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Goffe

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[45] ***Apr. 8, 1975**

[54] **MIGRATION IMAGING BY SPLITTING A SOFTENABLE MATERIAL**

[75] Inventor: **William L. Goffe,** Webster, N.Y.

[73] Assignee: **Xerox Corporation,** Stamford, Conn.

[*] Notice: The portion of the term of this patent subsequent to June 26, 1990, has been disclaimed.

[22] Filed: **Apr. 6, 1973**

[21] Appl. No.: **348,775**

Related U.S. Application Data

[63] Continuation of Ser. No. 784,164, Dec. 16, 1968, , which is a continuation-in-part of Ser. Nos. 725,676, May 1, 1968, abandoned, and Ser. No. 460,377, June 1, 1965, Pat. No. 3,520,681, and Ser. No. 483,675, Aug. 30, 1965, , said Ser. No. 725,676, is a continuation-in-part of Ser. No. 460,377, , and Ser. No. 483,675, , said Ser. No. 460,377, and Ser. No. , said Ser. No. 483,675, each is a continuation-in-part of Ser. No. 403,002, Oct. 12, 1964, abandoned.

[52] **U.S. Cl.** ..... **117/8;** 96/1 PS; 346/74 ES; 96/1.4

[51] **Int. Cl.** **G03g 13/14;** G03g 13/22

[58] **Field of Search** ..... 96/1.4, 1.5, 1 PS; 117/17.5, 218, 8; 346/74 ES

[56] **References Cited**

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Primary Examiner—Norman G. Torchin
Assistant Examiner—John L. Goodrow

[57] **ABSTRACT**

Providing an imaged member comprising a layer of softenable material and migration material selectively distributed in depth in said softenable material in first image configuration and comprising in addition to said first image pattern of migration material a background of substantial amounts of migration material in said softenable material but spaced apart, in depth, from said first image pattern; and removing said background.

