ELECTROPHOTOGRAPHIC PROCESS

Original Filed Sept. 26, 1962

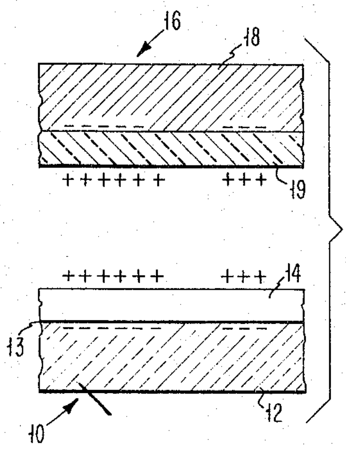
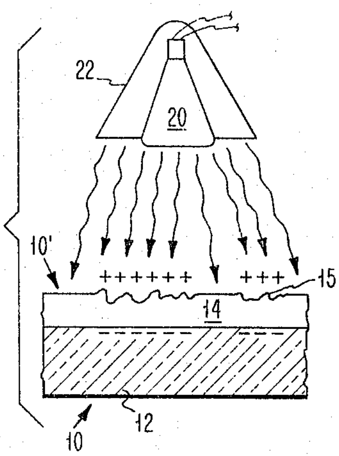


FIG. 1

FIG. 2



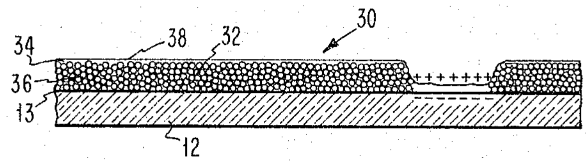


FIG. 3

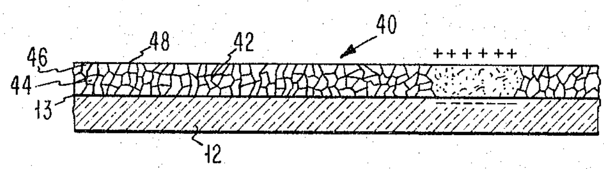


FIG. 4

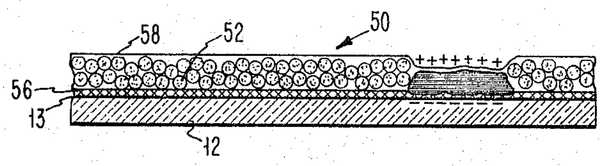


FIG. 5

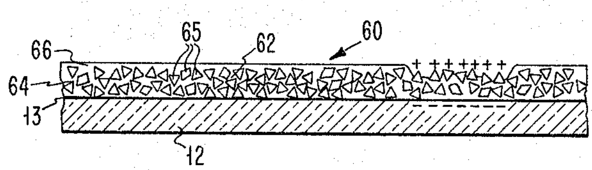


FIG. 6

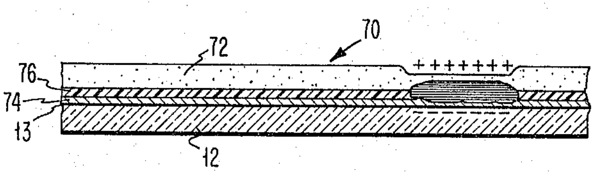


FIG. 7

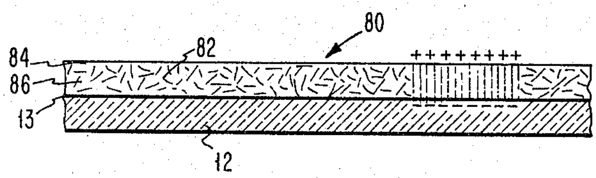


FIG. 8

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3,266,045
ELECTROPHOTOGRAPHIC PROCESS

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Continuation of application Ser. No. 226,376, Sept. 26, 1962. This application Oct. 19, 1965, Ser. No. 505,127
16 Claims. (Cl. 346—1)

This application is a continuation of the copending U.S. patent application Serial Number 226,376, filed on September 26, 1962, which application is now abandoned.

