Electrophotographic apparatus and method for imagewise charge generation and transfer

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ABSTRACT
An electrophotographic apparatus and method for imagewise generating electrostatic charges from a unique electrophotographic recording element and for simultaneously imagewise transferring such charges to an insulative receiving sheet to form a developable latent electrostatic image thereon. The recording element comprises a layer of radiation-responsive material, such as a photoconductor, which is disposed between a conductive backing and a fine conductive grid member, the latter being separated from the radiation-responsive layer by a small air-gap. Imagewise charge generation is accomplished by imagewise exposing the radiation-responsive layer of the recording element to actinic radiation while creating a sufficient electric field between the conductive backing of the recording element and the grid member to produce an ionic or corona discharge between the irradiated portions of the radiation-responsive layer and the grid member. Simultaneous imagewise charge transfer is accomplished by spacedly arranging the insulative receiving sheet relative to the grid member of the recording element and creating a second electric field between the grid member and an electrode disposed behind the receiving sheet, whereby charges generated during exposure of the electrophoretic plate are immediately drawn to the insulative receiving sheet.

15 Claims, 6 Drawing Figures
ELECTROPHOTOGRAPHIC APPARATUS AND
METHOD FOR IMAGewise CHARGE
GENERATION AND TRANSFER

BACKGROUND OF THE INVENTION

The present invention relates to novel electropho-

tographic recording elements, as well as to electropho-
tographic recording methods and apparatus wherein
electrostatic charges are imagewise generated and
transferred from an electrophotographic recording ele-
mont to a receiving sheet whereon they may be ren-
dered visible and permanentized.

Electrophotography, as practiced today, commonly
includes the separate and distinct steps of uniformly
charging the radiation-responsive layer of an electro-
photographic recording element to uniformly sensitize
such layer to radiation of some sort; imagewise expos-
ing the charged layer to actinic radiation to selectively
dissipate the uniform charge carried thereby, leaving
behind a developable electrostatic image; developing
such electrostatic image by applying electrophoretic
toner particles to it; and transferring the developed
or toned image to a receiving sheet whereon the toned
image can be permanentized or fused to provide a hard
copy.

As evidenced by the multitude of patents relating to
the electrophotographic art and the numerous articles
and texts which have been published in this area, con-
siderable effort has been expended heretofore in
improving or refining the electrophotographic reproduc-
tion process and apparatus, first disclosed by Chester
F. Carlson more than three decades ago. One area
wherein considerable attention has been focused in-
volves the image-wise transfer of electrostatic charges
from an electrophotographic recording element, across
a small air-gap, to a dielectric or insulative receiving
sheet. Techniques for accomplishing such charge trans-
fer are referred to in the art as TESI processes, an acro-
nym derived from Transfer of Electro-Static Images. A
particularly intriguing TESI process, from a scientific
as well as a commercial standpoint, is one wherein the
 electrostatic image is both generated and transferred
while the dielectric receiving sheet is arranged in a
face-to-face relationship with a conventional electro-
photographic plate, separated therefrom by a minute
air-gap. In such a process, the normally separate steps
of charging, imagewise exposing, and transferring the
image (in this case a charge image, rather than a toner
image) to the ultimate receiving sheet are accom-
plished substantially simultaneously. Such a process is
disclosed in U.S. Pat. No. 2,825,814 issued to L.
Walkup. Imagewise charge generation and transfer are
accomplished by simultaneously applying an electrical
potential between the conductive backing of the electro-
photographic recording element and an electrode
deposited on the rear surface of the receiving sheet, and
imagewise exposing the photoconductive layer of the
recording element, either through a transparent con-
ductive backing or through the receiving sheet, to ac-
tinic radiation. During exposure, an electrostatic image
is formed on the dielectric receiving sheet by an induc-
tive transfer of charge from the plate across the small
air-gap separating the dielectric and photoconductive
surfaces.

While capable of providing high quality copies under
controlled conditions in the laboratory, TESI processes
of the type referred to above have not been found com-
mercially practical. A major difficulty, of course, stems
from the requirement of repetitively establishing a uni-
form minute air-gap, typically ten microns wide, be-
tween the electrophotographic recording element and
the receiving sheet each time a copy is made. When the
air-gap is too great, charge transfer cannot occur due
to the reduction in electric field; on the other hand,
when the gap is too small for the applied potential, arc-
ing occurs. While considerable work has been directed
at this problem, no economically feasible solution has
been found to date.