17 Claims, 9 Drawing Figures

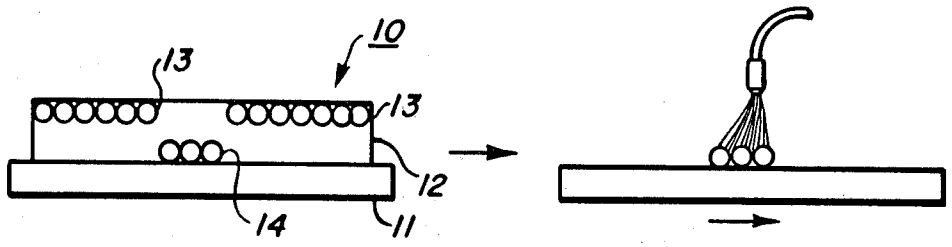


FIG. 1A

FIG. 1B

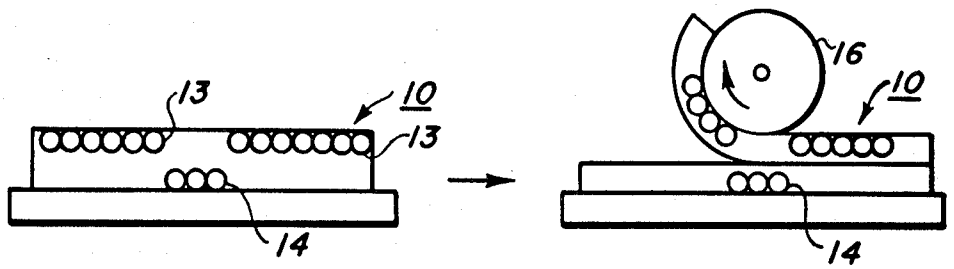


FIG. 2A

FIG. 2B

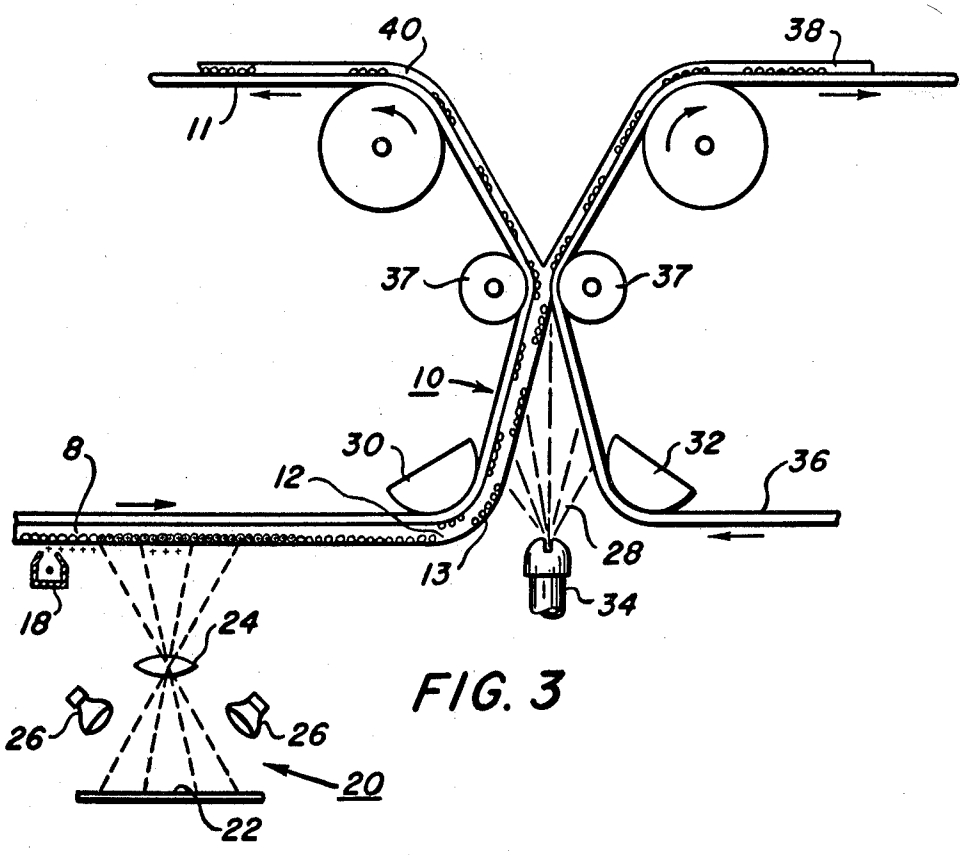


FIG. 3

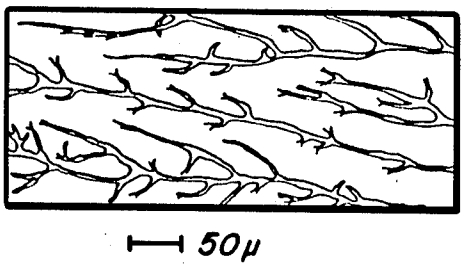


FIG. 4A

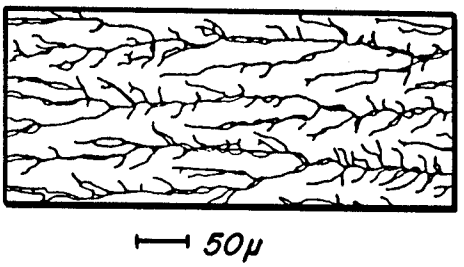


FIG. 4B

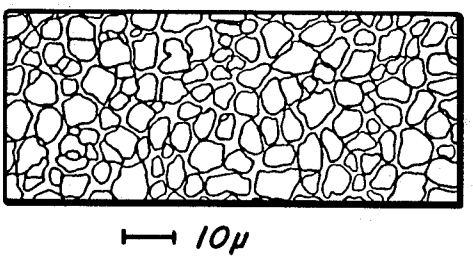


FIG. 4C

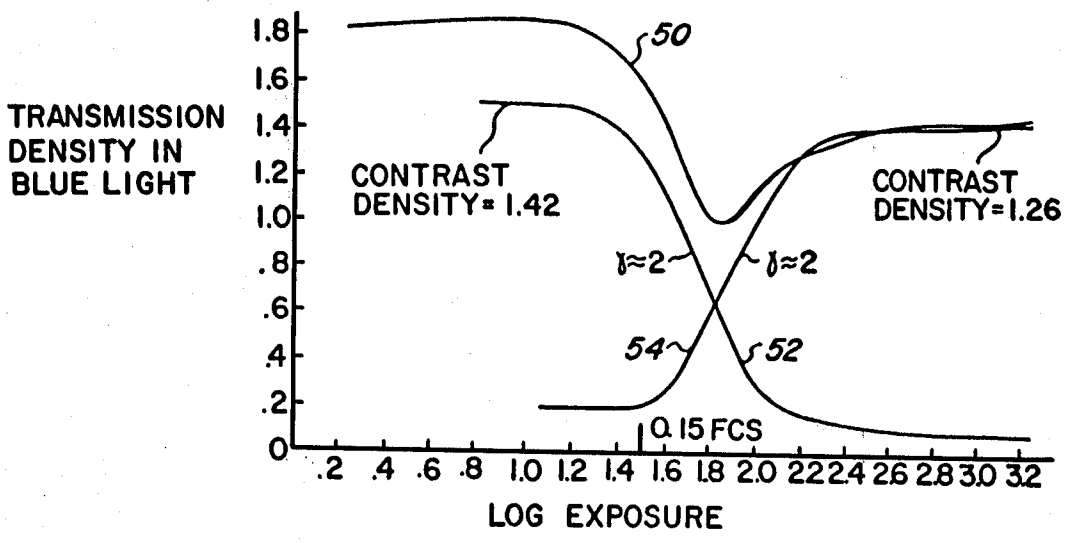


FIG. 5

MIGRATION IMAGING BY SPLITTING A SOFTENABLE MATERIAL

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a continuing application of copending U.S. patent application Ser. No. 784,164, filed Dec. 16, 1968 which is a continuation-in-part of my three copending U.S. patent applications (1) Ser. No. 725,676, filed May 1, 1968, now abandoned; (2) Ser. No. 460,377, filed June 1, 1965, now U.S. Pat. No. 3,520,681 and (3) Ser. No. 483,675, filed Aug. 30, 1965. Patent application (1) is a continuation-in-part of applications (2) and (3) which are both continuations-in-part of my application Ser. No. 403,002, filed Oct. 12, 1964, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates in general to imaging, and more specifically to a migration imaging system and novel, surprising and advantageous modes of enhancing the usability and versatility of migration imaged members.

There has recently been developed a migration imaging system capable of producing high quality images of high density, continuous tone and high resolution, an embodiment of which is described in my aforementioned copending application Ser. No. 460,377. Generally, according to an embodiment thereof, an imaging member comprising a substrate with a layer of softenable material, containing photosensitive particles, overlying the substrate is imaged in the following manner: a latent image is formed on the member, for example, by uniformly electrostatically charging and exposing it to a pattern of activating electromagnetic radiation. The imaging member is then developed by exposing it to a solvent which dissolves only the softenable layer. The photosensitive particles which have been exposed to radiation migrate through the softenable layer as it is softened and dissolved, leaving an image of migrated particles corresponding to the radiation pattern of an original, on the substrate with the material of the softenable layer substantially completely washed away. The particle image may then be fixed to the substrate. For many preferred photosensitive particles, the image produced by the above process is a negative of a positive original i.e., the resultant particle image corresponds to the light struck portions of the imaging member. However, positive to positive systems are also possible by varying imaging parameters. Those portions of the photosensitive material which do not migrate to the substrate are washed away by the solvent with the softenable layer.

As disclosed therein, and as further described and claimed in my copending application Ser. No. 725,676, filed May 1, 1968, by other developing techniques, the softenable layer may at least partially remain behind on the supporting substrate.

In general, three basic imaging members may be used: a layered configuration which comprises a substrate coated with a layer of softenable material, and a fracturable and preferably particulate layer of photosensitive migration material contiguous i.e., at or embedded near the upper surface of the softenable layer; a binder structure in which the photosensitive migration particles are dispersed in the softenable layer which overcoats a substrate; and an overcoated structure in which a substrate is overcoated with a layer of softenable material followed by an overlayering of photosensitive particles and a second overcoating of softenable material which sandwiches the photosensitive particles. Fracturable layer or material as used herein, is intended to mean any migration layer or material, including a migration layer comprising particles, which is capable of breaking up during development and permitting portions to migrate towards the substrate in image configuration.

