

This Sheet Has Been Replaced



PCT

- 1 -

REPLACED SHEETS SG

☒ Description : paged ...1... to paged ...18...  
☒ Claim(s) : paged ...1... to paged ...25...  
☒ Drawing(s) : paged ...1/2... to paged ...24...  
☒ Abstract : paged ...24... to paged ...-...  
 DATE OF RECEIPT .....

1 PRINTING ON TRANSPARENT FILM2 FIELD OF THE INVENTION

3 The present invention relates to an improved  
 4 electrostatic processes for printing or coating on polymer  
 5 films and surfaces with toner and toner inks. The invention  
 6 specifically relates to a method of achieving high quality  
 7 high contrast colored or multi-colored images in continuous  
 8 roll printing on transparent, flexible packaging films.

9 BACKGROUND OF THE INVENTION

10 The coating of plastic films or surfaces e.g.  
 11 polyethylene, polypropylene, etc. for aesthetic or  
 12 functional purposes is of great utility and importance. A  
 13 major use of such films is in food packaging.

14 Electrostatic printing has inherent advantages which  
 15 would appear to make it particularly desirable for printing  
 16 on plastic films. The inherent advantages include  
 17 adaptability to short runs economically, high resolution, on  
 18 demand printing and good visibility. However, at present,  
 19 printing on transparent films, especially multi-color  
 20 printing is commercially performed in multi-head presses,  
 21 and only in long runs.

22 SUMMARY OF THE INVENTION

23 It is an object of certain aspects of the present  
 24 invention to produce improved quality color images  
 25 electrostatically on transparent plastic films and  
 26 substrates.

27 Color integrity of multi-color images is improved by  
 28 optimizing the image forming and transfer stages of the  
 29 printing process.

30 In order to improve the visibility of color images  
 31 printed on the inner surface of transparent flexible  
 32 packaging, according to a preferred embodiment of the  
 33 invention, the color image is overcoated with a  
 34 substantially opaque toner layer at least in those portions  
 35 of the packaging which are printed with color toners. Thus  
 36 on the packaging material, at least one color toner layer is

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1 situated closest to the material, and a white or other  
2 opaque layer is situated behind the colored layer or layers,  
3 i.e., further away from the material. Such images are viewed  
4 from the unprinted side of the substrate.

5       Alternatively, the complete multi-layer image is  
6 printed with the opaque layer uppermost on the intermediate  
7 transfer member so that, when the image is transferred to  
8 the substrate, the opaque layer is closest to the substrate.  
9 Such images are viewed from the printed side of the  
10 substrate.

11       Additionally, the white toner layer may also extend  
12 past the edges of the colored layers and directly contact  
13 the packaging material.

14       In order to avoid unnecessary alignment and  
15 registration steps, the different color images involved are  
16 sequentially transferred from an image forming surface onto  
17 an intermediate transfer member, each in alignment with  
18 previous images. The intermediate transfer member is heated  
19 so that each color image coalesces into a cohesive film, in  
20 which the respective color pigments are held so that they do  
21 not diffuse into other layers. Mixing of colors, especially  
22 with the opaque pigment is detrimental to image quality.

23       Each complete multi-color image is subsequently  
24 transferred from the intermediate transfer member to the  
25 substrate.

26       Another object of certain aspects of the present  
27 invention is to provide a process for printing toner polymer  
28 images on ionomer (high or low molecular weight) or ethylene  
29 vinyl acetate coatings on polymer surfaces, thereby  
30 achieving improved qualities. The toner polymer images may  
31 be based on high molecular weight ionomers, e.g. Surlyns,  
32 low molecular weight ionomers, e.g. Acllys, ionomers having  
33 an intermediate molecular weight, ethylene vinyl acetate  
34 polymers and ethelene copolymers or terpolymers e.g., Bynels  
35 and Nuclels, to achieve improved qualities, such as  
36 sealability, adhesiveness, food compatibility, and others.



1 In other aspects of the invention special toners,  
2 including opaque white, silver, gold and fluorescent toners  
3 have been prepared by adding pigments to a hot ionomer  
4 solution, preferably of low molecular weight ionomers, and  
5 stirring the mixture as it cools. This procedure has been  
6 used to prepare gold, silver, white opaque  $\text{TiO}_2$  based,  
7 magnetic and fluorescent inks, respectively.

8 There is thus provided, in accordance with a preferred  
9 embodiment of the invention, a printing process for forming  
10 high contrast color images on polymer surfaces, comprising:

11 (a) forming a layer of substantially opaque liquid  
12 toner comprising polymer based toner particles and a carrier  
13 liquid, on an imaging surface;

14 (b) transferring the layer to an intermediate transfer  
15 member;

16 (c) heating the layer on the intermediate transfer  
17 member to a temperature at which the toner particles at  
18 least partially coalesce;

19 (d) repeating (a) to (c) sequentially for at least one  
20 subsequent layer in at least one color, said at least one  
21 subsequent layer being transferred to the intermediate  
22 transfer member onto the opaque layer to form multiple  
23 layers on the intermediate transfer member; and

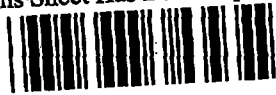
24 (e) transferring the multiple layers to a polymer  
25 surface.

26 There is further provided, in accordance with a  
27 preferred embodiment of the invention, a printing process  
28 for forming high contrast color images on polymer surfaces,  
29 comprising:

30 (a) forming a colored layer of liquid toner comprising  
31 polymer based toner particles and a carrier liquid, on an  
32 imaging surface;

33 (b) transferring the layer to an intermediate transfer  
34 member;

35 (c) heating the layer on the intermediate transfer  
36 member to a temperature at which the toner particles at



1 least partially coalesce;

2 (d) repeating (a) to (c) sequentially for at least a  
3 substantially opaque liquid toner layer, said substantially  
4 opaque layer being transferred to the intermediate transfer  
5 member onto the colored layer to a plurality of layers on  
6 the intermediate transfer member; and

7 (e) transferring the plurality of layers to a polymer  
8 surface.

9 Preferably, forming a layer comprises:

10 (i) charging a photoreceptor surface;

11 (ii) selectively discharging portions of the charged  
12 photoreceptor surface to form a predefined electrostatic  
13 image; and

14 (iii) developing a layer of charged opaque white toner  
15 particles onto the selectively discharged portions of the  
16 photoreceptor surface thereby providing a developed image  
17 corresponding to the latent image.

18 There is further provided, in accordance with a  
19 preferred embodiment of the invention, a printing process  
20 comprising:

21 (a) forming a liquid toner image comprising toner  
22 particles based on a first polymer and a carrier liquid, on  
23 an imaging surface;

24 (b) transferring the image to a surface coated with a  
25 second polymer; and

26 (c) fusing and fixing the image to the surface coating,  
27 wherein the second polymer is either an ionomer or an  
28 ethylene vinyl acetate polymer.

29 Preferably, the second polymer is either an ionomer or  
30 an ethylene vinyl acetate polymer high molecular weight  
31 ionomers, e.g. Surlins, low molecular weight ionomers, e.g.  
32 Aclyns, ionomers having an intermediate molecular weight,  
33 ethylene vinyl acetate polymers and ethylene copolymers or  
34 terpolymers e.g., Bynels and Nuclels.

35 There is further provided, in accordance with a  
36 preferred embodiment of the invention, a printing process



1 comprising:

2 (a) forming a liquid toner image comprising toner  
3 particles based on a first polymer and a carrier liquid, on  
4 an imaging surface;

5 (b) transferring the image to a surface coated with a  
6 second polymer; and

7 (c) fusing and fixing the image to the surface coating,  
8 wherein the first and second polymer is an ionomer.

9 Preferably, the first polymer is comprises an ionomer,  
10 more preferably the same ionomer as the second polymer.

11 There is further provided, in accordance with a  
12 preferred embodiment of the invention, a toner particle  
13 comprising:

14 a polymer; and

15 flakes of metal.

16 Preferably, the flakes which may be of gold or silver,  
17 have a dimension greater than about 4 micrometers, more  
18 preferably than 6 micrometers.

19 There is further provided, in accordance with a  
20 preferred embodiment of the invention, a toner particle  
21 comprising:

22 a polymer; and

23 a fluorescent material, preferably in the form of  
24 particles having a size greater than 2 micrometers.

25 Preferably, the polymer in the above toner particles is  
26 a low molecular weight ionomer.

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1                    **BRIEF DESCRIPTION OF THE DRAWINGS**

2            The invention will be more clearly understood from the  
3 following description of preferred embodiments thereof in  
4 conjunction with the following drawings which:

5            Fig. 1 is a simplified sectional illustration of  
6 electrostatic imaging apparatus constructed and operative in  
7 accordance with a preferred embodiment of the present  
8 invention; and

9            Fig. 2 is a simplified enlarged sectional illustration  
10 of the apparatus of Fig. 1.

11                    **DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS**

12            Reference is now made to Figs. 1 and 2 which illustrate  
13 a multi color electrostatic imaging system constructed and  
14 operative in accordance with a preferred embodiment of the  
15 present invention. As seen in Figs. 1 and 2 there is  
16 provided an imaging sheet, preferably an organic  
17 photoreceptor 12, typically mounted on a rotating drum 10.  
18 Drum 10 is rotated about its axis by a motor or the like  
19 (not shown), in the direction of arrow 18, past charging  
20 apparatus 14, preferably a corotron, scorotron or roller  
21 charger or other suitable charging apparatus as are known in  
22 the art and which is adapted to charge the surface of sheet  
23 photoreceptor 12. The image to be reproduced is focused by  
24 an imager 16 upon the charged surface 12 at least partially  
25 discharging the photoconductor in the areas struck by light,  
26 thereby forming an electrostatic latent image. Thus, the  
27 latent image normally includes image areas at a first  
28 electrical potential and background areas at another  
29 electrical potential.

30            A preferred photoreceptor sheet and preferred methods  
31 of mounting it on drum 10 are described in a co-pending  
32 application of Belinkov et al., IMAGING APPARATUS AND  
33 PHOTORECEPTOR THEREFOR, filed September 7, 1994 assigned  
34 serial number 08/301,775 and in corresponding applications in  
35 other countries, the disclosures of which are incorporated  
36 herein by reference. Alternatively, photoreceptor 12 may be



1 deposited on the drum 10 and may form a continuous surface.  
2 Furthermore, photoreceptor 12 may be a non-organic type  
3 photoconductor based, for example, on a compound of  
4 selenium.