Added to the air-gap problem of conventional TESI
processes is a self-quenching effect which limits the
amount of charge generation and transfer. In conven-
tional systems, the maximum potential which can be
applied between the recording element and the receiv-
ing sheet is typically of the order of 1,000 volts. Higher
voltages will produce arcing or corona discharge across
the air-gap even when the system is in the dark, or un-
exposed. Assuming that, during exposure, a field of say
300 volts must be applied to produce the necessary
charge generation, the travel through the air-gap and
discharge between the spaced members, this means that
the maximum charge that can be transferred to the receiving sheet before the
field in the air-gap drops below the level required for
charge generation is of the order of 350 volts (i.e., one-
half of the difference between the applied field and the
corona threshold voltage). Once a charge proportional
to 350 volts has transferred, the field in the air-gap is
insufficient to produce charges and quenching occurs.

SUMMARY OF THE INVENTION

In accordance with the present invention there is pro-
vided a novel electrophotographic recording element
and a method and apparatus for imagewise generating
electrostatic charges and transferring such charges to
a receiving surface. The recording element comprises
a conductive support having a radiation-responsive
layer (e.g., a photoconductive, heat deformable ther-
omplastic resin, or x-ray sensitive layer) disposed
thereon, a fine, electrically conductive grid or mesh
and means defining a small air-gap between the grid
and the radiation-responsive layer. Imagewise charge
generation is accomplished by establishing an electrical
field across the air-gap separating the grid from the
radiation-responsive layer, and simultaneously imagewise
exposing the radiation-responsive layer to actinic
radiation. The field in such air gap is adjusted so as to
be slightly less than the threshold level required for cor-
orna discharge or ionic movement across the air-gap
when the recording element is in the dark (i.e., unex-
posed). During imagewise exposure, due to the selec-
tive reduction in the resistivity of the radiation-
responsive layer or the selective shrinkage in distance
separating the spaced members of the recording ele-
ment, imagewise charge generation occurs between the
irradiated areas of the radiation-responsive layer and
the grid. Charge transfer is accomplished by spacedly
arranging a dielectric receiving sheet relative to the
grid and establishing a second electric field across the
air-gap separating the grid from the receiving sheet.
The second field is selected to be of a polarity and
strength such as to attract the charges generated during
imagewise exposure of the recording element, through
the grid, to the receiving sheet surface. In this manner,
a developable charge image is formed on the receiving
sheet. According to a preferred embodiment, an AC
field is established in the air gap separating the grid from the radiation-responsive layer; thus, both positive and negative ions are generated during exposure. By simply selecting the proper polarity for the field between the grid and receiving sheet, both positive and negative electrostatic images of the original are attainable.

As will be appreciated from the ensuing detailed description of preferred embodiments, the present invention offers several major advantages over known TESI techniques. For instance, unlike conventional techniques wherein it is suggested that the receiving sheet be brought into actual physical contact with the recording element (it being assumed that there will always be an air-gap of approximately 1 micron between the surfaces at most points), the receiving sheet, in accordance with the present invention, need never contact the radiation-responsive layer of the recording element. In fact, it may be maintained as far away from the grid member of the recording element (the uppermost surface) as one-half inch at all times. Thus, no abrading or contamination of the recording element is encountered and the useful lifetime of the plate is maximized. Also, the air-gap between the corona generating grid and recording element, once established, can be permanent; i.e., it need not change each time a copy is made. It should be noted that the air-gap between the grid and receiving sheet is not critical since its sole purpose is simply to attract ions or charges which are already generated (by the grid), not to produce such ions originally. Moreover, unlike convention TESI processes, the instant invention provides a means by which contrast can be added to the electrostatic image. It will be apparent from the ensuing description that the variation in density of the original document can be greatly exaggerated simply by employing a strong field between the grid and the receiving sheet while using relatively high exposures of the electrophotographic recording element.

