second set of rollers 41 to bear against, or in close register with the traveling web 21 containing the powder image and then wound up on power or take-up reel 42. Between said rollers 41 where said web 21 and transfer strip 39 are in transfer relationship is placed electromagnetic means, shown schematically, comprising lead wires 44, coil 45, and core 46, for effecting magnetic transfer of the electroscopic magnetic toner to the strip 39 and for heating the toner or its magnetic component. After transfer and fusion is effected, the image exists as a plurality of electroscopic-magnetic toner particles firmly bound to the transfer material and generally fused together. If desired, a rotating brush 48, or the like is disposed along the surface of the photosensitive member 24 between the transfer station 37 and the charging station 26 to remove residual quantities of the image powder.

In FIG. 2 there is shown a source 50 of electric current which is fed to a high frequency oscillator 51 and to a low frequency oscillator 52 to provide high and low fields for heating and transfer. Switching or mixing

means 53 is provided in the circuit between the frequency sources and coils of the magnet to produce fields which are pulsating, continuous, simultaneous or successive.

The use of the apparatus and method of the present invention to transfer images to various articles is clearly illustrated in FIG. 3 wherein electroscopic-magnetic powder image particles 55 are transferred from the travelling developing web 21 to a transfer web or transfer articles 27 and fixed thereto. The distance between the web and the article has been exaggerated for purposes of illustration and in most cases it is negligible, for the article and the web containing the image actually are in contact to completely minimize distortion from unsupported passage of toner across an air gap.

When the electroscopic-magnetic powder developer contains a carrier material, it is necessary to cause the toner-carrier composition to flow across the plate to develop the image. Means to effect such a result is disclosed in FIGS. 4 and 5 wherein guides 57 positioned at the outer edges of the web 21 cause the web supported by rollers 58 to tilt from its normal direction of travel resulting in the carrier particles cascading across the plate and discharging therefrom into collecting tray 59 by gravity but leaving the toner on the web to form a powder image from the electrostatic image. Another means to cause the toner-carrier composition to cascade across the traveling web by agitation is shown in FIG. 6 wherein a gentle reciprocating motion is given to the web by means of cam 60 which actuates cam roller 61 having rod 62 attached thereto carrying wheel or roll 63 which bears against the web 21. After the toner has been cascaded across the plate, the web can be turned from its path as shown by the guides in FIGS. 4 and 5 or by doubling the web on itself which also facilitates developing, as shown in FIGS. 7 and 8 where rollers 25 serve to carry and provide the necessary tension of the web while guide roll 64, having angular flanges 64a bearing against only the outer edges of the web 21, causes it to double back permitting the carrier particles to discharge into tray 59 while the developed powder image passes under the narrow portion of the drive roll without being disturbed.

When operating with certain vitreous selenium films, the photosensitive member must be maintained at about room temperature and not above about 50° C., to prevent formation of hexagonal selenium which would adversely effect its electrophotographic properties. Therefore, the web and transfer strip may be passed through the transfer zone at a speed which is sufficient to prevent any heating of the selenium or other electrophotographic or electrographic layer due to the effect of the high frequency field heating the magnetic portions of the developer powder or heating the conducting base if made of material subject to high frequency fields. It will be understood that, when cooling means are not utilized, the speed of the transfer strip and electrophotographic web may be adjusted in order that the web will pass through the transfer zone without heating and the powder image will also transfer onto the transfer strip without distortion. A motor control and synchronization system 65 is shown in block diagram in FIG. 1 to accomplish this result as well as to assure transfer in register between the various members. Moreover, as in FIG. 9, suitable cooling means 66 may be positioned adjacent the transfer strip containing the transferred powder image to direct a blast of cooling air against the heated resin to cause it to rapidly harden or set, and adhere to the transfer strip so that when it is wound up on take-up reel, the powder particles will not stick to adjacent layers to distort the developed picture.

While heat is very disadvantageous in its effect on amorphous selenium, heating of binder plates (i.e., a photoconductive insulating pigment in an electrically insulating resin binder as described above) has no such undesirable effect on the xerographic properties of the

material and, in fact, has been observed to be highly beneficial thereto. Thus, when the photoconductive insulating surface comprises such a material, i.e., a photoconductive pigment in a binder, the apparatus need not provide for any extra cooling means. If simultaneous transfer and fusing is to be used, it is desirable to coat the photoconductive insulating surface (irrespective to its nature) with a suitable adhesive material such as polytetrafluoroethylene, various silicone materials, etc. to avoid unwanted adhesion of toner particles thereto.