5       Also associated with drum 10 and photoreceptor sheet  
6 12, in a preferred embodiment of the invention, are a  
7 multicolor liquid developer spray assembly 20, a developing  
8 assembly 22, color specific cleaning blade assemblies 34, a  
9 background cleaning station 24, an electrified squeegee 26,  
10 a background discharge device 28, an intermediate transfer  
11 member 30, cleaning apparatus 32, and, optionally, a  
12 neutralizing lamp assembly 36. Developing assembly 22  
13 preferably includes a development roller 38. Development  
14 roller 38 is preferably spaced from photoreceptor 12  
15 thereby forming a gap therebetween of typically 40 to 150  
16 micrometers and is charged to an electrical potential  
17 intermediate that of the image and background areas of the  
18 image. Development roller 38 is thus operative, when  
19 maintained at a suitable voltage, to apply an electric field  
20 to aid development of the latent electrostatic image.

21       Development roller 38 typically rotates in the same  
22 sense as drum 10 as indicated by arrow 40. This rotation  
23 provides for the surface of sheet 12 and development roller  
24 38 to have opposite velocities at the gap between them.

25       In accordance with a preferred embodiment of the  
26 invention, an opaque white background image is initially  
27 developed on the photoreceptor surface and transferred to an  
28 intermediate transfer member 30. The background image is  
29 heated to a temperature that causes the white toner  
30 particles in the presence of carrier liquid to at least  
31 partially coalesce, preferably into a cohesive film, i.e.,  
32 the toner pigment is fixed in the layer in which it was  
33 deposited so that mixing of different color pigments in  
34 various layers is prevented. This is essential for the  
35 achievement of good color quality and contrast in the final  
36 composite image. Subsequent images in different colors are



1 individually developed and sequentially transferred in  
2 alignment with the previous image onto intermediate transfer  
3 member 30, which is heated as before so that each color  
4 forms a cohesive non-diffusive layer.

5       It should be noted that each of the layers is a viscous  
6 liquid and that while heating does cause the layers to  
7 coalesce, the balance between viscosity and surface tension  
8 of the layers is apparently such that the individual layers  
9 have only minimal mixing.

10       When all of the desired images have been transferred to  
11 intermediate transfer member 30, the complete multi-color  
12 image is transferred therefrom to substrate 72. Impression  
13 roller 71 only produces operative engagement between  
14 intermediate transfer member 30 and substrate 72 when  
15 transfer of the composite image to substrate 72 takes place,  
16 preferably with heat and pressure. Substrate 72 which is  
17 preferably a transparent flexible polymer film is fed from a  
18 feeder roller 77 and is taken up by take up roller 78. The  
19 printing process when carried out as described produces a  
20 high contrast high colored quality image.

21       Preferably, the motion of the polymer film is halted  
22 during the accumulation of the layers on the intermediate  
23 transfer member. Just prior to the transfer, the film is  
24 accelerated to a velocity substantially equal to the surface  
25 velocity of the intermediate transfer member, such that  
26 there is substantially zero relative motion between them at  
27 the time of contact. Furthermore, between transfers, the  
28 film is preferably partially rewound so that, after the  
29 acceleration, only a minimal blank space is left unprinted.

30       Multicolor liquid developer spray assembly 20, whose  
31 operation and structure is described in detail in U.S.  
32 Patent 5,117,263, the disclosure of which is incorporated  
33 herein by reference, may be mounted on axis 42 to allow  
34 assembly 20 to be pivoted in such a manner that a spray of  
35 liquid toner containing electrically charged pigmented toner  
36 particles can be directed either onto a portion of the



1 development roller 38, a portion of the photoreceptor 12  
2 or directly into a development region 44 between  
3 photoreceptor 12 and development roller 38. Alternatively,  
4 assembly 20 may be fixed. Preferably, the spray is directed  
5 onto a portion of the development roller 38.

6 Color specific cleaning blade assemblies 34 are  
7 operatively associated with developer roller 38 for separate  
8 removal of residual amounts of each colored toner remaining  
9 thereon after development. Each of blade assemblies 34 is  
10 selectably brought into operative association with developer  
11 roller 38 only when toner of a color corresponding thereto  
12 is supplied to development region 44 by spray assembly 20.  
13 The construction and operation of cleaning blade assemblies  
14 is described in PCT Publication WO 90/14619 and in US patent  
15 5,289,238, the disclosures of which are incorporated herein  
16 by reference.

17 Each cleaning blade assembly 34 includes a toner  
18 directing member 52 which serves to direct the toner  
19 removed by the cleaning blade assemblies 34 from the  
20 developer roller 38 to separate collection containers 54,  
21 56, 58, 60, and 68 and for each color to prevent  
22 contamination of the various developers by mixing of the  
23 colors. The toner collected by the collection containers is  
24 recycled to a corresponding toner reservoir (55, 57, 59, 61  
25 and 63). And a final toner directing member 62 always  
26 engages the developer roller 38 and the toner collected  
27 thereat is supplied into collection container 64 and  
28 thereafter to reservoir 65 via separator 66 which is  
29 operative to separate relatively clean carrier liquid from  
30 the various colored toner particles. The separator 66 may be  
31 typically of the type described in U.S. Patent 4,985,732,  
32 the disclosure of which is incorporated herein by reference.

33 In a preferred embodiment of the invention, as  
34 described in PCT Publication WO 92/13297, the disclosure of  
35 which is incorporated herein by reference, where the imaging  
36 speed is very high, a background cleaning station 24



1 typically including a reverse roller 46 and a wetting roller  
2 48 is provided. Reverse roller 46 which rotates in a  
3 direction indicated by arrow 50 is preferably electrically  
4 biased to a potential intermediate that of the image and  
5 background areas of photoconductive drum 10, but different  
6 from that of the development roller. Reverse roller 46 is  
7 preferably spaced apart from photoreceptor sheet 12 thereby  
8 forming a gap therebetween which is typically 40 to 150  
9 micrometers.

10 Wetting roller 48 is preferably partly immersed in a  
11 fluid bath 47, which preferably contains carrier liquid  
12 received from carrier liquid reservoir 65 via conduit 88.  
13 Wetting roller 48, which preferably rotates in the same  
14 sense as that of drum 10 and reverse roller 46, operates to  
15 wet photoreceptor sheet 12 with non-pigmented carrier liquid  
16 upstream of reverse roller 46. The liquid supplied by  
17 wetting roller 48 replaces the liquid removed from drum 10  
18 by development assembly 22, thus allowing the reverse  
19 roller 46 to remove charged pigmented toner particles by  
20 electrophoresis from the background areas of the latent  
21 image. Excess fluid is removed from reverse roller 46 by a  
22 liquid directing member 70 which continuously engages  
23 reverse roller 46 to collect excess liquid containing toner  
24 particles of various colors which is in turn supplied to  
25 reservoir 65 via collection container 64 and separator 66.

26 Wetting roller 48 is preferably electrically biased to  
27 a potential intermediate that of the image and background  
28 areas of photoconductive drum 10, but different from that of  
29 the development roller. This biasing of wetting roller 48  
30 assists in removing toner particles from the background  
31 areas of photoreceptor sheet 12. Wetting roller 48 is  
32 preferably spaced apart from photoreceptor sheet 12 thereby  
33 forming a gap therebetween which is typically 40 to 200  
34 micrometers.

35 The apparatus embodied in reference numerals 46, 47, 48  
36 and 70 is generally not required for low speed systems, but



1 is preferably included in high speed systems.

2        Preferably, an electrically biased squeegee roller 26  
3 is urged against the surface of sheet 12 and is operative to  
4 remove liquid carrier from the background regions and to  
5 compact the image and remove liquid carrier therefrom in the  
6 image regions. Squeegee roller 26 is preferably formed of  
7 resilient slightly conductive polymeric material as is well  
8 known in the art, and is preferably charged to a potential  
9 of several hundred to a few thousand volts with the same  
10 polarity as the polarity of the charge on the toner  
11 particles.

12        Discharge device 28 is operative to flood sheet 12 with  
13 light which discharges the voltage remaining on sheet 12,  
14 mainly to reduce electrical breakdown and improve transfer  
15 of the image to intermediate transfer member 30. Operation  
16 of such a device in a write black system is described in  
17 U.S. Patent 5,280,326, the disclosure of which is  
18 incorporated herein by reference.

19        Figs. 1 and 2 further show that multicolor toner spray  
20 assembly 20 receives separate supplies of colored toner  
21 typically from five different reservoirs 55, 57, 59, 61 and  
22 63. Figure 1 shows five different colored toner reservoirs  
23 55, 57, 59, 61 and 63, typically containing the colors  
24 Yellow, Magenta, Cyan, black and white, respectively. In  
25 addition, reservoir 65 contains relatively clean carrier  
26 liquid whose operation was described. Pumps 90, 92, 94, 96  
27 and 108, may be provided along respective supply conduits  
28 98, 101, 103, 105, and 107, for providing a desired amount  
29 of pressure to feed the colored toner to multicolor spray  
30 assembly 20. Alternatively, multicolor toner spray assembly  
31 20, which is preferably a three level spray assembly,  
32 receives supplies of colored toner from up to six different  
33 reservoirs (a sixth reservoir marked S is shown) which  
34 allows for custom colored toners in addition to the standard  
35 process colors, black and white.

36        Toners that can be used with the present invention are



1 described in Example 1 of U.S. Patent 4,794,651, the  
2 disclosure of which is incorporated herein by reference or  
3 variants thereof as are well known in the art. For colored  
4 liquid developers, carbon black is replaced by color  
5 pigments as is well known in the art. Other toners may  
6 alternatively be employed, including liquid toners and, as  
7 indicated above, including powder toners.

8 Other toners for use in the invention can be prepared  
9 using the following method:

10 1) Solubilizing 1400 grams of Nucrel 925 (ethylene  
11 copolymer by Dupont) and 1400 g of Isopar L (Exxon) are  
12 thoroughly mixed in an oil heated Ross Double Planetary  
13 Mixer at least 24 RPM for 1.5 hours, with the oil  
14 temperature at 130° C. 1200 g of preheated Isopar L is added  
15 and mixing is continued for an additional hour. The mixture  
16 is cooled to 45° C, while stirring is continued over a  
17 period of several hours, to form a viscous material.

18 2) Milling and Grinding 762 grams of the result of the  
19 Solubilizing step are ground in a 1S attritor (Union Process  
20 Inc. Akron Ohio), charged with 3/16" carbon steel balls at  
21 250 RPM, together with 66.7 grams of Mogul L carbon black  
22 (Cabot), 6.7 grams of BT 583D (blue pigment produced by  
23 Cookson), 5 grams of aluminum stearate (Riedel Dehaen) and  
24 an additional 1459.6 grams of Isopar L for eight hours at  
25 30° C.