The invention relates to electrophotography, and it particularly pertains to processes for use with electrophotographic film structures which can be developed by heat and viewed with simple optics.

A technique for rendering electrostatic charge patterns visible in the form of "Lichtenberg" figures on certain dielectric surfaces by the application of heat is described in an article by A. M. Thomas in the "British Journal of Applied Physics," volume 2, April 1951, pages 98–109. As described in this article, electrostatic patterns become visible in the form of small ridges, creases or pits in the otherwise smooth surface of the dielectric.

Another thermoplastic recording technique is described in an article by W. E. Glenn in the "Journal of Applied Physics," volume 30, No. 12, December 1959, pages 1870–1873. As described in this article, the film structure consists of a sandwich comprising a high melting base film, a transparent conducting coating laid down on the base film, and a low melting thermoplastic layer laid down on the conducting coating. The sandwich is placed in a vacuum chamber in which an electron gun is arranged. A charge pattern is laid down on the upper surface of the thermoplastic film by scanning the electron beam over the surface. The film is then heated to the melting point of the thermoplastic permitting the electrostatic forces between the charges on the film and the conductive coating to depress the surface of the thermoplastic where the charges occur until these forces are in equilibrium with the surface tension restoring forces. The film structure is then cooled below the melting point of the thermoplastic and the deformations are retained in the solidified surface. Erasure is accomplished by heating the film well above the melting point in the absence of any charge pattern whereby surface tension will then smooth out the deformations and the film is ready for reuse. According to this disclosure, the film is usually heated in the vacuum chamber for developing the deformations by inducing current in the transparent conducting coating. A modified schlieren optical system is necessary for viewing the heat developed images.

A form of eidophor for astronomical observation purposes is described by H. W. Babcock in the "Journal of the Optical Society of America," volume 48, No. 7, July 1958, in which the variable optical element is a thin, uniform, flexible, solid film of low, but finite electrical conductivity. A reflecting coat of aluminum is placed on one side of the film and the other side is coated with a mosaic of isolated target elements. The film is mounted within a cathode ray tube equipped with a transparent window instead of the usual screen with the aluminumized side of the thin film facing outward. The other side of the film then receives a raster charge deposited on the mosaic by the electron gun of the cathode ray tube. The resulting electrostatic forces give rise to corresponding deformation of the otherwise plane reflecting surface.

The necessity for producing electrostatic images on the film in vacuum by the prior art method is, of course, a considerable disadvantage. Likewise, the facts that only line images can be developed and that these must be ob-

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served with the aid of schlieren optics represent disadvantages.

An object of the invention is an electrophotographic process in which electrostatic images can be produced on film in air by known techniques and then developed in air, obviating the requirement for a vacuum chamber and the necessity of inserting the film therein and removing it therefrom.

Another object of the invention is to be able to develop continuous-tone images as well as line images.

A further object of the invention is to produce images which can be observed visibly without the aid of special optical systems.

Still another object of the invention is to produce a method applicable to direct photography, obviating the use of powders and powder handling devices and the attendant machine fouling problems.

A more specific object of the invention is to provide film structures for producing a photographic record in the form of electrostatic images by thermal development.

These objects are attained by a process wherein an electrostatic image is first established by known methods on a dielectric film structure according to the invention. After producing an electrostatic image on the dielectric, such as for example with the aid of a photoconductive member, the film structure according to the invention bearing a latent electrostatic image is heated for a sort time by known means to a temperature above the melting point of one of the constituents of the film structure to develop the image which may be seen with the naked eye and handled in simple optical systems.

Heat developing film structures according to the invention for producing visible images corresponding to electrostatic charge patterns established on the film generically comprise a sandwich of a base layer, an outer continuous optically smooth layer or stratum of resin and an intermediate layer or stratum having means imparting an optical characteristic of given nature to the film structure prior to heating and of a contrasting nature after heating to those areas corresponding to the electrostatic charge pattern. At least the outer layer or stratum has a melting point lower than that of the other layers. In some forms of the invention the outer and intermediate strata are not separated by any fine line of demarcation and, therefore, have the same melting point. The base layer is conductive to an extent sufficient for the image transfer process and is preferably, but not necessarily, transparent. In some cases the base layer may be stripped away from the remainder of the film if such is self-supporting after it is developed. In such cases, the base layer may be a metal plate.