Other advantages of the present invention will be apparent to those skilled in the electrophotography art from the ensuing detailed description of preferred embodiments, reference being made to the accompanying groups.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference is now made to the accompanying drawings wherein like reference numerals and characters designate like parts and wherein:

FIG. 1 is a diagrammatic cross-sectional view of an imagewise charge generating and transferring apparatus in accordance with a preferred embodiment of the invention, also illustrating a novel electrophotographic recording element of the invention;

FIGS. 2 and 3 are similar views illustrating alternate means for providing a minute airspace between the radiation-responsive layer of the electrophotographic recording element and the grid member;

FIG. 4 is a diagrammatic cross-sectional view of an electrophotographic copier embodying the invention;

FIGS. 5 and 6 are diagrammatic cross-sectional views illustrating other preferred embodiments of the invention wherein the radiation-responsive layer of the electrophotographic recording element comprises heat-deformable and x-ray sensitive layers, respectively.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

A novel electrophotographic recording element E, as well as apparatus for imagewise generating and transferring charges therefrom, is diagrammatically illustrated in FIG. 1. As shown, recording element E comprises a transparent support 10, such as a glass or quartz plate, or a flexible web of polyethylene terephthalate having a transparent conductive coating 11 disposed on at least one surface thereof. Coating 11 may comprise a thin layer of tin oxide, cuprous iodide, aluminum, silver or any other conductive material which can be coated sufficiently thin as to be substantially transparent to radiant energy. Disposed on coating 11 and in electrical contact therewith is a radiation-responsive layer 12 which may comprise, for instance, a photoconductive compound of cadmium sulfide, zinc oxide, lead oxide, selenium or any other photoconductive compound employed in electrophotography. Preferably, however, the radiation-responsive layer should have a bulk resistivity of less than approximately 10<sup>8</sup> ohm-cm. since compounds having a higher resistivity tend to prevent the current flow required in the operation of the novel process disclosed herein. The most useful photoconductive material has been found to be cadmium sulfide having a pigment-to-binder ratio of about 10:1. Closely spaced to the upper surface of radiation-responsive layer 12 is an electrically conductive grid 14 which typically comprises two arrays of uniformly spaced fine wires 16, such wires extending perpendicular to one another to form a screen-like electrode. Dielectric spacers 18 of polystyrene or the like serve to permanently establish a uniform air-gap 20 between grid 14 and layer 12. The average width of air-gap 20 may be anywhere between approximately 1 micron (i.e., virtual contact) to 1,000 microns. Preferably, however, air-gap 20 is between 10 and 100 microns.

Grid 14 acts as the charge-generating member of the apparatus and can comprise from 30 to 400 wires per inch in each direction. Preferably, the wires make up no more than 10–50 percent of the total grid area. For best results, the grid should comprise at least 200 wires per linear inch in each direction.

Spaced from the uppermost surface of the radiation-responsive layer 12, and extending substantially parallel thereto, is a dielectric receiving sheet 22, behind which an electrically conductive backing electrode 24 is disposed. Dielectric receiving sheet 22 may comprise, for instance, a sheet of Mylar, a polyethylene-coated paper, or the like. The spacing between the grid and receiving sheet should be between 0.08 to 0.50 inch, a spacing of 0.125 inch being preferred.

Preferably, the conductive coating 11 of recording element E is connected to grid 14 through an AC source of potential 26; however, for most applications, as explained subsequently herein, a DC source has equal utility. When unexposed to actinic radiation, the field produced by AC source 26 across air-gap 20 is slightly below the threshold value required for corona or ionic emission. Grid 14 is connected through DC source 28 to conductive electrode 24, disposed on the rear side of dielectric receiving sheet 22. In this manner, an electric field is established across the relatively large air-gap 30 separating dielectric receiving sheet 22 from grid 14.
In operation, actinic radiation from projector P is image-wise distributed on the radiation-responsive layer 12. While exposure of layer 12 is preferably effected through the transparent support 10 and conductive coating 11, exposure of layer 12 can be accomplished through the receiving sheet when the latter comprises a transparent dielectric material (e.g., a sheet of polyethylene terephthalate) and conductive backing 24 is also transparent. However, exposure through the receiving sheet results in a reduction in resolution of the transferred charge image due to the presence of grid 14 in the exposure path.