26 3) Continuation of Grinding 34.5 grams of ACumist A-12  
27 (a micronised polyethylene wax produced by Allied Signal) is  
28 added and grinding is continued for an additional 4 hours.  
29 The resulting particles are fibrous particles have a  
30 measured diameter in the range of 1-3 micrometers.

31 The resulting material is diluted with additional  
32 Isopar L and Marcol 82 to give a working developer in which  
33 the dry solids portion is about 1.7% and in which the  
34 overall ratio of Isopar L to Marcol is between about 50:1  
35 and 500:1, more preferably between about 100:1 and 200:1.  
36 Charge director as described in US patent application



1 07/915,291 (utilizing lecithin, BBP and ICIG3300B) and in WO  
2 94/02887, in an amount approximately equal to 40 mg/gm of  
3 solids in the final dispersion, is added to charge the toner  
4 particles. Other charge directors and additional additives  
5 as are known in the art may also be used.

6       The above described process produces a black toner.  
7 Cyan, magenta and yellow toners can be produced by using a  
8 different mix of materials for step 2). For Cyan toner, 822g  
9 of the solubilized material, 21.33 grams each of BT 583D and  
10 BT 788D pigments (Cookson), 1.73 grams of D1355DD pigment  
11 (BASF), 7.59 grams of aluminum stearate and 1426 grams of  
12 Isopar L are used in step 2. For Magenta toner, 810 grams of  
13 solubilized material, 48.3 grams of Finess Red F2B, 6.81  
14 grams of aluminum stearate and 1434.2 grams of Isopar L are  
15 used in step 2. For yellow toner 810 grams of solubilized  
16 material, 49.1 grams of D1355DD pigment, 6.9 grams of  
17 aluminum stearate and 1423 grams of Isopar L are used in  
18 step 2.

19       Other preferred liquid toners for use in the present  
20 invention are prepared as follows: 300 grams of a  
21 chargeable low molecular weight ionomer Aclyn 293A (made by  
22 Allied Signal) were solubilized in 1500 grams of Isopar - L  
23 with heating to 110°- 120°C while stirring. To form inks,  
24 dispersed pigments or color particles are added to and mixed  
25 with the hot solubilized polymer. The composition is  
26 allowed to cool while stirring.

27       The following liquid toner inks were prepared in this  
28 way:

29 **TiO<sub>2</sub> BASED OPAQUE WHITE TONER INK**

30       A preferred opaque white ink in accordance with the  
31 present invention is prepared by adding 200 grams of finely  
32 divided TiO<sub>2</sub> pigment, having an average diameter of about  
33 0.5 micrometers to the solubilized polymer while stirring.  
34 The mixture is allowed to cool and settle with continuous  
35 stirring. Charge director, as described above or other  
36 charged directors as known in the art, and additional Isopar



1 L and MARCOL 82 carrier liquid are added to form a liquid  
2 toner. The opaque white liquid toner so obtained is used,  
3 as previously mentioned, to enhance the quality of color  
4 images when it serves as a back layer for color contrast.  
5 The median pigmented toner particle size in the toner is  
6 4.81 micrometers.

7 An alternative preferred method for producing white  
8 toner ink concentrate, in accordance with a preferred  
9 embodiment of the invention comprises the steps of (1)  
10 plasticizing 35% Nucrel 699 (ethylene-metacrylic acid  
11 copolymer by DuPont) in Isopar L (EXXON) by heating the  
12 materials in a Ross double planetary mixer to 150°C while  
13 mixing the materials and allowing the mixture to cool while  
14 mixing continues until the mixture is fully mixed and  
15 homogeneous; (2) mixing 3071 grams of the mixture produced  
16 by step (1) with 1075 grams of KRONOS 2310 titanium dioxide  
17 (NL Chemicals) and 4454 grams of Isopar L in a Ross type LAB  
18 ME high shear mixer until the new mixture is completely  
19 homogeneous; and (3) grinding the mixture at about 56°C (the  
20 temperature of the mixture without cooling) for 16 hours in  
21 a SEECO M18 Vibratory Mill charged with 3/8" zirconia media.  
22 The resultant toner has a median diameter of about 3  
23 microns.

24 The material is charged and diluted as described above  
25 and 3 micrometer micron particles of TEFLON M1200 are  
26 optionally added to act as protective spacers against  
27 abrasion for the final image.

28 Other inks are prepared in a manner similar to the  
29 first method for producing white toner ink and provided the  
30 following results:

#### 31 GOLD TONER INK

32 Aclyn293A, (made by Allied Signal) 150 grams, and  
33 Isopar-L, 800 grams, are heated with mixing in a glass  
34 beaker, at a temperature of 110° - 120° C. 100 grams of 6-  
35 10 micrometer gold flakes (made by SCHLENK) are slowly added  
36 and mixing is continued for 5 minutes. The temperature is



1 allowed to fall to 90° C.

2       The composition is mixed at high shear (ROSS HIGH  
3 SHEAR MIXER) for 1 minute and cooled, while mixing, to room  
4 temperature while mixing is continued at 250 RPM.

5       Final ink median particle size as measured by a  
6 SCHIMADZU PARTICLE SIZE ANALYZER is 18.6 micrometers.

7       The ink was tested in an E-PRINT 1000 (using the single  
8 final transfer mode described above and separate transfer of  
9 individual colors to the final substrates) printer (INDIGO,  
10 N.V.) giving metallic gold prints which are free of  
11 background contamination. It should be noted that this  
12 method of preparing gold ink (and the other inks described  
13 below), without grinding, results in large reflective gold  
14 particles being laid onto the substrate. While the flakes  
15 are unaligned in the toner, when the toner is formed into a  
16 thin layer during heating and fixing to the substrate, the  
17 flakes selectively align themselves to give good specular  
18 reflection.

#### 19 SILVER INK

20       The materials used in the preparation are 300 grams  
21 Aclyn293A (made by Allied Signal), 1500 grams Isopar-L and  
22 100 Grams silver flakes 6-10 micrometers (made by SCHLENK).  
23 The same procedure as for gold ink is used to obtain ink  
24 with a median particle size of 8.2 micrometers.

25       The ink was tested in both printing modes, in the  
26 printer giving metallic silver prints without background  
27 contamination.

#### 28 MAGNETIC INK

29       The materials used in the preparation are 20 grams  
30 Aclyn293A (made by Allied Signal), 37 grams MO 4431 magnetic  
31 oxide (made by ISK MAGNETICS) with a particle size of 8-10  
32 micrometers and 180 grams Isopar-L. The same procedure as  
33 for gold ink is used to obtain magnetic ink with a median  
34 particle size of 9.08 micrometers as measured by SCHIMADZU  
35 Particle Size Analyzer.

36       When the magnetic ink is deposited at a mass/area of



1 0.26mg./sq.cm., the resultant layer has a magnetic signal  
2 of 82% of standard as measured by a NMI apparatus marketed  
3 by Checkmate Electronics, and an optical density of 1.5  
4 (transmittance).

5 **FLUORESCENT INK**

6 The materials used in the preparation are 500 grams  
7 Aclyn293A (made by Allied Signal), 333.3 grams fluorescent  
8 pigment RC15 (made by RADIANT COLOR) having a median  
9 particle size of 2.5 - 4.5 micrometers and 1500 grams  
10 Isopar-L.

11 The resin is solubilized by the ISOPAR L in a ROSS  
12 DOUBLE PLANETARY MIXER heated at 110° C.

13 The pigment is predispersed and wetted by using a warm  
14 solution of Aclyn293A, then adding the predispersed pigment  
15 gradually into the double planetary mixer. The material is  
16 mixed for about 10 minutes, while heating is maintained, to  
17 obtain a homogeneous composition. Heating is stopped and  
18 mixing is continued for an additional 1.5 hours to obtain  
19 toner concentrate with a particle size of 3.82 micrometers.  
20 Working dispersions are prepared using a high shear mixer.

21 Intermediate transfer member 30 may be any suitable  
22 intermediate transfer member having a multilayered transfer  
23 portion such as those described below or in US Patents  
24 5,089,856 or 5,047,808 or in U.S. Patent application  
25 08/371,117, filed January 11, 1995 and entitled IMAGING  
26 APPARATUS AND INTERMEDIATE TRANSFER BLANKET THEREFOR (and in  
27 corresponding applications in other countries), the  
28 disclosures of which are incorporated herein by reference.  
29 Member 30 is maintained at a suitable voltage and  
30 temperature for electrostatic transfer of the image thereto  
31 from the image bearing surface. Intermediate transfer member  
32 30 is preferably associated with a pressure roller 71 for  
33 transfer of the image onto a final substrate 72, preferably  
34 by heat and pressure. Additionally, pressure roller 71 may  
35 be electrified to overcome the voltage on the intermediate  
36 transfer member or to provide an additional electric field



1 to aid transfer of the electrified toner to the substrate.

2       Cleaning apparatus 32 is operative to scrub clean the  
3 surface of photoreceptor 12 and preferably includes a  
4 cleaning roller 74, a sprayer 76 to spray a non- polar  
5 cleaning liquid to assist in the scrubbing process and a  
6 wiper blade 78 to complete the cleaning of the  
7 photoconductive surface. Cleaning roller 74, which may be  
8 formed of any synthetic resin known in the art, for this  
9 purpose is driven in the same sense as drum 10 as indicated  
10 by arrow 80, such that the surface of the roller scrubs the  
11 surface of the photoreceptor. Any residual charge left on  
12 the surface of photoreceptor sheet 12 may be removed by  
13 flooding the photoconductive surface with light from  
14 optional neutralizing lamp assembly 36, which may not be  
15 required in practice.

16       While the invention has been described with respect to  
17 printing on the inside of clear wrapping material (i.e.,  
18 with the opaque layer furthest from the substrate), in an  
19 alternative preferred embodiment of the invention, the layer  
20 closest to the substrate is opaque. Such images are designed  
21 to be viewed from the side of the substrate on which the  
22 image is printed. For this embodiment of the invention, the  
23 white layer will be formed on the imaging surface and  
24 transferred to the intermediate transfer member after the  
25 other, colored layers.

26       In addition to the details of the printing processes  
27 given above, additional details of printing processes and  
28 operates are given in the patents and publications  
29 incorporated herein by reference.

30       It has been found that the above mentioned toners and  
31 other toners based on similar materials and high molecular  
32 weight ionomers such as surlyns adhere well to the  
33 substrates used in food packaging. This adhesion is found to  
34 be especially good when the toner is based on an ionomer or  
35 ethylene polymer or copolymer and the polymer film is  
36 coated by a similar material. Such coatings, particularly



1 Surlyn 1601 ionomer, EVA (particularly low molecular weight  
2 EVA) and ethylene acrylic acid are often provided on the  
3 inner surface of food wrappings to give improved properties  
4 such as sealability, adhesiveness and food compatibility.