If desired, the dusting apparatus can be connected to drying towers and a heater to reduce the moisture content of the air and also the powder it contacts. Thus, when it is caused to circulate through the apparatus to effect agitation of the powder particles before and during dusting, the particles readily dust without clumping, sticking, or causing imperfect powder images. The return pipe leading back to the blower is fitted with a sieve to remove the particles from the air stream which would clog the drying tower. A valve provides means for entry of fresh air in desired regulated amounts.

The novel developer compositions of the instant invention have special utility in developing electrostatic images. In the normal xerographic process such images are created and developed on the surface of the photoconductive insulating member which is generally amorphous selenium. In addition, rather than developing the electrostatic image on the photoconductive insulating layer, if desired the electrostatic image pattern may be transferred to an electrically insulating film as polyethylene terephthalate. This process is described more fully in U.S. 2,825,814 to L. E. Walkup. The toner composition of the instant invention may then be used to develop the electrostatic image on this insulating film to form a powder image corresponding to the electrostatic image thereon. The resulting powder image may then be either permanently affixed to the insulating film or transferred to a support member as paper, metal, plastic, etc. and the insulating film cleaned and reused in the process.

In a presently preferred embodiment of the invention, as illustrated in FIG. 10 the toner particle 69 is a two-component material containing one or more magnetic pigment particles 70 held in a binder 71. Generally speaking, this binder should be non-tacky, whereby it is readily removed from the image surface, and fusible by heat or solvent, whereby the transferred image body can be permanently fixed on the transfer surface.

The thickness of the electroscopic binder on the magnetic particles is such that sufficient binder is present to effectively coat the magnetic material or substantially coat it so that the toner particle will effectively move or be attracted by electrostatic forces in order to develop the electrostatic image and fuse to the transfer material. The toner particles do not necessarily need to be spherical in shape although obviously such is more desirable as it facilitates dusting and tends to make resulting pictures of even density throughout. As used in developing electrostatic images the toner composition is loosely coated on a carrier surface to which it remains loosely affixed by reason of electrostatic attraction thereto. The most widely used method of carrier development is known as cascade carrier development as more fully described in U.S. 2,618,551, to L. E. Walkup; U.S. 2,618,552 to E. N. Wise; and U.S. 2,638,416 to Walkup and Wise. In this process the electroscopic toner is desirably mixed with a granular carrier, either electrically conducting or insulating, magnetic or non-magnetic, provided that the particles of granular material when brought in close contact with the powder particles acquire a charge having an opposite polarity to that of the powder particles adhering to and surrounding the granular carrier particles. In FIG. 11 a carrier particle 73 is shown in cross-section carrying a number of toner particles 69 held thereon by virtue of their triboelectric properties.

The electroscopic component of the improved toner of this invention should have the property of being electrically attracted to, or repelled by, the charges on the surface of the plate. The electroscopic component should readily flow when heated and quickly coat and firmly adhere to the base without smudging or distortion and thus should also function as a binder when fused to the transfer medium or copy, as by means of heat, chemical, or other action. The electroscopic material should adhere on transfer to such bases as cloth, glass, and magnetic or non-magnetic metals, paper, wood, and synthetic materials like nylon, rayon and cellulose acetate and nitrate. Organic resins have been found to have such desirable properties. Examples of suitable electroscopic materials of this type are phenolformaldehyde resins, rosin-modified phenol-formaldehyde and maleic glyceride resins, polystyrene and butadiene-styrene copolymers, asphalts, such as gilsonite, manjak and asphaltite, calcium lactate, rosin, chlorinated rubber, glycol and glyceryl esters of hydrogenated rosin, polystyrene resin, Pliofilm (rubber hydrochloride), polyvinyl chloride, polyvinyl acetate, polyvinyl butyral, copolymerized vinyl chloride and vinyl acetate resins, other vinyl resins, alkyl resins, acrylic resins and the like. These materials can be used singly or mixed together as desired, and may be mixed together by dissolving in a solvent or by milling or mixing in conventional rubber or other compounding machinery.