During image-wise exposure of layer 12, the conductivity thereof is selectively increased, thereby selectively reducing the threshold potential required for corona emission to occur across the air-gap separating the exposed areas of layer 12 from grid 14. Due to the AC field provided by AC source 26, both positive and negative ions, 31 and 32, respectively, are image-wise generated in the air-gap. Substantially simultaneously with the image-wise generation of charges between layer 12 and grid 14, a fraction of those charges having a polarity opposite that of electrode 24 is drawn upward, through grid 14, and deposited on the surface of the dielectric receiving sheet 22. The result is a latent electrostatic image on the dielectric receiving sheet which may be developed by any one of a number of conventional electrographic development techniques, and subsequently permanentized.

From the foregoing, the advantages of the present invention are readily apparent. For instance, unlike conventional TESI techniques, the strength of the electrostatic image transferred to the receiving sheet is not limited by the maximum potential which could be applied between the electrographic recording element and the dielectric receiving sheet (i.e., the grid in the case of the present invention) in the absence of exposure to actinic radiation. In accordance with the present invention, the charge transferred to the dielectric receiving sheet will continue to increase so long as the recording element is exposed, the upper limit being limited only by the potential provided by DC source 28, and the dielectric constant of the receiving sheet.

Another major advantage of the apparatus and process of the present invention is that once the grid 14 is positioned relative to the electrographic plate, thereby establishing the necessary ionization air-gap between the members, subsequent adjustment of these members relative to one another is unnecessary. The only adjustment which is necessary in making one copy after another is the positioning of the receiving sheet relative to the grid surface and, since the spacing between the grid surface and the receiving sheet is not critical, so long as the receiving sheet is sufficiently spaced as to prevent arcing and not so greatly spaced as to allow a divergence and loss of resolution in the charge pattern being transferred, this spacing may be maintained with relative ease.

Rather than using dielectric spacers around the periphery of layer 12 to maintain the desired air gap between the grid and layer 12, this air gap can be maintained, as shown in FIG. 2, by uniformly distributing a fine layer of dielectric particles 32, such as particles of Lucite (methyl methacrylate), on the surface of the radiation-responsive layer 12 and then bringing the grid into contact with the particles to provide a sandwich-like structure. To permanently position the grid relative to the electrographic plate, the structure is heated to a temperature such as to slightly soften the dielectric particles 32. Upon cooling, the position of the grid is fixed. This spacing technique is particularly useful when grid 14 is flimsy or flexible in nature, a property which would otherwise make uniform spacing from layer 12 difficult. Particles 32 are, of course, sufficiently small as to prevent any substantial loss of resolution in charge generation.

Still another method for positioning grid 14 relative to layer 12 is illustrated in FIG. 3 wherein exposure of layer 12 is shown as occurring through a transparent receiving sheet 22' having a transparent conductive backing 24'. As shown, the grid is disposed atop a thin, transparent dielectric coating 33 which overcoats the radiation-responsive layer 12. Coating 33 may comprise, for instance, a 0.5 mil layer of polyethylene terephthalate, cellulose acetate, or the like. To provide the necessary discharge path (i.e., air-gap) between the grid and radiation-responsive layer, dielectric coating 33 is rendered uniformly porous by exposing the entire recording element to actinic radiation, such that arcing occurs through the dielectric layer 33 at many points along the grid wires, thereby producing a multitude of minute pores which extend perpendicularly toward the radiation-responsive layer. In addition to providing the necessary separation between grid 14 and layer 12, coating 33 may be doped with a dye which will absorb unwanted radiation from the corona emission. When exposing through the receiving sheet, support 10 may, of course, comprise a sheet of metallic material, such as aluminum or copper. When exposing through the recording element, support 10, as well as its conductive coating, must be transparent; however, dielectric coating 33 need not be transparent.

The invention is further illustrated by the following example:

**EXAMPLE**

Ten grams of CdS-Powder, Type F-2111, (a photoconductive cadmium sulfide powder manufactured by Radio Corporation of America), was mixed thoroughly with 3 grams of copolymer styren-butadiene (85/15) (30 percent solids in toluene). The mix was twice coated on a Mylar (polyethylene terephthalate) support, 1 mil thick, with doctor blade; first coating 3 mils wet, second coating 5 mils wet. After 48 hours of drying at room temperature, the total thickness of this coating was approximately 4.5 mils.