5       It should be understood that the invention is not  
6 limited to the specific type of image forming system used  
7 and the present invention is also useful with any suitable  
8 imaging system which forms a liquid toner image on an image  
9 forming surface and, the specific details given above for  
10 the image forming system are included as part of a best mode  
11 of carrying out the invention, however, many aspects of the  
12 invention are applicable to a wide range of systems as known  
13 in the art for electrostatic printing and copying.

14       It will be appreciated by persons skilled in the art  
15 that the present invention is not limited by the description  
16 and example provided hereinabove. Rather, the scope of this  
17 invention is defined only by the claims which follow:

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CLAIMS

- 1  
2 1. A printing process for forming high contrast color  
3 images on polymer surfaces, comprising:
  - 4 (a) forming a layer of substantially opaque liquid  
5 toner comprising polymer based toner particles and a carrier  
6 liquid, on an imaging surface;
  - 7 (b) transferring the layer to an intermediate transfer  
8 member;
  - 9 (c) heating the layer on the intermediate transfer  
10 member to a temperature at which the toner particles at  
11 least partially coalesce;
  - 12 (d) repeating (a) to (c) sequentially for at least one  
13 subsequent layer in at least one color, said at least one  
14 subsequent layer being transferred to the intermediate  
15 transfer member onto the opaque layer to form multiple  
16 layers on the intermediate transfer member; and
  - 17 (e) transferring the multiple layers to a polymer  
18 surface.
- 19  
20 2. A process according to claim 1 wherein the opaque layer  
21 is the lowest layer of the multiple layers on the  
22 intermediate transfer member.
- 23  
24 3. A printing process for forming high contrast color  
25 images on polymer surfaces, comprising:
  - 26 (a) forming a colored layer of liquid toner comprising  
27 polymer based toner particles and a carrier liquid, on an  
28 imaging surface;
  - 29 (b) transferring the layer to an intermediate transfer  
30 member;
  - 31 (c) heating the layer on the intermediate transfer  
32 member to a temperature at which the toner particles at  
33 least partially coalesce;
  - 34 (d) repeating (a) to (c) sequentially for at least a  
35 substantially opaque liquid toner layer, said substantially  
36 opaque layer being transferred to the intermediate transfer



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- 20 -

1 member onto the colored layer to a plurality of layers on  
2 the intermediate transfer member; and  
3 (e) transferring the plurality of layers to a polymer  
4 surface.

5

6 4. A printing process according to claim 3 and including  
7 repeating (a) to (c) sequentially prior to (d) for at  
8 least one subsequent layer in at least one different color,  
9 said colored and opaque layers forming multiple layers on  
10 the intermediate transfer member.

11

12 5. A process according to claim 3 or claim 4 wherein the  
13 opaque layer is the uppermost layer of the multiple layers  
14 on the intermediate transfer member prior to transfer to the  
15 polymer surface.

16

17 6. A process according to any of the preceding claims  
18 wherein the colored layers are in the form of an image.

19

20 7. A process according to any of the preceding claims  
21 wherein the opaque liquid toner contains a white pigment.

22

23 8. A process according to claim 7 wherein the white  
24 pigment is  $TiO_2$ .

25

26 9. A process according to any of the preceding claims  
27 wherein forming a layer comprises:

28

(i) charging a chargeable imaging surface;

29

(ii) selectively discharging portions of the charged  
30 imaging surface to form a predefined electrostatic image;  
31 and

32

(iii) developing a layer of charged opaque white toner  
33 particles onto the selectively discharged portions of the  
34 imaging surface thereby providing a developed image  
35 corresponding to the latent image.

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- 21 -

1 10. A process according to any of the preceding claims  
2 wherein the polymer surface is the surface of a transparent  
3 film.

4

5 11. A process according to any of the preceding claims  
6 wherein the polymer surface is coated.

7

8 12. A process according to claim 11 wherein the coating is  
9 an ionomer.

10

11 13. A process according to claim 12 wherein the ionomer has  
12 a low molecular weight.

13

14 14. A process according to claim 12 wherein the ionomer has  
15 a high molecular weight.

16

17 15. A process according to claim 11 wherein the coating is  
18 an ethylene vinyl acetate polymer.

19

20 16. A process according to any of the preceding claims  
21 wherein the polymer surface is polypropylene.

22

23 17. A process according to any of claims 1-15 wherein the  
24 polymer surface is polyethylene.

25

26 18. A process according to any of the preceding claims  
27 wherein the transfer of the multiple layers to the polymer  
28 surface is effected with heat and pressure.

29

30 19. A process according to any of the preceding claims  
31 wherein at least one of the at least one color layers is a  
32 color halftone separation.

33

34 20. A process according to any of the preceding claims in  
35 which the toner particle layers form films on the  
36 intermediate transfer member.



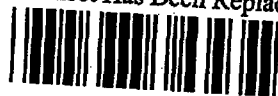
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- 1
- 2 21. A printing process comprising:
- 3 (a) forming a liquid toner image comprising toner
- 4 particles based on a first polymer and a carrier liquid, on
- 5 an imaging surface;
- 6 (b) transferring the image to a surface coated with a
- 7 second polymer; and
- 8 (c) fusing and fixing the image to the surface coating,
- 9 wherein
- 10 the second polymer is either an ionomer or an ethylene
- 11 vinyl acetate polymer.
- 12
- 13 22. A process according to claim 21 wherein the first
- 14 polymer is an ionomer.
- 15
- 16 23. A process according to claim 22 wherein the first
- 17 polymer is a high molecular weight ionomer.
- 18
- 19 24. A process according to claim 22 wherein the first
- 20 polymer is a low molecular weight ionomer.
- 21
- 22 25. A process according to claim 21 wherein the first
- 23 polymer is ethylene vinyl acetate.
- 24
- 25 26. A process according to claim 21 wherein the polymer is
- 26 a ethylene copolymer.
- 27
- 28 27. A process according to claim 21 wherein the polymer is
- 29 a ethylene terpolymer.
- 30
- 31 28. A process according to any of claims 21-27, wherein
- 32 the second polymer is an ionomer.
- 33
- 34 29. A process according to claim 28, wherein the second
- 35 polymer is a high molecular weight ionomer.
- 36



- 1 30. A process according to claim 28, wherein the second  
2 polymer is a low molecular weight ionomer.  
3
- 4 31. A process according to claim 28 wherein the second  
5 polymer is ethylene vinyl acetate.  
6
- 7 32. A process according to any of claims 21-31, wherein the  
8 substrate surface is a polypropylene film.  
9
- 10 33. A process according to any of claims 21-31, wherein the  
11 substrate surface is a polyethylene film.  
12
- 13 34. A printing process comprising:  
14 (a) forming a liquid toner image comprising toner  
15 particles based on a first polymer and a carrier liquid, on  
16 an imaging surface;  
17 (b) transferring the image to a surface coated with a  
18 second polymer; and  
19 (c) fusing and fixing the image to the surface coating,  
20 wherein the first polymer and the second polymer are both  
21 ionomers.  
22
- 23 35. A process according to claim 34 wherein the first  
24 ionomer is of a low molecular weight.  
25
- 26 36. A process according to claim 34 wherein the first  
27 ionomer is of a high molecular weight.  
28
- 29 37. A process according to any of claims 34-36, wherein the  
30 second ionomer is of a low molecular weight.  
31
- 32 38. A process according to any of claims 34-36 wherein the  
33 second ionomer is of a high molecular weight.  
34
- 35 39. A process according to any of claims 34-38 wherein the  
36 surface is a polypropylene film.



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2 40. A process according to any of claims 34-38 wherein the  
3 surface is a polyethylene film.

4

5 41. A process according to any of the preceding claims  
6 wherein the imaging surface is the surface of a  
7 photoreceptor.

8

9 42. A toner particle comprising:

10 a polymer; and  
11 flakes of metal.

12

13 43. A toner particles according to claim 42 wherein the  
14 flakes of metal have a dimension greater than about 4  
15 micrometers.

16

17 44. A toner particle according to claim 43 wherein the  
18 flakes of metal have a dimension greater than 6 micrometers.

19

20 45. A toner particle according to any of claims 42-44  
21 wherein the metal flakes comprise gold.

22

23 46. A toner particle according to any of claims 42-44  
24 wherein the metal flakes comprise silver.

25

26 47. A toner particle comprising:

27 a polymer; and  
28 a fluorescent material.

29

30 48. A toner particles according to claim 47 wherein  
31 fluorescent material is in the form of particles having a  
32 size greater than 2 micrometers.

33

34 49. A toner particle according to any of claims 42-48  
35 wherein the polymer is a low molecular weight ionomer.

36

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1 50. An electrified toner particle according to any of  
2 claims 42-49.

3

4 51. A liquid toner comprising:

5 a plurality of toner particles according to any of  
6 claims 42-50; and

7 a carrier liquid.

8

9 51. A printed image printed with toner particles according  
10 to any of claims 42-50.

11

12 52. A printed image printed with a process utilizing a  
13 liquid toner according to claim 51.

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ABSTRACT OF THE INVENTION

1  
2 A printing process for forming high contrast color  
3 images on polymer surfaces, comprising: (a) forming a layer  
4 of substantially opaque liquid toner comprising polymer  
5 based toner particles and a carrier liquid, on an imaging  
6 surface; (b) transferring the layer to an intermediate  
7 transfer member; (c) heating the layer on the intermediate  
8 transfer member to a temperature at which the toner  
9 particles at least partially coalesce; (d) repeating (a) to  
10 (c) sequentially for at least one subsequent layer in at  
11 least one color, said at least one subsequent layer being  
12 transferred to the intermediate transfer member onto the  
13 opaque layer to form multiple layers on the intermediate  
14 transfer member; and (e) transferring the multiple layers to  
15 a polymer surface.