The film structures according to the invention take different forms for different applications. In one form there is preferably, but not necessarily, a transparent base layer of suitable material on which there is a conductive layer and an outer layer of transparent dielectric material which has a melting point lower than that of the other layers.

A desired image established onto the surface of the dielectric material as an electrostatic charge pattern is made visible upon application of heat as a roughened area lying in a smooth background.

Another film structure according to the invention comprises a stratum layer of low melting point resin film normally transparent beneath which is another stratum of the same resin containing many minute bubbles of gas imparting an opaque characteristic, usually white in color, to the film. Upon the application of heat, the resin in the two strata melt and in those areas also under electrostatic charge stress the film is compressed and the bubbles collapse leaving a transparent image in an opaque background.

A further film structure according to the invention comprises upper and intermediate layers of wax or resin with a polycrystalline structure which is normally opaque rendering a diffused refraction of light at the interfaces of the crystals. The lowered surface tension of the melted layers subjected to the electric stress at the electrostatic charge image areas renders the crystals amorphous on the application of heat. The image then appears as a transparent area in an opaque background.

Another film structure according to the invention comprises a strata of resin having a smooth surface beneath which is more of the material containing minute capsules filled with dye-forming material. An intermediate layer contains a chemical which will react with the dye-forming material. Upon the application of heat above the melting point of the resin, a colored image is formed in the areas where the electrostatic stress is sufficient to cause the capsules of dye-forming material to collapse, thus releasing the dye-forming material to react with the chemical.

Still another film structure according to the invention comprises a stratum of fusible resin containing embedded infusible particles covered by another stratum of fusible resin only providing an optically smooth surface. The combination of heat with the electrostatic stress in the image areas compresses the resin below the upper portions of the infusible particles. This produces an image of roughened or grainy consistency on a smooth background.

A further film structure according to the invention comprises an outer continuous layer of one resin and a layer of compound reactive with each other to produce a color change and separated by a very thin layer of fusible resin. Upon the application of heat, the fusible resin flows sideways because of the electrostatic stress in the image lines, allowing the one resin and the reactive compound to come into contact and produce a colored image visible to the eye.

Still another film structure according to the invention comprises an upper continuous stratum of thermoplastic resin and an intermediate stratum of the same thermoplastic resin having a dispersion of elongated dielectric or ferroelectric particles of random orientation. In the electrostatically charged image areas, the heat melting therein will permit the particles to align themselves with the electrostatic field, thus allowing the passage of light normally blocked by the random oriented particles to form a photographic transparency.

In order that full advantage of the invention may be readily obtained in practice, preferred embodiments thereof, given by way of examples only, are described in detail hereinafter with reference to the accompanying drawing forming a part of the specification, and in which:

FIG. 1 illustrates the establishment of an electrostatic image charge pattern on a film structure according to the invention;

FIG. 2 illustrates the heating step in the development of an image according to the invention;

FIG. 3 illustrates a film structure according to the invention comprising bubbled filled resin;

FIG. 4 illustrates a film structure according to the invention comprising crystalline wax or resin;

FIG. 5 shows another film structure according to the invention comprising dye-filled capsules for reaction with a dye-forming material;

FIG. 6 shows a further film structure according to the invention wherein a fusible resin film contains embedded infusible particles;

FIG. 7 shows still another film structure according to the invention comprising two reactive materials separated by a thin layer of fusible resin; and

FIG. 8 illustrates a further film structure according to the invention comprising a fusible resin containing a dispersion of elongated dielectric or ferroelectric particles of random orientation.