"Contiguous," for the purposes of this invention, will be defined as in Webster's New Collegiate Dictionary, second edition, 1960; "In actual contact; touching; also, near, though not in contact; adjoining."

The imaging system of application Ser. No. 460,377 generally comprises a combination of process steps which include forming a latent image and developing with solvent liquid or vapor, or heat or combinations thereof to render the latent image visible. In certain methods of forming the latent image, non-photosensitive or inert, fracturable layers and particulate material may be used to form images, as described in copending application Ser. No. 483,675, filed Aug. 30, 1965, wherein an electrostatic image is formed by a wide variety of methods including charging in image configuration through the use of a mask or stencil; first forming such a charge pattern on a separate photoconductive insulating layer according to conventional xerographic reproduction techniques and then transferring this charge pattern to the imaging member by bringing the two layers into very close proximity and utilizing breakdown techniques as described, for example, in Carlson U.S. Pat. No. 2,982,647 and Walkup U.S. Pats. Nos. 2,825,814 and 2,937,943. In addition, charge patterns conforming to selected, shaped, electrodes or combinations of electrodes may be formed by the TESI discharge technique as more fully described in Schwertz U.S. Pats. Nos. 3,023,731 and 2,919,967 or by techniques described in Walkup U.S. Pats. Nos. 3,001,848 and 3,001,849 as well as by electron beam recording techniques, for example, as described in Glenn U.S. Pat. No. 3,113,179.

The characteristics of the images produced are dependent on such process steps as charging, exposure and development, as well as the particular combination of process steps. High density, continuous tone and high resolution are some of the image characteristics possible. The image is generally characterized as a fixed or unfixed particulate image with or without a portion of the softenable layer and unmigrated portions of the layer left on the imaged member, which can be used in a number of applications such as microfilm, hard copy, optical masks, and strip out applications using adhesive materials.

As described in application Ser. No. 725,676 by some modes of this new migration imaging system, migration material from a layer of migration material is caused to migrate in image configuration, in depth, in a softenable layer towards a substrate (typically for the softenable layer) by reason of the mechanism of softening the softenable material or otherwise making it more permeable to permit imagewise migration of the migration layer in depth in the softenable material as opposed to the dissolving away or washing away of the softenable material to cause migration of fracturable material to the substrate. This results typically in a migration material background, which may be in image

pattern, of relatively unmigrated migration material at a different depth in the softenable material of the imaged member.

This background may lower contrast where, for example, the imaged member is to be used as a projection transparency.

Thus, there is a need for a system to render imaged members as just described more readily viewable and otherwise more readily usable and specifically to remove this background of typically relatively unmigrated migration material.

As described in application Ser. No. 403,002, now abandoned, especially at p. 7, lines 1–24 and in claims 7, 8, & 12; in application Ser. No. 460,377 at p. 6, line 29 to p. 7, line 15 and in claims 9 & 12 and in application Ser. No. 483,675 at p. 7, line 26 to p. 9, line **6,** Example I and in claims 5 & 12; all portions hereby being expressly incorporated herein by reference, I have previously described how migration imaged members may have their background removed by wash-away methods, abrading away or by adhesively stripping to yield complementary positive and negative images. Also, parent application Ser. No. 725,676 specifically treats the same subject at numerous places and because of the detailed description of techniques to create the imaged members which are operated upon by the invention hereof the entire disclosure of the specification and claims of application Ser. No. 725,676 is hereby expressly incorporated herein by reference.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to provide a system of removing the background migration material from an imaged member comprising a layer of softenable material and migration material selectively distributed in depth in said softenable material in image configuration, to overcome the above-noted disadvantages and satisfy the above-noted wants.

It is a further object of this invention to provide a system of producing additional split images.

It is a further object of this invention to provide a system of producing additional strip images.

It is a further object of this invention to provide a system of simultaneously producing complementary positive and negative images.

It is a further object of this invention to provide a system of simultaneously producing fixed complementary positive and negative images.

It is a further object of this invention to provide a solvent wash-away mode of removing said background material.

It is a still further object of this invention to provide mechanical splitting means to remove said background material.

It is a still further object of this invention to provide means of abrading away said background material and adjacent portion of softenable material, to thereby remove said background material.

It is a still further object of this invention to provide imaged members usable per se which are converted or treated in various ways by this invention, for example, to improve their optical character or to enhance their usability as an image.

It is a still further object of this invention to provide a system to substantially simultaneously develop and split migration imaged members.

The foregoing objects and others are accomplished in accordance with this invention by providing an imaged member comprising a layer of softenable material and migration material selectively distributed in depth in said softenable material in image configuration and comprising in addition to said first image pattern of migration material a background of substantial amounts of migration material in said softenable material but spaced apart, in depth, from said first image pattern; and removing said background.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention as well as other objects and further features thereof, reference is made to the following detailed disclosure of this invention taken in conjunction with the accompanying drawings wherein:

FIG. **1** is a partially schematic drawing of an embodiment of an imaged member hereof, A, Wherein the background of relatively unmigrated particles is removed, B, by a solvent flush technique.

FIG. **2** is a partially schematic drawing of an embodiment of an imaged member hereof, A, wherein the background of relatively unmigrated particles is removed, B, by an optimum, surprising and advantageous mechanical splitting mode.

FIG. **3** is a partially schematic diagram of an automatic vapor development-mechanical splitting system.

FIGS. **4**A – C are drawings of, **4**A and **4**B about 175X and **4**C about 900X photomicrographs of strand patterns of vapor developed and then mechanically split imaged members made in a system similar to that shown in FIG. **3,** for high, medium and low vapor concentrations, respectively.

FIG. **5** represents a plot of transmission density in blue light versus log exposure for the migration image itself, curve **50,** and for its split images i.e., both the image remaining behind on the aluminized mylar substrate, curve **54,** and the image on the stripping layer, curve **52.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. **1**A, there is shown imaged member **10** comprising a background of relatively unmigrated particle portions **13** and migrated particle portions **14** which have migrated completely through softenable layer **12** to the softenable layer **12**-substrate **11** interface.