To form a conductive electrode on the CdS layer, aluminum was evaporated by standard procedures to a thickness of about 1 micrometer. This conductive aluminum layer was then placed on a conductive vacuum plate. An electroplated metal grid of 150 wires per inch in each direction and 60 percent open area (manufactured by Buckby-Mears) was laid flat on top of the Mylar side of the sandwich, with the edges of the grid held in position by insulating tape. Electrical connections were made to both the grid and the vacuum plate. An AC potential of 1.5kv peak-to-peak, 60Hz, was applied between the grid and the vacuum plate.

A transparent receiving sheet was arranged one-eighth inch from the grid. The receiving sheet comprised an 0.25 mil thick transparent sheet of Mylar with a conductive, transparent electrode of CuI deposited thereon. A DC potential of 2,000 volts was applied between the grid and the conductive electrode of the re-
ceiving sheet, the grid being connected to the positive terminal of the DC supply. While both the AC and DC potentials were applied and the systems kept in the dark, an image was projected onto the cadmium sulfide layer through the transparent receiving sheet and grid. The projected image was from a standard 35mm microfilm (negative) slide; the images were magnified in the projection step to typewriter size. The exposure was made by a two foot-candle source for one-half second. Following exposure, the AC- and DC-potentials were disconnected from the device and the Mylar receiving sheet was removed. The electrostatic latent image on the receiving member was made visible by dipping the entire receiving sheet in a liquid xerographic toner of negative polarity for approximately two seconds. In this manner, a negative copy of the projected original was produced. Such copy exhibited a clear, transparent background and good density in the image areas.

From the foregoing example, it is clear that a positive copy of the original could have been produced by simply connecting the positive terminal of the DC source to the lower electrode on the receiving sheet, rather than to the grid. In this manner, the negative charges or ions produced by the AC source would have been transferred to the receiving sheet and, by applying a negative toner, a positive copy could have been provided.

FIG. 4 schematically illustrates a cross-section of a commercial-type electrographic copier incorporating the spacing technique illustrated in FIG. 3. As shown, a transparent cylindrical support 10 having a transparent conductive coating 11 is suitably journaled for rotation (by means not shown) in the direction indicated by the arrow. Disposed on the outer surface of conductive coating 11 is a radiation-responsive layer 12 which, as mentioned above, may comprise a photoconductive compound. Atop layer 12 is a dielectric layer 33 which serves to provide a uniform spacing between the radiation-responsive layer and a conductive grid 14 which is fixedly arranged on the outermost surface of dielectric layer 33. Layer 33 may be made porous by the technique described hereinabove so as to provide a discharge path between the grid and the outer surface of layer 12. Concentrically spaced from grid 14 is a conductive electrode 24. Conductive electrode 24 is preferably in the form of a vacuum plate having holes therein which communicate with a vacuum pump 40 via conduit 42.

In operation, a dielectric receiving sheet 22', which can be a resin-coated paper, is advanced from a supply spool 44 to a take-up spool 46 along a predetermined path which is partially defined by the surface S of electrode 24. Dielectric recording sheet 22 is continuously maintained in contact with conductive electrode 24 by the vacuum applied to the electrode by vacuum pump 40. Grid 14' and conductive coating 11' are connected to an AC source of potential (not shown) to establish an alternating field therebetween. A DC potential (not shown) is applied between grid 14' and conductive electrode 24'. Prior to imagewise exposure of radiation-responsive layer 12', the field established across layer 33 by the AC source is adjusted to a value slightly less than the threshold required for corona discharge or charge generation. Imagewise exposure of layer 12' is accomplished through transparent support 10' and coating 11' by a conventional projection system P'. Upon exposure of layer 12', the impedance thereof is selectively reduced in the exposed area causing imagewise charge generation in the vicinity of grid 14' on the side facing dielectric layer 33'. Almost simultaneously with such charge generation, a fraction of the charges is imagewise drawn toward the receiving sheet 22' owing to the DC electric field between the grid 14' and electrode 24'. The result is a latent electrostatic image on dielectric receiving sheet 22' which may be developed in a conventional manner at development station 55 and permanentized at fusing station 60. When conductive electrode 24' and the dielectric receiving sheet are transparent, imagewise exposure can, of course, be accomplished through the receiving sheet. However, as mentioned above, a reduction in resolution will be encountered due to the presence of grid 14' in the exposure path.