FIG. 1 is an illustration of electrostatic image formation by one means on a film structure **10** according to the invention comprising a transparent base layer **12**, a transparent conductive surface element **13**, and a film **14** of melting point lower than that of the base layer. An example of the base layer **12** is polyethylene terephthalate and the conductive element **13** for such an example is a thin deposit of aluminum. If desired, a known form of conductive glass may be substituted for the combination. Examples of the film **14** are ester gum (with and without plasticizer), cumar resin, maleic anhydride resin, silicone varnish, petroleum wax and polyethylene. A charge pattern on a xerographic plate **16** comprising a metallic substrate **18** and a selenium layer **19** is produced by conventional means. The image appearing on the selenium layer **19** is transferred to the film structure **10**. Methods and apparatus for establishing electrostatic images on dielectric material are well known. There are also preferred processes of electrostatic image transfer described in the copending U.S. patent applications of Harold C. Medley and Roland M. Schaffert, Serial No. 127,725, filed on July 28, 1961, and of Roland M. Schaffert, Serial No. 159,892, filed on December 18, 1961, and now Patent No. 3,147,769. The establishment of the image on the xerographic plate **16** and the subsequent transfer to the film structure **10** in and of themselves form no part of the invention as such operations are well known to those skilled in the art.

Development of the image on the film structure **10** is shown in FIG. 2 wherein the exposed film structure **10** is subjected to heat from a suitable source, such as the combination of an infra-red lamp **20** and a reflector **22** as shown. The film **14** is heated by the lamp **20** slightly above the melting point whereupon the surface tension and the stresses of the electrostatic forces of the charge produces roughness of the surface as shown at line **15**. There will be diffuse reflection in the image areas due to surface roughness and specular reflection in the background areas. If the film is transparent, the surface distortion in the image areas will cause differential refractive effects, and when viewed by transmitted light, the image areas will cast a shadow, giving the effect of a photographic transparency.

Thus, a photographic transparency has been developed without resorting to powder and powder developing devices, and without the necessity of inserting parts into and moving them from vacuum chambers.

FIG. 3 illustrates a film structure according to the invention which functions to produce a visible image in a manner somewhat different from the simple film structure shown in FIGS. 1 and 2. In FIG. 3 and the following figures, an enlarged cross-section of the film structure is shown. At the left is the structure before developing by heating and fixing by cooling and at the right is an example of a line or small area after processing according to the invention. A film structure **30** according to the invention comprises a base layer **12** and a layer **32** having an upper stratum **34** with a smooth obverse surface **38** and an intermediate stratum **36** filled with gas bubbles as shown. The obverse surface **38** is smooth and continuous in contrast to the spongy nature of the intermediate stratum **36**. Otherwise, the layer **32** is homogeneous and there is no finite line of demarcation between the strata **34** and **36**. The film **32** may be formed by exposing a vesicular film uniformly overall to ultra-violet light creating bubbles which render the film white and translucent. An example of such film is polyvinylidene chloride containing a diazo compound and known better by the trademark "Kalfax." The base layer **12** is a transparent material which may be conductive or have a conductive film laid thereon. For example, the base layer **12** is polyethylene terphthalate film manufactured and sold under the trademark "Mylar" and the conductive surface necessary for the establishment of the charge according to the desired image is a transparent coating of aluminum. Alternatively, other transparent conductive coatings, or a conductive glass material may be used. Where transparency is not required, a metal base layer is practical. Some of the film structures according to the invention are self-supporting and may be removed from the base layer 12 after development. In such cases a metal base layer is quite practical. Upon subjecting the exposed film to the charge pattern and transferring the charge thereto and thereafter subjecting the exposed film to heat, the surface tension and the electrostatic stress coact to collapse the bubbles in the areas corresponding to the charge rendering the film 32 clear and transparent at these areas, whether they be the small areas of a line image or the larger areas of a field. Tones are developed according to the invention in accordance with the specific variation of the electrostatic charge. The base member 12 may be transparent rendering the developed film structure transparent in the image areas and opaque in the background areas. Alternatively, the base layer 12 may be opaque and colored, for example, black or red or blue, or the like, so that the image appears colored in the image areas and white in the background areas. Alternatively, the film structure 30 comprises a base layer 12, a conductive coating or layer 13 and another layer having two strata: a foam or sponge stratum 36 of chemically blown polyvinyl chloride plastisol or Freon blow polyurethane foam topped with a smooth stratum 34 of the same material. In this embodiment there is actually no fine demarcation between strata, the only point made is that it is preferable, but no really necessary, that the obverse surface 38 be smooth and continuous as contrasted with the "spongy" surface that would appear otherwise. An example of alternative film structure 30 according to the arrangement shown in FIG. 3 is made of a "Mylar" base film 12 about 5.0 mils thick with an aluminum layer 13 deposited thereon, atop which is a layer of foam resin.