Background as used herein refers to, in an imaged member comprising migration material selectively distributed in depth in a softenable material in a first image configuration, substantial amounts (such that, for example, removal of said amounts noticeably changes the optical character of said imaged member) of migration material also in said softenable material but spaced apart in depth from said first image configuration of migration material, which background may take the form of a second image pattern of migration material complementary to said first image configuration which migration material may be substantially unmigrated or relatively unmigrated compared to the migration of said first image configuration of migration material.

While this imaged member in its **1**A form has many uses as described in copending application Ser. No. 725,676, in some imaging applications, it is found that

the removal of background portions **13** of migration material eliminates the sometimes undesirable optical effect of this material. For example, when imaged member **10** is used as a projection transparency, assuming substrate **11** and the material comprising the softenable layer **12** are at least partially transparent to the projecting light, a more distinctly visible projected image is produced by the effect of particles **14** on substrate **11** upon removal of background **13,** which provides for a sharper and more contrasty projected image.

Any suitable mode of removing either the relatively migrated image pattern comprising particles **14** or the background of relatively unmigrated particles **13** in an image pattern complementary to that formed may be used. Three methods are found to be preferred herein (a) solvent wash as illustrated in FIG. 1; (b) mechanical splitting (which is the optimum mode) as shown in FIGS. **2, 3** and **4** and (c) abrading away the background migration material, with adjacent portions of softenable material.

In the solvent wash-away mode of removing background portions of migration material, a liquid solvent at any time after the formation of the imaged member may be applied to the imaged member to wash-away layer **12** and in the case illustrated in FIG. **1** the relatively unmigrated portions **13.** In this regard, it is noted that the liquid solvent applied to the imaged member for wash-away need not be insulating; conductive liquids may be used.

Referring now to FIG. **2,** there is again shown an embodiment of an imaged member **10** similar to that shown in FIG. 1A, which is caused by the optimum and surprising mode of splitting, to be mechanically split on the average along a plane, typically approximately in the middle of the thickness of layer **12** when vapor softening is used in the splitting operation, thus causing the background of relatively unmigrated particles **13** to be mechanically split away from the relatively migrated particles **14** which are, illustratively, left with a substantial amount of softenable material surrounding them to create simultaneously complementary positive and negative fixed images. Splitting is accomplished preferably by contacting the free surface of the softenable layer with a solid stripping member. The stripping member and the matrix optionally on a substrate are pulled opposite to one another until the matrix separates-splits-into two parts. This preferred mode of strip splitting is accomplished in FIG. **2B** by contacting roller **16** with the free surface of the softenable layer to at least slightly tack the roller to the top of the layer whereupon an upward force is exerted on that portion of the softenable layer to surprisingly cause a splitting away and a separation of the top portion of the softenable layer with its image pattern from the bottom portion of the softenable layer with its image pattern.

A preferred strip-splitting technique herein which also substantially simultaneously accomplishes migration development is to latent image i.e., apply a migration force to the migration layer of a migration imaging member by any of the techniques amply described in the aforementioned copending applications, and then develop i.e., soften the matrix **12** by contacting the latent imaged member to a softening liquid for the softenable layer, the liquid carried on a stripping member. Typical softening liquids include at least partial solvents for the softenable material which are not complete solvents for the migration material. But softening liquids also include liquids which mainly swell softenable material **12.** Typical softening liquids are described in application Ser. No. 725,676. The stripping member, softening liquid layered side down is placed against, typically a free surface of the softenable layer and then stripped apart to create complementary positive and negative split images. A preferred mode of layering a softening liquid on the stripping member is to fix on the surface a layer of rupturable (typically and preferably, pressure rupturable) capsules containing a softening solvent. Then when the stripping member is contacted with the imaging member the two are pressed together sufficiently to rupture the capsules to release the liquid which causes migration. Stripping of the stripping member then causes splitting of the imaged member to create complementary images. One convenient mode of contacting a stripping member to an imaged member is to use a stripping sheet or web and pass it with the imaged member in a sandwich configuration through opposed pressure rollers. Any suitable capsules and methods for making and layering same may be used as described in Brynko U.S. Pat. No. 3,357,354 and references cited therein.

Referring now to FIG. **3** there is shown a system for automatically vapor developing and mechanically splitting to produce substantially simultaneously, positive and negative images.

As an elongate strip of imaging member **8** advances from a supply towards shoe **30,** an imagewise migration force is applied to migration layer **15** by the optimum electrical-optical mode, described in detail in application Ser. No. 725,676 of electrically charging the imaging member, for example, by corona discharge device **18,** shown to be emitting positively charged ions to the surface of the imaging member followed by exposure at exposure station **20,** whereat an original **22** to be reproduced is projected onto the image surface by means of lens **24** operating in conjunction with lighting means, for example, light bulbs **26,** the lens, original and lighting means synchronized by apparatus well known in the art (not shown) to the motion of imaging member **10.** After the imagewise migration force is applied, the imaging member **10,** at this point typically a latent imaged member is then developed i.e., the material from migration layer **13** is caused to imagewise migrate in depth in layer **12** by advancing imaging member **8** into the vapor **28** from nozzle **34,** the vapor a softening agent for softenable material **12.** Of course, this method of causing the imagewise migration in depth just described, in relation to FIG. **3,** is illustrative only and any suitable method may be used including all of those described in copending application Ser. No. 725,676. Vapor **28** also imbues the desired amount of tack to the free surface of softenable layer **12** so that when stripping member **36** in web form is advanced past shoe **32** and is converged (preferably in non-skidding contact) against the free surface of layer **12,** illustratively, through a wringer arrangement provided by pressure rolls **37,** and thereafter when web **36** and imaged member **10** are caused to diverge or to be stripped apart the imaged member **10** is caused to be mechanically split, approximately in half, on the average along a plane about one-half the thickness of the softenable layer.

Splitting results have been obtained with layer **12** thicknesses from about 0.5 microns up to about 16 mi-

crons. However, optimum results are obtained with layer **12** thicknesses from about 0.5 to about 2 microns. Thicker films produce larger strands and some disturbance of the particles. The average splitting plane in the device of FIG. **3** is about half way into the plastic layer for layer **12** thicknesses from about 0.5 to about 1.5 microns. As the film thickness increases about about 1.5 microns, the average plane moves proportionately deeper, i.e., closer to the substrate **11,** up to about two-thirds of the layer **12** thickness for layer **12** thicknesses of about 2.5 microns.