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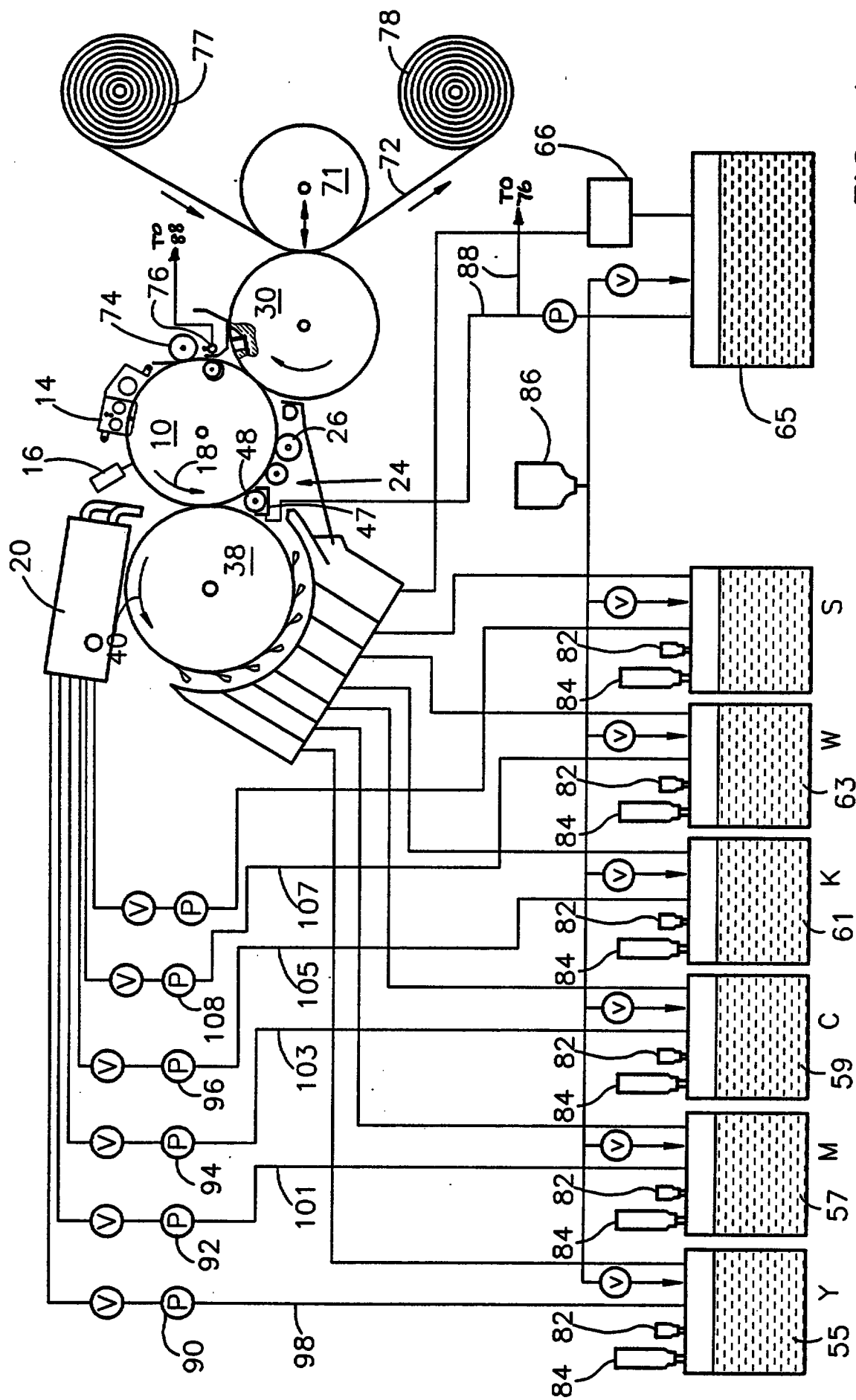
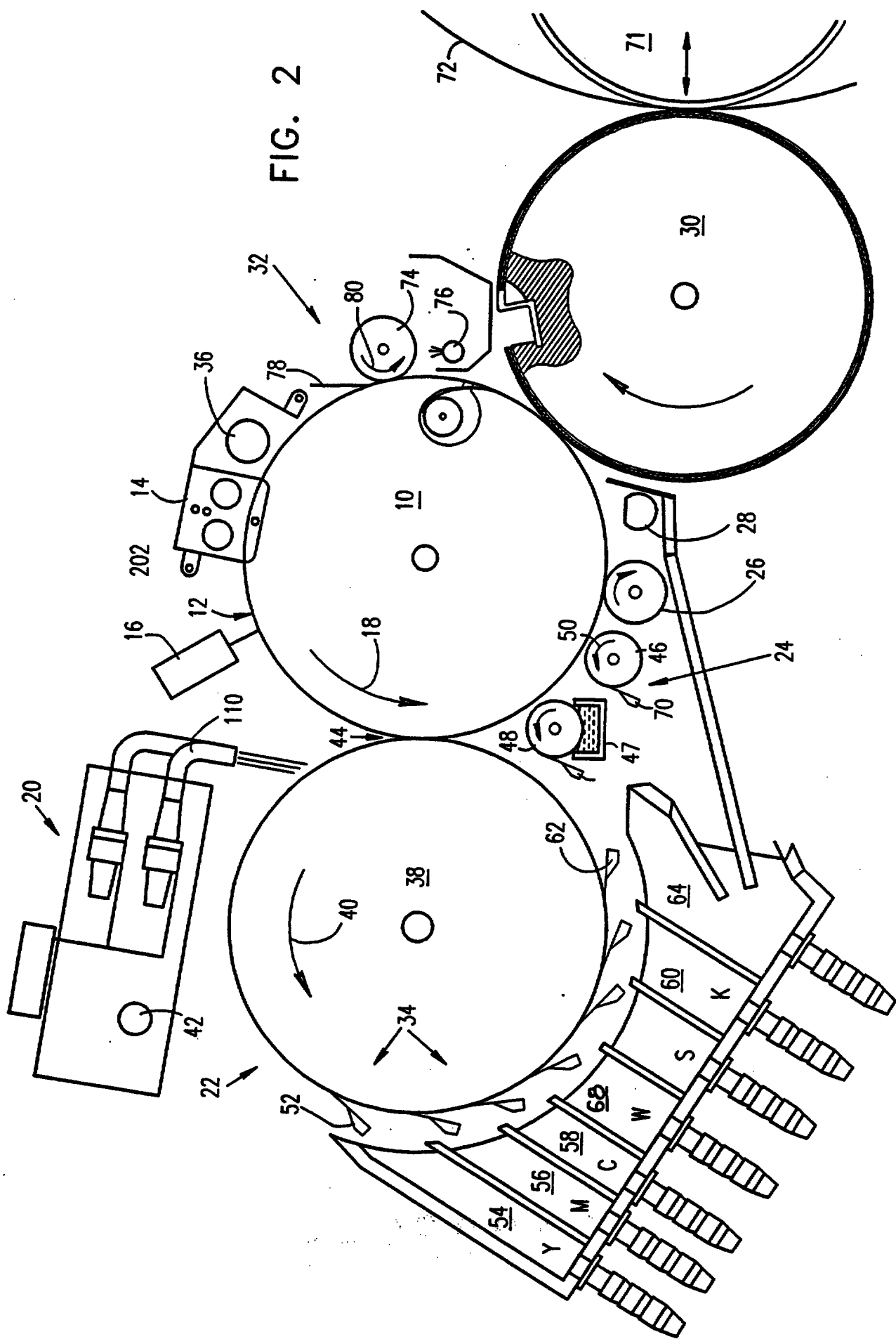


FIG. 1



| REPLACED SHEETS                     |                                           | SG |
|-------------------------------------|-------------------------------------------|----|
| <input type="checkbox"/>            | Description : paged ..... to paged .....  |    |
| <input checked="" type="checkbox"/> | Claim(s) : paged ..19... to paged ..25... |    |
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| REPLACEMENT SHEETS                  |                                             | SG |
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| <input checked="" type="checkbox"/> | Description : paged ..1... to paged ..18... |    |
| <input checked="" type="checkbox"/> | Claim(s) : paged ..19... to paged ..25...   |    |
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- 1 -

# 1 PRINTING ON TRANSPARENT FILM

## 2 FIELD OF THE INVENTION

3 The present invention relates to an improved  
4 electrostatic processes for printing or coating on polymer  
5 films and surfaces with toner and toner inks. The invention  
6 specifically relates to a method of achieving high quality  
7 high contrast colored or multi-colored images in continuous  
8 roll printing on transparent, flexible packaging films.

## 9 BACKGROUND OF THE INVENTION

10 The coating of plastic films or surfaces e.g.  
11 polyethylene, polypropylene, etc. for aesthetic or  
12 functional purposes is of great utility and importance. A  
13 major use of such films is in food packaging.

14 Electrostatic printing has inherent advantages which  
15 would appear to make it particularly desirable for printing  
16 on plastic films. The inherent advantages include  
17 adaptability to short runs economically, high resolution, on  
18 demand printing and good visibility. However, at present,  
19 printing on transparent films, especially multi-color  
20 printing is commercially performed in multi-head presses,  
21 and only in long runs.

## 22 SUMMARY OF THE INVENTION

23 It is an object of certain aspects of the present  
24 invention to produce improved quality color images  
25 electrostatically on transparent plastic films and  
26 substrates.

27 Color integrity of multi-color images is improved by  
28 optimizing the image forming and transfer stages of the  
29 printing process.

30 In order to improve the visibility of color images  
31 printed on the inner surface of transparent flexible  
32 packaging, according to a preferred embodiment of the  
33 invention, the color image is overcoated with a  
34 substantially opaque toner layer at least in those portions  
35 of the packaging which are printed with color toners. Thus  
36 on the packaging material, at least one color toner layer is

REPLACEMENT SHEET

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- 2 -

1 situated closest to the material, and a white or other  
2 opaque layer is situated behind the colored layer or layers,  
3 i.e., further away from the material. Such images are viewed  
4 from the unprinted side of the substrate.

5       Alternatively, the complete multi-layer image is  
6 printed with the opaque layer uppermost on the intermediate  
7 transfer member so that, when the image is transferred to  
8 the substrate, the opaque layer is closest to the substrate.  
9 Such images are viewed from the printed side of the  
10 substrate.

11       Additionally, the white toner layer may also extend  
12 past the edges of the colored layers and directly contact  
13 the packaging material.

14       In order to avoid unnecessary alignment and  
15 registration steps, the different color images involved are  
16 sequentially transferred from an image forming surface onto  
17 an intermediate transfer member, each in alignment with  
18 previous images. The intermediate transfer member is heated  
19 so that each color image coalesces into a cohesive film, in  
20 which the respective color pigments are held so that they do  
21 not diffuse into other layers. Mixing of colors, especially  
22 with the opaque pigment is detrimental to image quality.

23       Each complete multi-color image is subsequently  
24 transferred from the intermediate transfer member to the  
25 substrate.