The magnetic component should be a material which will respond to a low or high frequency magnetic field so that it will readily transfer the electroscopic binder and preferably can be heated, thereby causing the electroscopic component of the developer to melt or flow and become attached to the transferred material. Magnetic materials suitable for the purposes of the present invention are magnetic iron and its alloys, such as nickel-iron alloys, nickel-cobalt-iron alloys, and magnetic oxides, such as hematite (Fe_2O_3) and magnetite (Fe_3O_4) and ferromagnetic ferrites. Cobalt and its alloys are also useful, such as, for example, aluminum-nickel-cobalt, copper-nickel-cobalt, and cobalt-platinum-manganese alloys. Moreover, other alloys, such as certain magnetic alloys of aluminum, silver, copper, magnesium and manganese can likewise be used with satisfactory results. These materials can be added singly or in mixtures to the electroscopic powder component.

The magnetic component should be finely divided, as this enables it to be readily mixed or coated with the organic electroscopic binder component and greatly increases its pigment value. The magnetic component should be substantially coated or firmly attached to a relatively larger amount, areawise, of the electroscopic component in order that the powder will readily be influenced by and develop electrostatic images since the magnetic component itself may not be susceptible to electrostatic charges and not, by itself, developed. Particle sizes of 1 to 20 microns will be satisfactory for producing good, clear dense pictures.

There should be sufficient resin present in the composition so that the resin, containing the magnetic component, will respond to the electrical charges on the plate and thereby develop a picture even if the magnetic component not be electroscopic. There should also be sufficient resin present to hold the magnetic portion when the powder is transferred and fixed. The magnetic material should be present in an amount sufficient to respond to the electromagnetic field and to carry the resin through such a field, as will as to have a mass or volume to provide, under the influence of a high frequency electromagnetic field, sufficient heat to fuse or flow the resin attached to it. It has been found that the ratio of binder or resin to the magnetic component can vary from 19 to 1 to 2 to 3. For the best results, there should be at least 20% of the magnetic powder, but not over 70%, as the higher amounts may contain too little binder to

satisfactorily secure the magnetic portion to the transferred media.

The magnetic developer powder can be readily prepared by first finely dividing or crushing the resin material, after which it is mixed with the magnetic material. Thorough mixing is necessary in order to insure that the magnetic particles have been entirely encased with the binder. The mixed resin and magnetic powders are melted and stirred to thoroughly disperse the magnetic powder in the resin. The mass is then permitted to cool, and preferably is mixed on a rubber mill where the heated rollers assure sufficient plasticity to blend the components thoroughly, after which it is broken into small chunks and again subdivided. It is then micronized and sieved to size. Obviously other methods can readily be devised by those skilled in the art for the production of extremely fine pigmented resin powders of this type where the pigment particles are magnetic in character.

The novel electroscopic-magnetic toners of this invention can be used with, or without, carriers as will be more fully discussed below. However, for most purposes, it may be desirable to use a carrier component as a sheet or roller or, when the mixture is dusted or cascaded across a plate a granular carrier. Thus, before the picture is developed from the electrostatic image, the prepared electroscopic-magnetic toner is desirably mixed with a granular carrier, either conducting magnetic or insulating, provided that the particles of granular material when brought in close contact with the toner particles acquire a charge having an opposite polarity to that of the toner particles, such that the toner particles adhere to, and surround, the granular carrier particles. The carrier is also selected so that the toner particles acquire a charge having the opposite polarity to that of the electrostatic image.

Thus, the materials for the carrier surface are selected in accordance with their triboelectric properties with respect to the electroscopic-magnetic toner, so that, when mixed or brought into mutual contact, one material is charged positively if the other is below it in a triboelectric series, and negatively if the other material is above it in a triboelectric series. The selection can be made from many materials that have been tested, and occupy recognized positions in a triboelectric series so that, when mixed, they acquire opposite triboelectric charges, the charge required by the electroscopic toner particles having a polarity opposite to that of the charged areas of the dielectric layer on the plate and also opposite to that of the carrier surface.