While the description herein has centered mainly on layered configuration imaging members as described more specifically in application Ser. No. 725,676; binder member structures as described more specifically in copending application Ser. No. 634,757, filed Apr. 28, 1967, now abandoned, may also be used. In binder structures, the average splitting plane may shift substantially according to the migration image. In the migrated areas, it may become less deep in the matrix, presumably because of the extended particle-plastic interface and the lower particle to plastic concentration in the splitting zone.

Shoes **30** and **32** permit imaging member **8** and stripping member **36** to slide freely past without scratching and may be composed of or surface coated with any suitable slippery material for example, Teflon, polytetrafluoroethylene film. The shoes act as a bearing surface to determine the input angle as the two layers converge before being pressed together in the wringer arrangement provided by rollers **37.** Rollers may be used in place of the shoes.

The split image portion **38** carrying the background of relatively unmigrated particles is carried away with stripping web **36,** for example, to a take up spool and the split portion **40** carrying the relatively migrated particles, which are shown to have migrated all the way to substrate **11,** are taken to their storage place.

When splitting is done with heat softening, that is a heat roller nip and no solvent vapor, the average splitting plane position is controllable being nearer the hotter roller.

The stripping member material may be in any suitable form, such as sheet material, a continuous layer of material similar to web **36** or in the form of a surface of a roller, illustratively roller **16** in FIG. **2,** and of any suitable material such as paper, metal, glass, resins or plastics, which adheres sufficiently to the free surface of layer **12** after migration to substantially strip away the background. Preferred stripping layer materials were found to include adhesive tape type materials, Mylar film, Baryta coated paper, aluminized Mylar and glass. Preferred stripping layers will change with process and material changes. Process parameters will also change depending on the processes and materials used. For example, when solvent vapor development is used to cause migration as shown in FIG. **3,** it is found that stripping occurs without any additional mode of tacking layer **12,** but for heat softening migration development, it is often found preferable to soften and tackify the surface of layer **12** by further heat or vapor before pressing the stripping surface into contact with the surface of layer **12.**

While the splitting plane, on the average is in the middle of layer **12,** when observed microscopically the separating region or splitting zone, appears to take the form of strands as one might expect in pulling a finger free of a film of molasses. It is found that these strands do not substantially disturb particles which have not substantially migrated or particles which have migrated all the way to the substrate, but may move particles which are relatively close to or caught in the splitting zone. However, when the film is softened after splitting which may be an additional preferred process step in some embodiments of this invention, most of these particles are found to move back to their original position as the film smooths over.

By varying such splitting parameters as the film angles in the wringer, the vapor flow and splitting speed, a wide variety of strand patterns and sizes may be obtained. However, several different combinations of parameters produced the same patterns.

FIG. **4** illustrates three types of patterns obtained as the vapor **28** flow and concentration were decreased, causing the viscosity of the matrix of softenable layer **12** to increase going from FIG. **4A** to FIG. **4C.** At very high viscosities very small strands formed a pattern of cells about 5 to 10 microns in diameter as shown in FIG. **4C.** This pattern produced the least net displacement of particles when the strands were smoothed over by a short post split exposure to solvent vapor.

Referring now to FIG. **5** there is illustrated the plots of transmission density in blue light versus log exposure for the migration image itself, member **10** in FIG. **3,** curve **50,** and for its split images i.e., both the image remaining behind on the aluminized Mylar substrate, curve **54,** and the image on a stripping layer of Mylar film, curve **52,** where the imaging member **10** constitutes an aluminized Mylar (the thin aluminum layer over the Mylar support being about 50 percent white light transmissive) substrate **11,** about a two micron layer of a softenable layer of a copolymer of styrene and hexylmethacrylate and where migration layer **13** is about a 0.25 micron microscopically discontinuous layer of amorphous selenium. After splitting the above described imaging member in a system as shown in FIG. **3,** at speeds of from about 0.4 to about 5 inches/-second, as shown in FIG. **5,** a contrast density of each of the split images of from about 1.2 to about 1.4, (the background density including the film base being from about 0.1 to about 0.2) a gamma of about 2 and a film sensitivity faster than that of cascade xerography with commercial amorphous selenium plates were realized. Resolutions were in excess of 228 lp/mm for both split images.

Adding up the time to form the migration image (electrically) charging, exposing and the initial vapor softening) (5 seconds) the time for splitting the image (1 second) and the time to smooth the film (2 seconds) the total time to obtain the two complementary images with the aforementioned excitingly excellent photographic characteristics was about 8 seconds. Faster splits to produce quality images may be made especially if in fabrication of imaging member **8,** a special interlayer within the softenable layer is used which prompts splitting to occur along this interlayer plane. Such a layer may comprise zinc stearate particles and should permit imaging particles to migrate through the interlayer while the interlayer remains in position.

Still another preferred technique of removing background in an imaged member according to this invention is by abrading it away. Typically the relatively unmigrated particles are abraded away but the substrate and the relatively migrated particles may be abraded

away to leave a background image pattern of migration material which may, if desired, then, if not previously, be layered on a suitable mechanical support. This technique has its advantages but does not provide for complementary positive and negative images as in the optimum split process.

The following Examples further specifically define the present invention with respect to removing background from a migration imaged member according to the invention. The parts and percentages are by weight unless otherwise indicated. The Examples below are intended to illustrate various preferred embodiments of the background migration material image removing system of this invention.

EXAMPLE I

A layered configuration imaging member is made by forming about a 2 micron thick layer of Staybelite Ester 10 on about a 3 mil thick substrate of Mylar film overcoated with a thin aluminum layer being about 50 percent visible light transmissive. The migration layer is formed contiguous the free surface of the softenable layer by depositing about a 0.5 micron layer of indigo carried by cascading about 50 micron steel beads carrying the indigo particles over the Staybelite layer and subsequently softening the Staybelite layer to seat and embed the indigo particles in the Staybelite.