26       Another object of certain aspects of the present  
27 invention is to provide a process for printing toner polymer  
28 images on ionomer (high or low molecular weight) or ethylene  
29 vinyl acetate coatings on polymer surfaces, thereby  
30 achieving improved qualities. The toner polymer images may  
31 be based on high molecular weight ionomers, e.g. Surlins,  
32 low molecular weight ionomers, e.g. Aclyns, ionomers having  
33 an intermediate molecular weight, ethylene vinyl acetate  
34 polymers and ethelene copolymers or terpolymers e.g., Bynels  
35 and Nuclels, to achieve improved qualities, such as  
36 sealability, adhesiveness, food compatibility, and others.

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1 In other aspects of the invention special toners,  
2 including opaque white, silver, gold and fluorescent toners  
3 have been prepared by adding pigments to a hot ionomer  
4 solution, preferably of low molecular weight ionomers, and  
5 stirring the mixture as it cools. This procedure has been  
6 used to prepare gold, silver, white opaque  $\text{TiO}_2$  based,  
7 magnetic and fluorescent inks, respectively.

8 There is thus provided, in accordance with a preferred  
9 embodiment of the invention, a printing process for forming  
10 high contrast color images on polymer surfaces, comprising:

11 (a) forming a layer of substantially opaque liquid  
12 toner comprising polymer based toner particles and a carrier  
13 liquid, on an imaging surface;

14 (b) transferring the layer to an intermediate transfer  
15 member;

16 (c) heating the layer on the intermediate transfer  
17 member to a temperature at which the toner particles at  
18 least partially coalesce;

19 (d) repeating (a) to (c) sequentially for at least one  
20 subsequent layer in at least one color, said at least one  
21 subsequent layer being transferred to the intermediate  
22 transfer member onto the opaque layer to form multiple  
23 layers on the intermediate transfer member; and

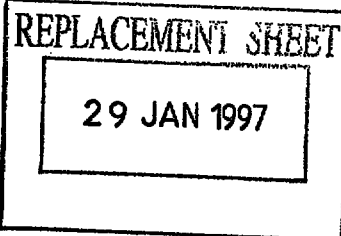
24 (e) transferring the multiple layers to a polymer  
25 surface.

26 There is further provided, in accordance with a  
27 preferred embodiment of the invention, a printing process  
28 for forming high contrast color images on polymer surfaces,  
29 comprising:

30 (a) forming a colored layer of liquid toner comprising  
31 polymer based toner particles and a carrier liquid, on an  
32 imaging surface;

33 (b) transferring the layer to an intermediate transfer  
34 member;

35 (c) heating the layer on the intermediate transfer  
36 member to a temperature at which the toner particles at



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1 least partially coalesce;

2 (d) repeating (a) to (c) sequentially for at least a  
3 substantially opaque liquid toner layer, said substantially  
4 opaque layer being transferred to the intermediate transfer  
5 member onto the colored layer to a plurality of layers on  
6 the intermediate transfer member; and

7 (e) transferring the plurality of layers to a polymer  
8 surface.

9 Preferably, forming a layer comprises:

10 (i) charging a photoreceptor surface;

11 (ii) selectively discharging portions of the charged  
12 photoreceptor surface to form a predefined electrostatic  
13 image; and

14 (iii) developing a layer of charged opaque white toner  
15 particles onto the selectively discharged portions of the  
16 photoreceptor surface thereby providing a developed image  
17 corresponding to the latent image.

18 There is further provided, in accordance with a  
19 preferred embodiment of the invention, a printing process  
20 comprising:

21 (a) forming a liquid toner image comprising toner  
22 particles based on a first polymer and a carrier liquid, on  
23 an imaging surface;

24 (b) transferring the image to a surface coated with a  
25 second polymer; and

26 (c) fusing and fixing the image to the surface coating,  
27 wherein the second polymer is either an ionomer or an  
28 ethylene vinyl acetate polymer.

29 Preferably, the second polymer is either an ionomer or  
30 an ethylene vinyl acetate polymer high molecular weight  
31 ionomers, e.g. Surlyn, low molecular weight ionomers, e.g.  
32 Aclyn, ionomers having an intermediate molecular weight,  
33 ethylene vinyl acetate polymers and ethylene copolymers or  
34 terpolymers e.g., Bynels and Nucrels.

35 There is further provided, in accordance with a  
36 preferred embodiment of the invention, a printing process

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1 comprising:

2 (a) forming a liquid toner image comprising toner  
3 particles based on a first polymer and a carrier liquid, on  
4 an imaging surface;

5 (b) transferring the image to a surface coated with a  
6 second polymer; and

7 (c) fusing and fixing the image to the surface coating,  
8 wherein the first and second polymer is an ionomer.

9 Preferably, the first polymer is comprises an ionomer,  
10 more preferably the same ionomer as the second polymer.

11 There is further provided, in accordance with a  
12 preferred embodiment of the invention, a toner particle  
13 comprising:

14 a polymer; and

15 flakes of metal.

16 Preferably, the flakes which may be of gold or silver,  
17 have a dimension greater than about 4 micrometers, more  
18 preferably than 6 micrometers.

19 There is further provided, in accordance with a  
20 preferred embodiment of the invention, a toner particle  
21 comprising:

22 a polymer; and

23 a fluorescent material, preferably in the form of  
24 particles having a size greater than 2 micrometers.

25 Preferably, the polymer in the above toner particles is  
26 a low molecular weight ionomer.

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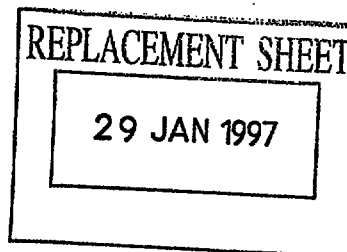
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1                    **BRIEF DESCRIPTION OF THE DRAWINGS**

2            The invention will be more clearly understood from the  
3 following description of preferred embodiments thereof in  
4 conjunction with the following drawings which:

5            Fig. 1 is a simplified sectional illustration of  
6 electrostatic imaging apparatus constructed and operative in  
7 accordance with a preferred embodiment of the present  
8 invention; and

9            Fig. 2 is a simplified enlarged sectional illustration  
10 of the apparatus of Fig. 1.

11                    **DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS**

12            Reference is now made to Figs. 1 and 2 which illustrate  
13 a multi color electrostatic imaging system constructed and  
14 operative in accordance with a preferred embodiment of the  
15 present invention. As seen in Figs. 1 and 2 there is  
16 provided an imaging sheet, preferably an organic  
17 photoreceptor 12, typically mounted on a rotating drum 10.  
18 Drum 10 is rotated about its axis by a motor or the like  
19 (not shown), in the direction of arrow 18, past charging  
20 apparatus 14, preferably a corotron, scorotron or roller  
21 charger or other suitable charging apparatus as are known in  
22 the art and which is adapted to charge the surface of sheet  
23 photoreceptor 12. The image to be reproduced is focused by  
24 an imager 16 upon the charged surface 12 at least partially  
25 discharging the photoconductor in the areas struck by light,  
26 thereby forming an electrostatic latent image. Thus, the  
27 latent image normally includes image areas at a first  
28 electrical potential and background areas at another  
29 electrical potential.

30            A preferred photoreceptor sheet and preferred methods  
31 of mounting it on drum 10 are described in a co-pending  
32 application of Belinkov et al., IMAGING APPARATUS AND  
33 PHOTORECEPTOR THEREFOR, filed September 7, 1994 assigned  
34 serial number 08/301,775 and in corresponding applications in  
35 other countries, the disclosures of which are incorporated  
36 herein by reference. Alternatively, photoreceptor 12 may be

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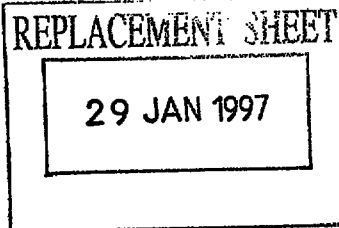
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1 deposited on the drum 10 and may form a continuous surface.  
2 Furthermore, photoreceptor 12 may be a non-organic type  
3 photoconductor based, for example, on a compound of  
4 selenium.

5 Also associated with drum 10 and photoreceptor sheet  
6 12, in a preferred embodiment of the invention, are a  
7 multicolor liquid developer spray assembly 20, a developing  
8 assembly 22, color specific cleaning blade assemblies 34, a  
9 background cleaning station 24, an electrified squeegee 26,  
10 a background discharge device 28, an intermediate transfer  
11 member 30, cleaning apparatus 32, and, optionally, a  
12 neutralizing lamp assembly 36. Developing assembly 22  
13 preferably includes a development roller 38. Development  
14 roller 38 is preferably spaced from photoreceptor 12  
15 thereby forming a gap therebetween of typically 40 to 150  
16 micrometers and is charged to an electrical potential  
17 intermediate that of the image and background areas of the  
18 image. Development roller 38 is thus operative, when  
19 maintained at a suitable voltage, to apply an electric field  
20 to aid development of the latent electrostatic image.

21 Development roller 38 typically rotates in the same  
22 sense as drum 10 as indicated by arrow 40. This rotation  
23 provides for the surface of sheet 12 and development roller  
24 38 to have opposite velocities at the gap between them.

25 In accordance with a preferred embodiment of the  
26 invention, an opaque white background image is initially  
27 developed on the photoreceptor surface and transferred to an  
28 intermediate transfer member 30. The background image is  
29 heated to a temperature that causes the white toner  
30 particles in the presence of carrier liquid to at least  
31 partially coalesce, preferably into a cohesive film, i.e.,  
32 the toner pigment is fixed in the layer in which it was  
33 deposited so that mixing of different color pigments in  
34 various layers is prevented. This is essential for the  
35 achievement of good color quality and contrast in the final  
36 composite image. Subsequent images in different colors are



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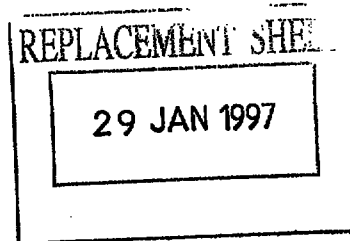
1 individually developed and sequentially transferred in  
2 alignment with the previous image onto intermediate transfer  
3 member 30, which is heated as before so that each color  
4 forms a cohesive non-diffusive layer.

5       It should be noted that each of the layers is a viscous  
6 liquid and that while heating does cause the layers to  
7 coalesce, the balance between viscosity and surface tension  
8 of the layers is apparently such that the individual layers  
9 have only minimal mixing.

10       When all of the desired images have been transferred to  
11 intermediate transfer member 30, the complete multi-color  
12 image is transferred therefrom to substrate 72. Impression  
13 roller 71 only produces operative engagement between  
14 intermediate transfer member 30 and substrate 72 when  
15 transfer of the composite image to substrate 72 takes place,  
16 preferably with heat and pressure. Substrate 72 which is  
17 preferably a transparent flexible polymer film is fed from a  
18 feeder roller 77 and is taken up by take up roller 78. The  
19 printing process when carried out as described produces a  
20 high contrast high colored quality image.