Another film structure 40 according to the invention is shown in FIG. 4 comprising a base layer 12 and a film layer 42 consisting of two strata with one stratum 44 comprising crystalline wax or resin crystals of random structure and the other stratum 46 comprising crystals of the same material, but of structure forming a smooth obverse surface 48. Like the previous embodiment, there is no fine line of demarcation between strata. Again, the substrate 12 may be transparent or opaque; optionally black or of another color, as previously described. When exposed to an electrostatic charge and thereafter heated, the crystals in the image area fuse to the amorphous state permitting light to be transmitted through the image area which is of a light transmitting characteristic contrasting with that of the crystalline wax or resin. An example of a material suitable for this embodiment is crystalline polyethylene.

FIG. 5 depicts a further film structure 50 according to the invention comprising a base or reverse layer 12, an upper or obverse layer 52 comprising resin film containing encapsulated dye former and an intermediate layer 56 containing a chemical reactive with the dye former. The obverse surface 58 of the encapsulated resin film 52 is smooth. When an electrostatic image is formed on the film and it is heated, the electrostatic stress and surface tension in the image areas coact to collapse the dye former capsules causing a reaction with the reactive chemical in the intermediate layer 56 to produce an area of contrasting optical characteristics visible to the naked eye.

The encapsulating of dye formers and the resulting formation of a marking of optically contrasting characteristic upon rupture by pressure of a stylus or typebar are well known in the art. These form no part of the invention in and of themselves, the invention being concerned with the application of heat and electrostatic pressure for rupturing the capsules. The teaching in the copending U.S. patent applications Serial No. 11,287, of R. M. Lindquist et al., filed February 26, 1960, and now Patent No. 3,111,407, for "Record Materials and Methods for Making the Same"; Serial No. 11,341, of Z. Reyes, filed February 26, 1960, for "Process of Making Microcapsules"; Serial No. 39,150, of H. Huff et al., filed June 27, 1960, and now abandoned for "Process of Making Microcapsules"; and Serial No. 66,688, of Z. Reyes, filed November 2, 1960, for "Preparation of Polyvinyl Alcohol Microcapsules," are suggested for the details of the arrangements, bearing in mind that the materials and methods set forth therein should be selected with an eye to the reactions to heat and electrostatic pressure for the practice of the instant invention.

A further film structure 60 according to the invention is shown in FIG. 6. In this embodiment of the invention a layer 62 comprised of fusible resin film is laid upon base layer 12 and a conductive film 13. The layer 62 has a stratum 64 containing embedded infusible particles 65. All of the particles 65 are below an obverse stratum 66 so that the obverse surface 68 is optically smooth and somewhat removed from the particles 65. The fusible resin melts when exposed to heat and the electrostatic stress plus the reduction in surface tension pulls the surface 68 down below the tops of the particles 65 in the charged areas as shown at the right forming a roughened surface similar to that shown at 15 in FIG. 2.

The particles of infusible material can be powdered or ground glass, magnesium acetate, magnesium sulphate, and the like. The index of refraction should be comparable for both the resin and the particles. For example, light flint glass, the index of refraction of which lies in the range of 1.605–1.572, can be used with polystyrene which has an index of refraction (I.R.) of 1.59. Polyethylene, I.R. 1.51 will go well with ordinary crown glass, I.R. 1.532–1.511, as will acrylate, I.R. 1.49–1.51. Other combinations are suggested, for example, polyvinyl acetate, I.R. 1.46–1.5 and magnesium acetate, I.R. 1.49 which should not be too finely ground. Polyvinyl acetate and magnesium sulphate in one of its forms may be used. The latter in one form, with 5 molecules of water of hydration, has an I.R. of 1.495–1.514. In its common form, with 4 molecules of water of hydration, it has an I.R. of 1.508–1.522 and rose colored, which fact may discourage its use somewhat. Acrylate and albite glass, I.R. 1.489 are also suggested.