The member is uniformly electrostatically charged, exposed to a light image and then exposed to the vapors of trichlorotrifluorethane available as Freon 113 from DuPont, causing the indigo particles to substantially completely migrate in only the exposed areas, to the softenable layer-substrate interface with the unexposed particles remaining behind, substantially unmigrated.

The migration image is converted to a more readily visible and higher contrast transparency by strip-splitting the unmigrated particles with about the upper half of the softenable layer while leaving the migrated particles on the original aluminized Mylar support embedded in softenable layer material, in a fixed condition.

Stripping is accomplished by pressing (outside of the vapor development chamber, in air, while the Staybelite is still soft from the previous vapor softening,) the imaged member against a stripping sheet of pressure sensitive adhesively coated Mylar which is gently pressed against the top of softened layer **12,** followed by pulling the Mylar stripping sheet and the imaged member apart. Each split image has a gamma (γ) of about 1, a maximum contrast density of about 0.8 in red light with resolutions greater than about 100 line pairs per mm.

EXAMPLES II -IV

Example I is followed except stripping sheets of Baryta coated paper, aluminized Mylar and glass are used, respectively, with similar results to create complementary positive and negative images with the split images on these stripping sheets giving somewhat lower resolutions.

EXAMPLES V -VII

A layered configuration imaging member is made as in Example I except that the migration layer is made up of iron, zinc oxide and indigo, respectively, and a latent electrostatic image is formed on the member by corona charging through a metal mask and the layer is softened by exposing to a solvent vapor to cause particles in the charged areas to migrate to the substrate and leave in the non-charged areas, the migration layer substantially unmigrated.

The last paragraph of Example I is then followed to simultaneously create complementary positive and negative images similar in character to those formed in Example I.

EXAMPLES VIII -X

Example VII is followed except that Baryta coated paper, aluminized Mylar and glass, respectively, are used as the stripping layer with results similar to those in Example VII to create complementary positive and negative images.

EXAMPLE XI

An imaging member according to Example VII is latent electrostatically charged as in Example VII and then heat softened by subjecting the latent image member to hot air to raise the softenable material to a temperature of about 100°C. for about 5 seconds to cause the particles in the charged areas to migrate to the substrate and to cause substantially no migration in the uncharged areas.

The last paragraph of Example I is then followed to simultaneously create complementary positive and negative images similar in character to those formed in Example I.

EXAMPLES XII -XIV

Example XI is followed except that Baryta coated paper, aluminized Mylar and glass are respectively used as the stripping layer.

EXAMPLE XV

A layered configuration imaging member is made by forming about a 4 micron thick layer of Piccotex 100 on about a 3 mil thick substrate of Mylar film. Over the softenable layer is layered a pigment binder dispersion made by adding X-form metal-free phthalocyanine prepared as described in Byrne et al. U.S. Pat. No. 3,357,989, Piccotex 100 in a dry weight ratio of pigment to softenable layer material of about 1 to 3, about 10 parts of toluene and about 20 parts of one-eighth inch low carbon steel balls in about a 2 ounce jar and agitating in a Red Devil Quickie Mill for about 30 minutes which forms a fried migration binder layer of about 2 microns thick.

An imagewise migration force is applied to the member by uniformly electrostatically charging the member to a positive surface potential of about 4,000 volts using single-sided corona charging employing a grounded plate and contact exposing to a positive transparency with the white light exposure in exposed areas being about 0.10 f.c.s. with substantially no exposure in the unexposed areas.

The latent imaged member is softened by exposing the member to the vapors of toluene for about 5 seconds which produces complete development to cause substantially no migration in exposed areas and substantial migration of particles in unexposed areas to produce a pigment to binder weight ratio (in unexposed substantial migration areas) at about the substrate-softenable layer greater than about **1** pigment to about **1** binder.

The imaged member is then further softened by subjecting it to hot air at about 120°C. for about 5 seconds while contacting the free surface of the softenable layer to a stripping member of a sheet of Mylar. The stripping sheet and the image member are then separated to cause the unmigrated particles to be split off producing a negative image split off and positive image left behind on the original substrate either one of which may be used as a projection transparency or viewed directly by eye in transmitted light.

EXAMPLE XVI

An imaging member is made by forming about a 1.5 micron layer of a custom synthesized copolymer of polystyrene and hexylmethacrylate on an aluminized Mylar substrate, the migration layer, contiguous the free surface of the softenable layer, being about a ¼ micron layer of about ¼ micron selenium particles.

The member is uniformly electrostatically charged to a surface potential of about +150 volts, exposed to a light image through a step tablet with the maximum exposure being about 9 f.c.s. of white light and then exposed to the vapors of trichoroethane for about 5 seconds by positioning the latent imaged member adjacent the top of a gallon bottle containing fluid solvent in the bottom.

Stripping is accomplished by pressing about a 3 mil thick Mylar polyester film, using the apparatus illustrated in FIG. **3,** but using a splitting solvent vapor of methylene chloride, a splitting speed of about 1 inch/second with roller pressure of about 7 lbs/linear inch between a pair of rollers corresponding to rollers **37** in FIG. **3,** the rollers about 3 millimeters in diameter. Excellent split images are obtained with photographic characteristics similar to those of the split images shown in FIG. **5.** Both images are glazed over to remove any strand patterns remaining after splitting by exposing each split image to the vapors of trichloroethane for about 3 seconds.

EXAMPLE XVII

Example XVI is followed except that the imaging member is charged negatively and developed by heating at about 120°C. for about 5 seconds to produce the migration image. The split images with photographic characteristics similar to those of Example XVI are obtained except that the images exhibit lower densities, with maximum contrast densities in each of about 1.

EXAMPLE XVIII

Example XVI is followed except that the splitting speed is about 5 inches per second with a higher concentration of vapor coming from the nozzle of the splitting device illustrated in FIG. **3.** Images similar to those resulting in Example XVI are obtained.

EXAMPLE XIX

Example XVI is followed except that the original is a resolution target, and the maximum exposure in light struck areas of the imaging member is about 2.5 f.c.s.