In FIG. 5, another embodiment of the invention is presented wherein the radiation-responsive layer 12 of electrographic recording element E comprises a heat-deformable material, such as a wax or thermoplastic resin having a low melting point. Upon being imagewise exposed to thermal radiation 62, the heat-struck areas expand toward grid 14, thereby selectively reducing the spacing between the grid and layer 12. By appropriately adjusting the value of AC source 26, imagewise charge generation will occur between the grid and the irradiated areas of the heat-deformable layer. Due to field produced by a DC source 28, charges are imagewise attracted to the dielectric receiving sheet 22.

In FIG. 6, still another embodiment of the invention is disclosed wherein the radiation-responsive layer 12 of electrophotographic recording element E comprises a photoconductive layer 65 having a phosphorous overcoat 66. Upon imagewise exposing the phosphorous coating to X-rays, fluorescence is stimulated therein which imagewise increases the conductivity in the photoconductive layer. Upon establishing an appropriate field between the grid 14 and the conductive support 10 (which may be a metallic sheet in the case of X-ray exposure), and a second field between the grid and backing electrode 24, an electrostatic image is substantially simultaneously formed on the receiving sheet shown in FIG. 6, the spacing between grid 14 and the upper surface of the phosphorous overcoat 66 is maintained by a thin dielectric layer, such as a 0.5 mil layer of Teflon which has been rendered porous by the technique described above.

From the foregoing it can be readily appreciated that a much improved method and apparatus have been provided for imagewise generating and transferring electrostatic charges from an electrographic recording element of novel structure to a dielectric receiving sheet. It should also be appreciated that, in describing the subject invention, certain phrases and terms have been used in a rather general sense, rather than in a strictly technical sense, to facilitate an understanding of the invention. For instance, the phrase "air-gap" should be interpreted herein as referring to a space or region containing any ionizable gas, not necessarily "air." Similarly, the phrase "radiation-responsive" as used herein to describe the imagewise exposed layer 12 of the electrographic recording element includes all materials, photoconductive, heat deformable, X-ray-sensitive, etc., which, when exposed to activating radiation undergo a physical and/or electrical change which can result in a selective corona emission when employed in an environment as herein described. Simi-
larly, the term "grid" should be interpreted broadly since a "grid" could, in addition to comprising a suit-
able array of fine wires, comprise point electrodes, per-
forated materials, etc..

This invention has been described in detail with par-
ticular reference to preferred embodiments thereof,
but it will be understood that variations and modifica-
tions can be effected within the spirit and scope of the
invention.

I claim:

1. A method for forming an electrostatic image on a
dielectric receiving surface, said method comprising
the steps of:

a. spatially positioning said receiving surface relative
to an electrographic recording element, said re-
ording element comprising a radiation-responsive
layer, and an electrically conductive grid member
spaced between 1.0 and 1,000 microns from said
layer, said receiving surface being positioned rela-
tive to the recording element so as to face the grid
member thereof;

b. establishing a first electrical field across the space
between said layer and said grid member while si-
multaneously imagewise exposing said radiation-
responsive layer to activating radiation to image-
wise vary the threshold potential required for cor-
rona emission between said radiation-responsive
layer and said grid member, and to produce image-
wise charge generation between said layer and said
grid member; and

c. establishing a second electrical field between said
receiving surface and said grid member to image-
wise attract charges generated during imagewise
exposure of said radiation-responsive layer to said
receiving surface.

2. The invention according to claim 1 wherein said
first electrical field is an AC field, whereby both posi-
tive and negative charges are imagewise generated dur-
ing imagewise exposure of said radiation-responsive
layer.