The particles 65 alternatively are reactive with a chemical to change color. This chemical would be swabbed over the surface after development by heating and fixing by cooling to color only the exposed particles to provide the desired contrast.

FIG. 7 illustrates a still further embodiment of the invention comprising a film structure 70 having a base layer 12, a layer 72 of one resin, for example, vinyl resin, and a layer 74 of a zinc compound, for example, zinc oxide, separated by a very thin layer 76 of fusible resin, which preferably is white or transparent. Electrostatic stress and heat causes the very thin layer 76 of fusible resin to melt and allows the vinyl resin to contact the zinc compound leaving an area of contrasting optical characteristics in the image areas. For the example given, of zinc oxide and vinyl resin, the exposed and developed areas will be black providing a very effective image visible to the naked eye. For this embodiment of the invention, the reaction between dimethyl glyoxime and nickelous chloride is also suggested.

A different film structure 80 according to the invention is shown in FIG. 8. This film structure 80 comprises a base layer 12, a conductive film 13, and a layer of fusible resin 82 having an upper strata 84 and an intermediate strata 86 of fusible resin containing a dispersion of elongated dielectric crystals. Here, electrostatic stress plus heat permits the orientation of the crystals in the direction of the electrostatic field, thereby providing an optical characteristic of contrasting nature in the image area to that in the background. An example of crystals for this embodiment is calcium citrate, which is in the form of elongated white needles. It is not important to match the indices of refraction in this embodiment. The randomly oriented crystals in the resin, say polyethylene, render the film structure fairly opaque and more light will be transmitted where the crystals are aligned, though not nearly as much contrast will be afforded here as with some of the other embodiments. Polarized light is suggested as a means of improving the contrast.

While the invention has been shown and described, particularly with reference to preferred embodiments thereof, and various alternatives have been suggested, it should be understood that those skilled in the art may effect still further changes without departing from the spirit and scope of the invention as defined hereinafter.

The invention claimed is:

1. The use of a resin film structure in a process for producing a photographic record, including the steps of:

establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure of given optical characteristic comprising:

a smooth continuous obverse stratum of resin of relatively low melting point,

a reverse stratum, and

an intermediate stratum of material at least partially convertible, when heated with an electrostatic field applied thereto, to an optical characteristic of contrasting characteristic to be given optical characteristic of said film structure,

heating said film structure uniformly to a temperature sufficient to convert said intermediate stratum, thereby

imparting an optical characteristic of contrasting nature to said film structure in those areas corresponding to the electrostatic charge pattern, and

cooling said film structure uniformly for solidifying the same.

2. The use of a film structure having a smooth dielectric surface in a process for producing a photographic record, including the steps of:

establishing an electrostatic charge pattern corresponding to an image to be recorded on the dielectric surface of said film structure, said film structure having a supporting base and a layer carrying the dielectric surface selected from the group consisting of:

(1) a layer of a synthetic resin having a multitude of bubbles throughout the film structure, thereby giving the layer an opaque appearance,

(2) a layer of an organic compound selected from the group of crystalline waxes and crystalline resins, capable of changing from a crystalline state to an amorphous state upon heating,

(3) a layer consisting of a stratum of a fusible compound separating two stratum, each containing a compound reactive with the other to form a colored product,

(4) a layer of continuous fusible compound having infusible particles dispersed therein, and

(5) a continuous fusible compound containing ferroelectric particles embedded in random orientation within said compound,

heating said film structure uniformly to a temperature such that the continuous component is in a thermally relaxed condition whereby, in the areas of said electrostatic charge pattern,

the cells of (1) collapse and render the areas transparent,

the crystalline component of (2) change into an amorphous state,

the two reactive components of (3) make contact and react,

the infusible particles of (4) become exposed to the surface, and

the ferroelectric particles of (5) reorientate in a uniform direction, and

cooling said film structure uniformly to solidify the film now having optically contrasting areas corresponding to said image.