By selecting materials in accordance with their triboelectric effect, the polarities of their charges, when mixed are such that the electroscopic toner particles adhere to and are coated on the carrier surface, and also adhere to the electrostatic image on the plate which thus retains the electroscopic toner in the charged areas that have a greater attraction for the electroscopic toner than the carrier surface have. If desired, the triboelectric relationship of the carrier and toner and the developing conditions may be so adjusted as to yield photographic reversal.

When the mixture of electroscopic-magnetic material and carrier is used with a positive charge on the plate or web and a direct rather than reversal print is desired, the electroscopic-magnetic toner should be capable of acquiring a negative charge by contact with the dielectric material, and the granular or sheet material should be capable of acquiring a positive charge at the same time by such contact. An example of a mixture that can be used with a positively charged plate is calcium lactate as an electroscopic material which is mixed with ammonium chloride as a carrier in the proportion of approximately ten parts by weight of the granular carrier to one part of the powder developer.

In cases where the granular carrier is capable of acquiring a negative charge and a direct print is desired, or where a negative or reversal print is desired from a posi-

tively charged image, the plate is given a negative charge, and the electroscopic-magnetic toner is selected so as to acquire a positive charge. Such a result can be had with Gilsonite, an asphaltite found in eastern Utah and western Colorado, or manjak, an asphaltite found in the East Indies, as the electroscopic binder material, with the magnetic material, and then mixed with ammonium chloride in the proportion of five parts of the latter to one part of the electroscopic-magnetic powder; or, ten parts of ammonium chloride to one part of a magnetically pigmented phenol-formaldehyde resin.

The granular carrier particles are grossly larger than the toner particles by at least one order of magnitude of size, and are shaped to roll across the image bearing surface. Generally speaking, the carrier particles should be of sufficient size so that their gravitation or momentum force is greater than the force of attraction of the toner in the charged areas where the toner is retained on the plate in order that the granular carrier particles will not be retained by the toner particles, while, at the same time, the toner particles are attracted and held, or repelled, as the case may be, by the charged or uncharged areas of the plate, since they acquire a charge of opposite polarity to the charges of both the granular carrier particles and the plate. It has been found best to use granular carrier particles of a size larger than about 100 mesh, usually between about 20 and about 60 mesh, and electroscopic powder particles of a size of from 1 to 20 microns, usually about 5 microns. The granular carrier particles may, if desired, be somewhat larger or smaller, as long as a proper size relationship to the electroscopic toner is maintained, so that the granular carrier particles will flow easily over the image surface by gravity when the plate is inclined, without requiring additional means or measures to remove them.

The degree of contrast or other photographic qualities in the finished image may be varied by changing the ratio of granular carrier to electroscopic toner. Successful results have been had with from about 10 to about 200 parts by weight of granular carrier particles capable of being passed through a 30-mesh screen, and being collected on a 60-mesh screen, to one part of micronized electroscopic-magnetic toner having a particle size of 1-20 microns. Generally speaking, carrier-toner ratios in the order of about 100:1 prove satisfactory and preferred compositions run from about 70:1 to about 150:1. In such preferred compositions, the carrier acts effectively to remove any toner particles which might tend to adhere to a non-image area and the toner itself forms a dense, readily transferrable and fusible image.

The granular carrier may consist of materials, granular or pulverized and coated or uncoated, such as, for example, polymerized methyl methacrylate resin, sodium chloride, silicon carbide, ammonium chloride, aluminum potassium chloride, Rochelle salt, sodium nitrate, aluminum nitrate, potassium chlorate, zircon oxalic acid, glass beads, soy bean protein, polystyrene, and adipic acid. These granular carrier particles may be of any shape within the preferred size range, although it is desirable to have them round, or nearly round, so as to facilitate their movement in gravitating over the plate. Particularly desirable carrier structures are disclosed in U.S. 2,618,551 to L. E. Walkup.

In addition to the use of granular particles to provide the carrier surface, the bristles of a fur brush may also be used. Here also, the toner particles acquire an electrostatic charge of polarity determined by the relative position of the toner particles and the fur fibers in the triboelectric series. The toner particles form a coating on the bristles of the fur, clinging thereto by reason of the electrostatic attraction between the toner and the fur just as the toner clings to the surface of the granular carrier particles. The general process of fur brush development is described in greater detail in U.S. patent application, Serial No. 401,811, filed by L. E. Walkup on January 4, 1954.