3. The invention according to claim 1 wherein said
radiation-responsive layer comprises a photoconduc-
tive material.

4. The invention according to claim 1 wherein said
radiation-responsive layer comprises a heat-
deformable material.

5. The invention according to claim 1 wherein said
radiation-responsive layer comprises contiguous first
and second sublayers, said first sublayer comprising a
photoconductive material, and said second sublayer
comprises a phosphor-containing material which, when
imagewise exposed to x-radiation, fluoresces and
thereby selectively increases the conductivity of said
first sublayer.

6. A process for imagewise generating charges in an
electrophotographic recording element and for sub-
stantially simultaneously imagewise transferring such
charges to a dielectric receiving sheet disposed on a
conductive support, such recording element compris-
ing a radiation-responsive layer having an electrically
conductive backing, an electrically conductive grid
member, and means defining a substantially uniform
air-gap having an average width of between approxi-
mately 1.0 and 1,000 microns between said layer and
grid member, said process comprising the steps of

a. spacedly arranging said receiving sheet relative to
said grid member;

b. electrically biasing said grid member relative to
said conductive backing while simultaneously im-
agewise exposing said radiation-responsive layer to
actinic radiation to imagewise vary the threshold
potential required for corona emission between
said radiation-responsive layer and said grid mem-
ber, and to produce imagewise charge generation
between said layer and said grid member; and

c. electrically biasing said conductive support rela-
tive to said grid member to imagewise attract
charges generated during imagewise exposure of
said radiation-responsive layer to said receiving
sheet.

7. The invention according to claim 6 wherein elec-
trical biasing of said grid member relative to said con-
ductive backing is achieved by applying an AC source
of potential between said grid member and said con-
ductive backing, whereby both positive and negative
charges are generated during image-wise exposure of
said radiation-responsive layer.

8. The invention according to claim 6 wherein said
receiving sheet is spaced from said grid member an av-
erage distance of from 1.0 to 10.0 millimeters.

9. The invention according to claim 6 wherein said
radiation-responsive layer comprises a photoconduc-
tive compound.

10. The invention according to claim 6 wherein said
radiation-responsive layer comprises a heat-deformable
material.

11. The invention according to claim 6 wherein said
radiation-responsive layer comprises contiguous first
and second sublayers, said first sublayer comprising a
photo-conductive material, and said second sublayer
comprises a phosphor-containing material.

12. An electrophotographic process comprising the
steps of

a. spacedly arranging a dielectric receiving sheet rela-
tive to an electrophotographic recording element,
such element comprising a photoconductive insu-
lating layer having a conductive backing disposed
on one surface thereof and an electrically conduc-
tive grid member between 1.0 and 1,000 microns
from and extending substantially parallel to the
other surface of said layer, said receiving sheet
being arranged so as to face said grid member and
be spaced therefrom an average distance of from
1.0 to 10.0 millimeters;

b. applying an electrical potential between said grid
member and said conductive backing while simul-
taneously imagewise exposing said photoconduc-
tive layer to actinic radiation to selectively increase
the conductivity of said layer and produce image-
wise charge generation between said layer and said
grid member; and

c. establishing an electric field between said grid
member and said receiving sheet to imagewise at-
tract charges generated during exposure of said
photoconductive layer to said receiving sheet.

13. The invention according to claim 12, further
comprising the step of selectively depositing toner par-
ticles on said receiving sheet to render the charge
thereon visible.

14. The invention according to claim 13, further
comprising the step of fusing the toner particles to said
receiving sheet.
15. A method for forming an electrostatic charge pattern on an electrically insulative surface, said method comprising the steps of:

- positioning an insulative surface apart from and parallel to a photoconductive insulating layer;
- interposing a conductive grid between said surface and said layer, so as to be spaced from and extend substantially parallel to both said insulative surface and said layer, the spacing between said grid and said layer being between 1.0 and 1,000 microns;
- establishing a first electric field in the space between said grid and said layer, such first electric field being of an intensity less than the threshold level required for ionic movement between said grid and said layer when said layer is unexposed to activating radiation;

simultaneously exposing said layer to a pattern of activating radiation to produce selective ionic movement between said grid and said layer; and

simultaneously applying a second electric field in the space between said surface and said grid to image-wise attract ions to said surface.

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