3. The use of a resin film structure in a process for producing a photographic record, including the steps of:

establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,

a smooth continuous obverse stratum of said thermoplastic resin, and

a stratum of said resin beneath said obverse stratum containing globules of gas rendering said film structure, opaque,

heating said film structure uniformly to a temperature sufficient to convert said thermoplastic resin, whereby

the globules of gas in the areas of said electrostatic charge pattern collapse thereby

rendering said film structure transparent in said areas, and

cooling said film structure uniformly for solidifying the same.

4. The use of a resin film structure in process for producing a photographic record, including the steps of:

establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,

a smooth continuous obverse stratum of crystalline wax or resin,

a stratum of said wax or resin of uniformly opaque characteristic in the crystalline state beneath said obverse stratum rendering said film structure opaque, and

a continuous base layer,

heating said film structure uniformly to a temperature sufficient to convert said wax or resin, whereby

the crystalline wax or resin in the areas of said electrostatic charge pattern pass into the amorphous state, thereby

rendering said film structure transparent in said areas, and

cooling said film structure uniformly for solidifying the same.

5. The use of a resin film structure in a process for producing a photographic record, including the steps of:

establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,

a smooth continuous obverse stratum of crystalline polyethylene,

a continuous base layer, and

a stratum of said crystalline polyethylene intermediate said obverse stratum and said base layer rendering said film structure opaque,

heating said film structure uniformly to a temperature sufficient to convert said crystalline polyethylene, thereby

transforming said crystalline polyethylene to the amorphous state in the areas of said electrostatic charge pattern, thereby

rendering said film structure transparent in said areas, and

cooling said film structure uniformly for solidifying the same.

6. The use of a resin film structure in a process for producing a photographic record, including the steps of:

establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,

a smooth continuous obverse stratum of crystalline resin,

a continuous base layer, and

a stratum of said crystalline resin intermediate said obverse stratum and said base layer rendering said film structure opaque,

heating said film structure uniformly to a temperature sufficient to convert said crystalline resin, thereby
transforming said crystalline resin to the amorphous state in the areas of said electrostatic charge pattern, thereby
rendering said film structure transparent in said areas, and
cooling said film structure uniformly for solidifying the same.

7. The use of a resin film structure in a process for producing a photographic record, including the steps of:
establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,
two reactive components separated by a fusible resin component and exhibits a uniform color field, and
heating said film structure uniformly to a temperature sufficient to convert said fusible resin, whereby
said fusible resin component flows aside in the areas of said electrostatic charge pattern, thereby
imparting an image of contrasting color on a background of the first said color,
cooling said film structure uniformly for solidifying the same.

8. The use of a resin film structure in a process for producing a photographic record, including the steps of:
establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,
a continuous obverse stratum of thermoplastic resin,
a layer of resin containing encapsulated dyestuff imparting a uniform given color to said film structure, and
a layer of material containing a dye-former reactive with said dyestuff to impart color to said film structure contrasting with said given color,
heating said film structure uniformly to a temperature sufficient to convert at least said layer containing encapsulated dyestuff,
releasing said dyestuff in the areas corresponding to said electrostatic charge pattern for effecting a reaction of said dyestuff and said dye-former for producing an image of said contrasting color upon a background of said given color, and
cooling said film structure uniformly for solidifying the same.

9. The use of a resin film structure in a process for producing a photographic record, including the steps of:
establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,
a continuous obverse stratum of thermoplastic resin,
globules of dyestuff in said resin imparting a uniform field of given color to said film structure, and
a continuous reverse stratum of material containing a dye-former reactive with said dyestuff to impart color to said film structure contrasting with said given color,
heating said film structure uniformly to a temperature sufficient to convert said globules, thereby
collapsing said globules in the areas corresponding to said electrostatic charge pattern for effecting a reaction of said dyestuff and said dye-former for producing an image of said contrasting color upon a background of said given color, and
cooling said film structure uniformly for solidifying the same.