Still another method of carrier development is known as sheet carrier development in which the toner particles are placed on a sheet or pellicle as of paper, plastic, or metal. This process is described in U.S. patent application, Serial No. 399,293, filed by C. R. Mayo on December 21, 1953, now U.S. Patent No. 2,895,847. As described therein the electrostatic attraction between the sheet surface and toner particles necessary to assure electrostatic attraction therebetween may be obtained by leading the sheet through a mass of electroscopic toner particles whereby there is obtained a rubbing or sliding contact between the sheet and the toner. In general it is desirable to spray the surface of the sheet bearing the electroscopic toner particles with ions of the desired polarity as by the use of a corona charging device as described in the aforesaid application of Mayo. In any event, as used in developing an electrostatic image the toner composition of the instant invention is electrostatically coated on a suitable carrier surface which is then in turn contacted with the surface bearing the electrostatic image whereby the electroscopic-magnetic toner particles are transferred to the surface bearing the electrostatic image to form thereon a powder image corresponding to the electrostatic image.

It is, thus, seen that the present invention provides a very efficient powder developer composition, article, method of development and apparatus for use therewith. Significantly blacker transferred images have been obtained with the composition of the present invention than have been known in the prior art and the transfer is substantially independent of and unaffected by atmospheric conditions and the like. Furthermore, the image member, according to the present invention, can be more easily cleaned than when using conventional powder developers. The present process and composition facilitates the reproduction of stencils and other originals, and particularly sound records previously difficult to reproduce by xerography and by conventional printing and photographic methods. Further, it makes possible great flexibility in design of computers and business machines by reason of affording differential image effects due to response to both magnetic and electrostatic fields. Particularly, there is no need to separately heat to fix the developer of the present invention but the same is put in the proper condition at the time of transfer. A particular advantage is that the toner composition of the invention is useful in placing variable information on punched cards and being permanently affixed thereto without in any way affecting the dimensional stability of the card stock.

It is, thus, seen that the invention disclosed therein, provides a new and novel xerographic developing composition, as well as a new and novel method and means of achieving transfer of a developed image from a plate or an image bearing surface to produce a novel image which is permanently fixed thereto, as well as apparatus for effecting such purposes. In a specific embodiment of the invention these new and novel results have been achieved with a toner for xerography having magnetic and electroscopic components which is transferred and simultaneously fixed automatically by the utilization of a high and low electromagnetic field, wherein the electromagnetic field heats the magnetic body at the same time causing the resin to flow approximately while being transferred, and thereby fuses it to the transfer medium directly on contact.

In particular, by using magnetic transfer the electrostatic image is unaffected by the transfer operation thus permitting a multiplicity of powder images to be formed and transferred without recharging and re-exposing.

This application is a continuation-in-part of my copending application Serial No. 339,208, filed February 27, 1953, now abandoned, and a division of my copending application Serial No. 734,683, filed May 12, 1958, now U.S. Patent No. 3,093,039. Having thus described the invention, what is claimed as new and novel and is desired to be secured by Letters Patent is:

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1. Apparatus for developing an electrostatic latent image on a flexible linear web comprising means to advance said web along a predetermined developing path, means to support at least a portion of said web such that said web is advanced in a substantially horizontal plane while being inclined from the horizontal plane at an angle perpendicular to its direction of advance with the electrostatic latent image uppermost, and means to flow electrostatic image development material downwardly across the upper surface of said web while supported in said inclined position.

2. Apparatus for developing an electrostatic latent image on a flexible linear web comprising means to advance said web in a substantially horizontal plane with the electrostatic image bearing surface uppermost, means to incline said web from the horizontal at an angle perpendicular to its direction of advance, and means to flow electrostatic image development material downwardly across the upper surface of said web while in said inclined position.

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3. Apparatus for developing an electrostatic latent image on a flexible linear web comprising means to advance said web in a substantially horizontal plane with the electrostatic image bearing surface uppermost, means to incline said web from the horizontal at an angle perpendicular to its direction of advance, means to flow electrostatic image development material downwardly across the upper surface of said web while in said inclined position, and means to realign said web in a horizontal plane after development thereof.

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