21       Preferably, the motion of the polymer film is halted  
22 during the accumulation of the layers on the intermediate  
23 transfer member. Just prior to the transfer, the film is  
24 accelerated to a velocity substantially equal to the surface  
25 velocity of the intermediate transfer member, such that  
26 there is substantially zero relative motion between them at  
27 the time of contact. Furthermore, between transfers, the  
28 film is preferably partially rewound so that, after the  
29 acceleration, only a minimal blank space is left unprinted.

30       Multicolor liquid developer spray assembly 20, whose  
31 operation and structure is described in detail in U.S.  
32 Patent 5,117,263, the disclosure of which is incorporated  
33 herein by reference, may be mounted on axis 42 to allow  
34 assembly 20 to be pivoted in such a manner that a spray of  
35 liquid toner containing electrically charged pigmented toner  
36 particles can be directed either onto a portion of the



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1 development roller 38, a portion of the photoreceptor 12  
2 or directly into a development region 44 between  
3 photoreceptor 12 and development roller 38. Alternatively,  
4 assembly 20 may be fixed. Preferably, the spray is directed  
5 onto a portion of the development roller 38.

6 Color specific cleaning blade assemblies 34 are  
7 operatively associated with developer roller 38 for separate  
8 removal of residual amounts of each colored toner remaining  
9 thereon after development. Each of blade assemblies 34 is  
10 selectably brought into operative association with developer  
11 roller 38 only when toner of a color corresponding thereto  
12 is supplied to development region 44 by spray assembly 20.  
13 The construction and operation of cleaning blade assemblies  
14 is described in PCT Publication WO 90/14619 and in US patent  
15 5,289,238, the disclosures of which are incorporated herein  
16 by reference.

17 Each cleaning blade assembly 34 includes a toner  
18 directing member 52 which serves to direct the toner  
19 removed by the cleaning blade assemblies 34 from the  
20 developer roller 38 to separate collection containers 54,  
21 56, 58, 60, and 68 and for each color to prevent  
22 contamination of the various developers by mixing of the  
23 colors. The toner collected by the collection containers is  
24 recycled to a corresponding toner reservoir (55, 57, 59, 61  
25 and 63). And a final toner directing member 62 always  
26 engages the developer roller 38 and the toner collected  
27 thereat is supplied into collection container 64 and  
28 thereafter to reservoir 65 via separator 66 which is  
29 operative to separate relatively clean carrier liquid from  
30 the various colored toner particles. The separator 66 may be  
31 typically of the type described in U.S. Patent 4,985,732,  
32 the disclosure of which is incorporated herein by reference.

33 In a preferred embodiment of the invention, as  
34 described in PCT Publication WO 92/13297, the disclosure of  
35 which is incorporated herein by reference, where the imaging  
36 speed is very high, a background cleaning station 24

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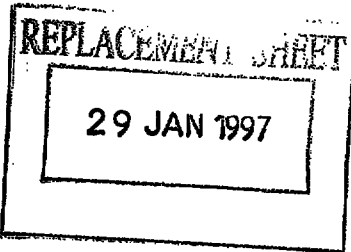
- 10 -

1 typically including a reverse roller 46 and a wetting roller  
2 48 is provided. Reverse roller 46 which rotates in a  
3 direction indicated by arrow 50 is preferably electrically  
4 biased to a potential intermediate that of the image and  
5 background areas of photoconductive drum 10, but different  
6 from that of the development roller. Reverse roller 46 is  
7 preferably spaced apart from photoreceptor sheet 12 thereby  
8 forming a gap therebetween which is typically 40 to 150  
9 micrometers.

10       Wetting roller 48 is preferably partly immersed in a  
11 fluid bath 47, which preferably contains carrier liquid  
12 received from carrier liquid reservoir 65 via conduit 88.  
13 Wetting roller 48, which preferably rotates in the same  
14 sense as that of drum 10 and reverse roller 46, operates to  
15 wet photoreceptor sheet 12 with non-pigmented carrier liquid  
16 upstream of reverse roller 46. The liquid supplied by  
17 wetting roller 48 replaces the liquid removed from drum 10  
18 by development assembly 22, thus allowing the reverse  
19 roller 46 to remove charged pigmented toner particles by  
20 electrophoresis from the background areas of the latent  
21 image. Excess fluid is removed from reverse roller 46 by a  
22 liquid directing member 70 which continuously engages  
23 reverse roller 46 to collect excess liquid containing toner  
24 particles of various colors which is in turn supplied to  
25 reservoir 65 via collection container 64 and separator 66.

26       Wetting roller 48 is preferably electrically biased to  
27 a potential intermediate that of the image and background  
28 areas of photoconductive drum 10, but different from that of  
29 the development roller. This biasing of wetting roller 48  
30 assists in removing toner particles from the background  
31 areas of photoreceptor sheet 12. Wetting roller 48 is  
32 preferably spaced apart from photoreceptor sheet 12 thereby  
33 forming a gap therebetween which is typically 40 to 200  
34 micrometers.

35       The apparatus embodied in reference numerals 46, 47, 48  
36 and 70 is generally not required for low speed systems, but



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1 is preferably included in high speed systems.

2 Preferably, an electrically biased squeegee roller 26  
3 is urged against the surface of sheet 12 and is operative to  
4 remove liquid carrier from the background regions and to  
5 compact the image and remove liquid carrier therefrom in the  
6 image regions. Squeegee roller 26 is preferably formed of  
7 resilient slightly conductive polymeric material as is well  
8 known in the art, and is preferably charged to a potential  
9 of several hundred to a few thousand volts with the same  
10 polarity as the polarity of the charge on the toner  
11 particles.

12 Discharge device 28 is operative to flood sheet 12 with  
13 light which discharges the voltage remaining on sheet 12,  
14 mainly to reduce electrical breakdown and improve transfer  
15 of the image to intermediate transfer member 30. Operation  
16 of such a device in a write black system is described in  
17 U.S. Patent 5,280,326, the disclosure of which is  
18 incorporated herein by reference.

19 Figs. 1 and 2 further show that multicolor toner spray  
20 assembly 20 receives separate supplies of colored toner  
21 typically from five different reservoirs 55, 57, 59, 61 and  
22 63. Figure 1 shows five different colored toner reservoirs  
23 55, 57, 59, 61 and 63, typically containing the colors  
24 Yellow, Magenta, Cyan, black and white, respectively. In  
25 addition, reservoir 65 contains relatively clean carrier  
26 liquid whose operation was described. Pumps 90, 92, 94, 96  
27 and 108, may be provided along respective supply conduits  
28 98, 101, 103, 105, and 107, for providing a desired amount  
29 of pressure to feed the colored toner to multicolor spray  
30 assembly 20. Alternatively, multicolor toner spray assembly  
31 20, which is preferably a three level spray assembly,  
32 receives supplies of colored toner from up to six different  
33 reservoirs (a sixth reservoir marked S is shown) which  
34 allows for custom colored toners in addition to the standard  
35 process colors, black and white.

36 Toners that can be used with the present invention are

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1 described in Example 1 of U.S. Patent 4,794,651, the  
2 disclosure of which is incorporated herein by reference or  
3 variants thereof as are well known in the art. For colored  
4 liquid developers, carbon black is replaced by color  
5 pigments as is well known in the art. Other toners may  
6 alternatively be employed, including liquid toners and, as  
7 indicated above, including powder toners.

8 Other toners for use in the invention can be prepared  
9 using the following method:

10 1) Solubilizing 1400 grams of Nucrel 925 (ethylene  
11 copolymer by Dupont) and 1400 g of Isopar L (Exxon) are  
12 thoroughly mixed in an oil heated Ross Double Planetary  
13 Mixer at least 24 RPM for 1.5 hours, with the oil  
14 temperature at 130° C. 1200 g of preheated Isopar L is added  
15 and mixing is continued for an additional hour. The mixture  
16 is cooled to 45° C, while stirring is continued over a  
17 period of several hours, to form a viscous material.

18 2) Milling and Grinding 762 grams of the result of the  
19 Solubilizing step are ground in a 1S attritor (Union Process  
20 Inc. Akron Ohio), charged with 3/16" carbon steel balls at  
21 250 RPM, together with 66.7 grams of Mogul L carbon black  
22 (Cabot), 6.7 grams of BT 583D (blue pigment produced by  
23 Cookson), 5 grams of aluminum stearate (Riedel Dehaen) and  
24 an additional 1459.6 grams of Isopar L for eight hours at  
25 30° C.

26 3) Continuation of Grinding 34.5 grams of ACumist A-12  
27 (a micronised polyethylene wax produced by Allied Signal) is  
28 added and grinding is continued for an additional 4 hours.  
29 The resulting particles are fibrous particles have a  
30 measured diameter in the range of 1-3 micrometers.

31 The resulting material is diluted with additional  
32 Isopar L and Marcol 82 to give a working developer in which  
33 the dry solids portion is about 1.7% and in which the  
34 overall ratio of Isopar L to Marcol is between about 50:1  
35 and 500:1, more preferably between about 100:1 and 200:1.  
36 Charge director as described in US patent application

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1 07/915,291 (utilizing lecithin, BBP and ICIG3300B) and in WO  
2 94/02887, in an amount approximately equal to 40 mg/gm of  
3 solids in the final dispersion, is added to charge the toner  
4 particles. Other charge directors and additional additives  
5 as are known in the art may also be used.

6       The above described process produces a black toner.  
7 Cyan, magenta and yellow toners can be produced by using a  
8 different mix of materials for step 2). For Cyan toner, 822g  
9 of the solubilized material, 21.33 grams each of BT 583D and  
10 BT 788D pigments (Cookson), 1.73 grams of D1355DD pigment  
11 (BASF), 7.59 grams of aluminum stearate and 1426 grams of  
12 Isopar L are used in step 2. For Magenta toner, 810 grams of  
13 solubilized material, 48.3 grams of Finess Red F2B, 6.81  
14 grams of aluminum stearate and 1434.2 grams of Isopar L are  
15 used in step 2. For yellow toner 810 grams of solubilized  
16 material, 49.1 grams of D1355DD pigment, 6.9 grams of  
17 aluminum stearate and 1423 grams of Isopar L are used in  
18 step 2.

19       Other preferred liquid toners for use in the present  
20 invention are prepared as follows: 300 grams of a  
21 chargeable low molecular weight ionomer Aclyn 293A (made by  
22 Allied Signal) were solubilized in 1500 grams of Isopar - L  
23 with heating to 110°- 120°C while stirring. To form inks,  
24 dispersed pigments or color particles are added to and mixed  
25 with the hot solubilized polymer. The composition is  
26 allowed to cool while stirring.