10. The use of a resin film structure in a process for producing a photographic record, including the steps of:
establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,
a sheet of fusible resin and infusible particles em-

bedded within said resin to leave a smooth, specular, reflecting, obverse surface,
heating said film structure uniformly to a temperature sufficient to convert said fusible resin, thereby
exposing said embedded particles in the areas where said electrostatic charge exists, and
cooling said film structure uniformly for solidifying the same, whereby
the exposed particles impart a roughened diffuse reflecting image surface against a specular reflecting background.

11. The use of a resin film structure in a process for producing a photographic record, including the steps of:
establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,
a sheet of fusible resin and particles embedded within said resin,
heating said film structure uniformly to a temperature sufficient to convert said fusible resin, thereby
altering the position of said particles with respect to said sheet of resin in the areas where said electrostatic charge exists, and
cooling said film structure uniformly for solidifying the same, whereby
the optical characteristic of said film structure differs in the charged areas from that in the uncharged areas.

12. The use of a resin film structure in a process for producing a photographic record, including the steps of:
establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,
a plurality of strata of resin, including
a continuous obverse stratum of vinyl resin of given color,
a succeeding stratum of fusible resin,
a following stratum of material reactive with said vinyl resin for imparting a color contrasting with said given color, and
a reverse stratum of high melting point resin,
heating said film structure uniformly to a temperature sufficient to convert said fusible resin, whereby
said fusible resin flows away from the areas corresponding to said electrostatic charge pattern, and
cooling said film structure uniformly for solidifying the same, thereby
forming a photographic record of an image of said contrasting color against a background of said given color.

13. The use of a resin film structure in a process for producing a photographic record, including the steps of:
establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,
a plurality of strata of resin, including
a continuous obverse stratum of vinyl acetate, substantially black,
a succeeding stratum of fusible resin,
a following stratum of zinc-oxide, substantially white, and
a reverse stratum of high melting point resin,
heating said film structure uniformly to a temperature sufficient to convert said fusible resin, whereby
said fusible resin flows away from the areas corresponding to said electrostatic charge patterns, and
cooling said film structure uniformly for solidifying the same, thereby
forming a photographic record of a black image against a white background.

14. The use of a resin film structure in a process for producing a photographic record, including the steps of:
establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,

a fusible resin and elongated particles embedded in random orientation within said resin,
heating said film structure uniformly to a temperature sufficient to convert said resin for enabling reorientation of the particles therein, and
cooling said film structure uniformly for solidifying the same, and whereby
said fusible resin melts uniformly in said heating step permitting said particles to change position in the areas where said electrostatic charge exists, thereby
altering the optical characteristics of said film structure in said areas.

15. The use of a resin film structure in a process for producing a photographic record, including the steps of:
establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,
a fusible resin and elongated dielectric or ferroelectric crystalline particles embedded in random orientation within said resin,
heating said film structure uniformly to a temperature sufficient to convert said resin for enabling reorientation of the particles therein, and
cooling said film structure uniformly for solidifying the same, and whereby
said fusible resin melts uniformly in said heating step permitting reorientation of said particles in uniform direction in the areas where said electrostatic charge exists, thereby
improving the optical transmission characteristic of said film structure in said areas as against the background areas of remaining randomly oriented particles.

16. The use of a resin film structure in a process for producing a photographic record, including the steps of:
establishing an electrostatic charge pattern corresponding to an image to be recorded on a film structure comprising,
a layer of polyethylene and calcium citrate crystal particles embedded in random orientation within said polyethylene,
heating said film structure uniformly to a temperture sufficient to convert said polyethylene for enabling rotation of said calcium citrate crystals therein,
cooling said film structure uniformly for solidifying the same, and whereby
said polyethylene melts uniformly in said heating step permitting reorientation of said crystals in uniform direction in the areas where said electrostatic charge exists, thereby
improving the optical transmission characteristic of said film structure in said areas as against the background areas of remaining randomly oriented crystals.

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