The resulting split images exhibit resolutions greater than 228 line pairs/mm with maximum contrast in blue light being above 1.3, the split surface of each split image, when magnified about 900 times exhibiting a splitting strand pattern similar to that illustrated in FIG. **4C.**

EXAMPLE XX

Example XVI is followed with similar results, except that the splitting solvent vapor is 1-1-1, trichlorethane at a higher vapor concentration.

EXAMPLE XXI

Example XVI is followed with similar results except that the splitting solvent is an azeotrope composition of Freon 113 in methylene chloride, available as Freon TMC from DuPont.

EXAMPLES XXII

Example XVI is followed and the split images are then dipped in 1-1-1, trichloroethane liquid solvent to produce particle wash-away images having no plastic coating, of the type described in application Ser. No. 403,002.

EXAMPLE XXIII

Example XVI is followed except that the stripping member has a layer of Kodak Photo Resist layered on the side of the stripping member facing the imaging member. The photoresist layered resulting split image is exposed for a few seconds through the split image using the migrated particles as an optical mask. Said split image is then immersed in trichloroethylene to obtain a resist image, solvent etching removing all the softenable material and the KPR in unmasked KPR areas.

EXAMPLE XXIV

Example XVI is followed with similar results except that the stripping member is aluminized Mylar with the aluminized layer facing the imaging member during stripping.

EXAMPLE XXV

Example XVI is followed with similar results except that the stripping member is about a 6 millimeter diameter glass roller and splitting is done by rolling the roll over the migration imaged film at the mouth of the developing chamber.

EXAMPLE XXVI

An imaging member according to Example XVI is charged to a surface potential of about +150 volts, exposed with white light through a positive line copy transparency, with about 2.5 f.c.s. exposure in the maximum illuminated areas, (darker image areas in a relatively lighter background) and then solvent softening developed for about one-half second which occurs simultaneously with splitting by using a stripping member which is a NCR carbonless paper having encapsulated solvent facing the imaging member.

Splitting and developing are simultaneously accomplished by passing the latent imaged member together with and facing the solvent encapsulated side of the NCR paper between two rollers which crushes the capsules releasing the solvent to develop and soften the film for splitting upon separation.

The results are a positive image on the paper stripping member and a negative image on the imaging member substrate.

EXAMPLE XXVII

An imaging member as in Example XVI is provided

except that the softenable layer is a phenylmethyl silicone resin available under the designation R5062A from Dow Corning.

The imaging member is electrostatically charged to a uniform surface potential of about +100 volts exposed with white light with the exposure in the light struck areas being about 5 f.c.s. and solvent vapor developed using 1-1-1, trichloroethane for about 5 seconds. Stripping is accomplished by utilizing a stripping member of adhesively coated Mylar, and stripping manually in air by lightly contacting the members and pulling them apart, to produce split images with a maximum contrast density of about 1 with resolutions of about 100 lp/mm.

EXAMPLE XXVIII

An imaging member as in Example XVI is provided except that a mixture of Monastral Red B, a quinacridone pigment from DuPont and indigo particles constitute the migration layer in place of the amorphous selenium particles.

The imaging member is imaged by uniformly electrostatically charging it to a surface potential of about −100 volts and exposing with white light through a transparency of red and green light transmitting strips with exposure in the exposed areas being about 200 f.c.s. with vapor development following using Freon 113 for about 10 seconds.

Splitting is accomplished as in Example XXVII with Indigo only resulting on the imaging member substrate in red exposed areas and on the stripping member in the green exposed areas. The opposite effect is achieved for the Monastral Red B as the Monastral Red appears only on the imaging member in the green exposed areas and on the stripping member in the red exposed areas.

EXAMPLE XXIX

An imaging member is prepared by forming on an aluminized Mylar substrate, a softenable layer about 2 microns thick of a Staybelite Ester 10 binder and zinc oxide particles about 0.5 microns in average diameter uniformly dispersed throughout the upper half of the softenable layer in a dry weight ratio of pigment to softenable material binder of about 1/1. The migration layer is about a 0.5 micron thick layer of iron powder embedded at the upper surface of the softenable layer.

The member is latent imaged by uniformly electrostatically charging it to a negative surface potential of about 240 volts and exposing it to an optical image with exposure in exposed areas being about 200 f.c.s.

The latent imaged member is developed by exposing it to the vapors of Freon 113 for about 10 seconds to migrate the iron particles and zinc oxide particles in only the unexpected areas.

The stripping member is adhesively coated Mylar and splitting proceeds as in Example XXVII to give complementary split images with the iron and zinc oxide particles on the imaging member only in the unexposed areas with substantially only zinc oxide particles on the imaging member in the light exposed areas with a complementary image on the splitting member.

EXAMPLE XXX

A binder configuration imaging member is formed by layering the pigment-binder dispersion of Example XV directly onto about a 3 mil thick substrate of Mylar film. The member is imaged as in Example XV with results similar to Example XV, except there was background density on the imaging member after splitting and that the average splitting plane was higher up in the unexposed migrated areas with a maximum red light contrast density of about 1 for both images.

EXAMPLE XXXI

An imaging member as in Example XVI is imaged by uniformly electrostatically charging it to a −100 volt surface potential and exposing it with white light through a negative transparency with maximum exposure being about 2 f.c.s., development being accomplished by heating for about 20 seconds at about 110°C.

Splitting is accomplished by using a Mylar splitting layer about 3 mils thick and apparatus similar to that in FIG. 3 except that no vapor is used and the left roller 37 in FIG. 3 is at 70°C. while the right roller is about 140°C. with the roller pressure being about 7 lbs/linear inch with a pair of about 3 mm. diameter rollers and a splitting speed of about 0.3 inches/second.

The split images are then glazed to remove any strand pattern by exposing the split images to vapors of Freon TMC.

A high contrast positive image on the original film base is formed having a resolution in excess of 228 lp/mm and a maximum blue light contrast density of about 0.9 with a lower contrast negative image on the stripping member with an average splitting plane near the upper surface of the softenable plastic layer.

EXAMPLE XXXII

Example XXXI is followed except the left pressure roller 37 is at about 140°C. and the right roller is about 70°C. which results in a relatively lower contrast density positive image on the original film base and a higher contrast density image on the stripping member i.e., with a contrast density of about 1.2, with an image resolution in both members in excess of 100 lp/mm.

As a structure alternative or modification to enhance splitting, although excellent images have been obtained with the structures and materials described, the softenable layer 12 may be made up of two or more different layers of softenable material layered one on top of another with the interface between an upper and lower softenable layers serving as the splitting plane and which would be preferably between the relatively migrated particles and the background which would result typically when in image members hereof migration material is caused to imagewise migrate across said softenable material layer-softenable material layer interface. By using this configuration, it is possible to soften one layer more than the other and thus promote separation at the interface during stripping. By doing this, separation could be nearer the substrate or nearer the upper surface according to which is preferred rather than about the half way splitting that is found to occur where a single substantially homogeneous softenable layer is used. Splitting along the interface creates complementary split images, one above and one below the interface.

Although specific components and proportions have been stated in the above description of preferred embodiments of the background removing system of this invention, other suitable materials as listed herein may be used with similar results. In addition other materials

may be used herein and variations may be made in the various processing steps to synergize, enhance or otherwise modify the properties of this invention. For example, stripping may be enhanced by utilizing a stripping sheet which impregnates and hardens the upper region of the softenable layer to cause splitting at about the interface between the hardened and unhardened areas.

Also, as shown in the Examples:

a. The stripping member and the substrate **11** may have a light sensitive layer thereon which layer is exposed using the split migration image as an optical mask, as further described in application Ser. No. 725,676.

b. More than one kind of migration material may be used in the same imaging member such that upon splitting one kind of material results in one split member and the other kind of material in the other split member. This result may be obtained for example, by using a migration layer composed of two different color sensitive particles which are exposed to a color image.

c. Also, of course, the split images may be converted to particle wash-away images of the type described in application Ser. No. 403,002 by solvent wash-away development of split members.

d. The particles of the split members may be reacted with a chemical to make them visible or to enhance the contrast of the images.

It will be understood that various other changes in the details, materials, steps and arrangements which have been herein described and illustrated in order to explain the nature of the invention will occur to and may be made by those skilled in the art upon a reading of this disclosure and such changes are intended to be included within the principle and scope of this invention.

What is claimed is:

1. An imaging method comprising the steps of:

a. providing an imaged member comprising a layer of softenable material and migration material distributed in depth in said softenable material in first image pattern configuration, and comprising in addition to said first image pattern of migration material a background of migration material in said softenable material and spaced apart, in depth, from said first image pattern, said background being in a second image pattern of migration material complementary to said first image pattern configuration of migration material; and

b. removing said second image pattern of migration material by splitting the softenable layer on the average in a plane substantially between the first image pattern configuration of migration material and the second image pattern of migration material.

2. An imaging method according to claim **1** wherein said second image pattern of migration material is substantially unmigrated compared to the migration of said first image configuration of migration material.

3. An imaging method according to claim **1** wherein said first image configuration of migration material is contiguous to a substrate for said softenable layer.

4. An imaging method comprising the steps of:

a. providing an imaged member comprising a layer of softenable material and migration material distributed in depth in said softenable material in first image pattern configuration, and comprising in addition to said first image pattern of migration material a background of migration material in said softenable material and spaced apart, in depth, from said first image pattern, said background being in a second image pattern of migration material complementary to said first image pattern configuration of migration material; and

b. removing said second image pattern of migration material by abrading away said second image pattern of migration material.

5. An imaging method according to claim **4** wherein said second image pattern of migration material is substantially unmigrated compared to the migration of said first image configuration of migration material.

6. An imaging method according to claim **4** wherein said first image configuration of migration material is contiguous to a substrate for said softenable layer.

7. An imaging method comprising the steps of:

a. providing an imaging member comprising a layer of softenable material, said softenable material containing migration material, said softenable material capable of being solvent softened to allow both migration of migration material in depth in said softenable material and splitting of the member;

b. providing an electrostatic latent image on said imaging member;

c. providing a stripping member carrying a solvent on the surface thereto capable of softening said softenable material sufficiently to allow both migration of said migration material and splitting of the imaging member;

d. contacting said stripping member carrying said solvent with said imaging member sufficiently to soften said softenable material to allow migration of said migration material in a first image pattern configuration, in depth in said softenable material leaving a background of migration material spaced apart, in depth, from said first image pattern; and

e. removing said stripping member thereby splitting the softenable layer on an average in a plane substantially between said first image pattern configuration of migration material and said background migration material.

8. An imaging method according to claim **7** wherein said background is a second image pattern of migration material complementary to said first image pattern configuration of migration material.

9. An imaging method according to claim **7** wherein said image configuration of migration material is contiguous to a substrate for said softenable layer.

10. An imaging method according to claim **7** wherein the pressures used in contacting said stripping member with said imaging member is from about **3** to about **14** lbs. per linear inch.

11. An imaging method according to claim **10** wherein said softening solvent is encapsulated in pressure rupturable capsules fixed to the surface of said stripping member.

12. A splitting method comprising the steps of:

a. providing a continuous layer of softenable material, said softenable material capable of being softened sufficiently to allow splitting of said layer;

b. softening said softenable material sufficiently to allow splitting of said layer; and

c. splitting said layer on the average in a plane substantially between upper and lower surfaces of said layer.

13. The method according to claim 12 wherein said softenable material is a thermoplastic.

14. A splitting method comprising the steps of:

a. providing a continuous layer of softenable material, said layer capable of being split in a plane substantially between the upper and lower surfaces of said layer;

b. providing a stripping member capable of splitting said layer;

c. bringing said stripping member into tackified contact with said layer; and

d. separating said stripping member and said layer thereby splitting said layer on the average in a plane substantially between upper and lower surfaces of said layer.

15. The method according to claim 14 wherein said softenable material is a thermoplastic.

16. A splitting method comprising the steps of:

a. providing a continuous layer of softenable material, said softenable material capable of being solvent softened to allow splitting of said layer;

b. providing a stripping member carrying a solvent on the surface thereto capable of softening said softenable material to allow splitting of said layer;

c. contacting said stripping member carrying said solvent with said layer sufficiently to soften said softenable material; and

d. separating said stripping member and said layer thereby splitting said layer on an average in a plane substantially between upper and lower surfaces of said layer.

17. The method according to claim 16 wherein said softenable material is a thermoplastic.

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