27       The following liquid toner inks were prepared in this  
28 way:

29 **TiO<sub>2</sub> BASED OPAQUE WHITE TONER INK**

30       A preferred opaque white ink in accordance with the  
31 present invention is prepared by adding 200 grams of finely  
32 divided TiO<sub>2</sub> pigment, having an average diameter of about  
33 0.5 micrometers to the solubilized polymer while stirring.  
34 The mixture is allowed to cool and settle with continuous  
35 stirring. Charge director, as described above or other  
36 charged directors as known in the art, and additional Isopar

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1 L and MARCOL 82 carrier liquid are added to form a liquid  
2 toner. The opaque white liquid toner so obtained is used,  
3 as previously mentioned, to enhance the quality of color  
4 images when it serves as a back layer for color contrast.  
5 The median pigmented toner particle size in the toner is  
6 4.81 micrometers.

7 An alternative preferred method for producing white  
8 toner ink concentrate, in accordance with a preferred  
9 embodiment of the invention comprises the steps of (1)  
10 plasticizing 35% Nucrel 699 (ethylene-metacrylic acid  
11 copolymer by DuPont) in Isopar L (EXXON) by heating the  
12 materials in a Ross double planetary mixer to 150°C while  
13 mixing the materials and allowing the mixture to cool while  
14 mixing continues until the mixture is fully mixed and  
15 homogeneous; (2) mixing 3071 grams of the mixture produced  
16 by step (1) with 1075 grams of KRONOS 2310 titanium dioxide  
17 (NL Chemicals) and 4454 grams of Isopar L in a Ross type LAB  
18 ME high shear mixer until the new mixture is completely  
19 homogeneous; and (3) grinding the mixture at about 56°C (the  
20 temperature of the mixture without cooling) for 16 hours in  
21 a SEECO M18 Vibratory Mill charged with 3/8" zirconia media.  
22 The resultant toner has a median diameter of about 3  
23 microns.

24 The material is charged and diluted as described above  
25 and 3 micrometer micron particles of TEFLON M1200 are  
26 optionally added to act as protective spacers against  
27 abrasion for the final image.

28 Other inks are prepared in a manner similar to the  
29 first method for producing white toner ink and provided the  
30 following results:

### 31 GOLD TONER INK

32 Aclyn293A, (made by Allied Signal) 150 grams, and  
33 Isopar-L, 800 grams, are heated with mixing in a glass  
34 beaker, at a temperature of 110° - 120° C. 100 grams of 6-  
35 10 micrometer gold flakes (made by SCHLENK) are slowly added  
36 and mixing is continued for 5 minutes. The temperature is

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1 allowed to fall to 90° C.

2 The composition is mixed at high shear (ROSS HIGH  
3 SHEAR MIXER) for 1 minute and cooled, while mixing, to room  
4 temperature while mixing is continued at 250 RPM.

5 Final ink median particle size as measured by a  
6 SCHIMADZU PARTICLE SIZE ANALYZER is 18.6 micrometers.

7 The ink was tested in an E-PRINT 1000 (using the single  
8 final transfer mode described above and separate transfer of  
9 individual colors to the final substrates) printer (INDIGO,  
10 N.V.) giving metallic gold prints which are free of  
11 background contamination. It should be noted that this  
12 method of preparing gold ink (and the other inks described  
13 below), without grinding, results in large reflective gold  
14 particles being laid onto the substrate. While the flakes  
15 are unaligned in the toner, when the toner is formed into a  
16 thin layer during heating and fixing to the substrate, the  
17 flakes selectively align themselves to give good specular  
18 reflection.

#### 19 SILVER INK

20 The materials used in the preparation are 300 grams  
21 Aclyn293A (made by Allied Signal), 1500 grams Isopar-L and  
22 100 Grams silver flakes 6-10 micrometers (made by SCHLENK).  
23 The same procedure as for gold ink is used to obtain ink  
24 with a median particle size of 8.2 micrometers.

25 The ink was tested in both printing modes, in the  
26 printer giving metallic silver prints without background  
27 contamination.

#### 28 MAGNETIC INK

29 The materials used in the preparation are 20 grams  
30 Aclyn293A (made by Allied Signal), 37 grams MO 4431 magnetic  
31 oxide (made by ISK MAGNETICS) with a particle size of 8-10  
32 micrometers and 180 grams Isopar-L. The same procedure as  
33 for gold ink is used to obtain magnetic ink with a median  
34 particle size of 9.08 micrometers as measured by SCHIMADZU  
35 Particle Size Analyzer.

36 When the magnetic ink is deposited at a mass/area of

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1 0.26mg./sq.cm., the resultant layer has a magnetic signal  
2 of 82% of standard as measured by a NMI apparatus marketed  
3 by Checkmate Electronics, and an optical density of 1.5  
4 (transmittance).

#### 5 FLUORESCENT INK

6 The materials used in the preparation are 500 grams  
7 Aclyn293A (made by Allied Signal), 333.3 grams fluorescent  
8 pigment RC15 (made by RADIANT COLOR) having a median  
9 particle size of 2.5 - 4.5 micrometers and 1500 grams  
10 Isopar-L.

11 The resin is solubilized by the ISOPAR L in a ROSS  
12 DOUBLE PLANETARY MIXER heated at 110° C.

13 The pigment is predispersed and wetted by using a warm  
14 solution of Aclyn293A, then adding the predispersed pigment  
15 gradually into the double planetary mixer. The material is  
16 mixed for about 10 minutes, while heating is maintained, to  
17 obtain a homogeneous composition. Heating is stopped and  
18 mixing is continued for an additional 1.5 hours to obtain  
19 toner concentrate with a particle size of 3.82 micrometers.  
20 Working dispersions are prepared using a high shear mixer.

21 Intermediate transfer member 30 may be any suitable  
22 intermediate transfer member having a multilayered transfer  
23 portion such as those described below or in US Patents  
24 5,089,856 or 5,047,808 or in U.S. Patent application  
25 08/371,117, filed January 11, 1995 and entitled IMAGING  
26 APPARATUS AND INTERMEDIATE TRANSFER BLANKET THEREFOR (and in  
27 corresponding applications in other countries), the  
28 disclosures of which are incorporated herein by reference.  
29 Member 30 is maintained at a suitable voltage and  
30 temperature for electrostatic transfer of the image thereto  
31 from the image bearing surface. Intermediate transfer member  
32 30 is preferably associated with a pressure roller 71 for  
33 transfer of the image onto a final substrate 72, preferably  
34 by heat and pressure. Additionally, pressure roller 71 may  
35 be electrified to overcome the voltage on the intermediate  
36 transfer member or to provide an additional electric field

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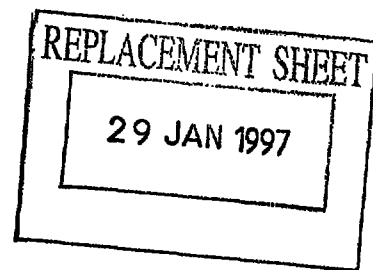
1 to aid transfer of the electrified toner to the substrate.

2       Cleaning apparatus 32 is operative to scrub clean the  
3 surface of photoreceptor 12 and preferably includes a  
4 cleaning roller 74, a sprayer 76 to spray a non- polar  
5 cleaning liquid to assist in the scrubbing process and a  
6 wiper blade 78 to complete the cleaning of the  
7 photoconductive surface. Cleaning roller 74, which may be  
8 formed of any synthetic resin known in the art, for this  
9 purpose is driven in the same sense as drum 10 as indicated  
10 by arrow 80, such that the surface of the roller scrubs the  
11 surface of the photoreceptor. Any residual charge left on  
12 the surface of photoreceptor sheet 12 may be removed by  
13 flooding the photoconductive surface with light from  
14 optional neutralizing lamp assembly 36, which may not be  
15 required in practice.

16       While the invention has been described with respect to  
17 printing on the inside of clear wrapping material (i.e.,  
18 with the opaque layer furthest from the substrate), in an  
19 alternative preferred embodiment of the invention, the layer  
20 closest to the substrate is opaque. Such images are designed  
21 to be viewed from the side of the substrate on which the  
22 image is printed. For this embodiment of the invention, the  
23 white layer will be formed on the imaging surface and  
24 transferred to the intermediate transfer member after the  
25 other, colored layers.

26       In addition to the details of the printing processes  
27 given above, additional details of printing processes and  
28 operates are given in the patents and publications  
29 incorporated herein by reference.

30       It has been found that the above mentioned toners and  
31 other toners based on similar materials and high molecular  
32 weight ionomers such as surlyns adhere well to the  
33 substrates used in food packaging. This adhesion is found to  
34 be especially good when the toner is based on an ionomer or  
35 ethylene polymer or copolymer and the polymer film is  
36 coated by a similar material. Such coatings, particularly



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1 Surlyn 1601 ionomer, EVA (particularly low molecular weight  
2 EVA) and ethylene acrylic acid are often provided on the  
3 inner surface of food wrappings to give improved properties  
4 such as sealability, adhesiveness and food compatibility.

5       It should be understood that the invention is not  
6 limited to the specific type of image forming system used  
7 and the present invention is also useful with any suitable  
8 imaging system which forms a liquid toner image on an image  
9 forming surface and, the specific details given above for  
10 the image forming system are included as part of a best mode  
11 of carrying out the invention, however, many aspects of the  
12 invention are applicable to a wide range of systems as known  
13 in the art for electrostatic printing and copying.

14       It will be appreciated by persons skilled in the art  
15 that the present invention is not limited by the description  
16 and example provided hereinabove. Rather, the scope of this  
17 invention is defined only by the claims which follow:

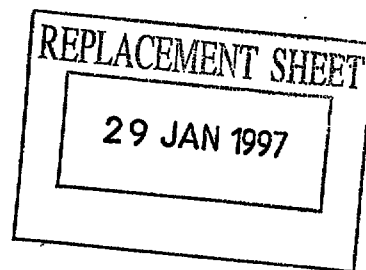
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CLAIMS

- 1  
2 1. A printing process for forming high contrast color  
3 images on polymer surfaces, comprising:
  - 4 (a) forming a layer of substantially opaque liquid  
5 toner comprising polymer based toner particles and a carrier  
6 liquid, on an imaging surface;
  - 7 (b) transferring the layer to an intermediate transfer  
8 member;
  - 9 (c) heating the layer on the intermediate transfer  
10 member to a temperature at which the toner particles at  
11 least partially coalesce;
  - 12 (d) repeating (a) to (c) sequentially for at least one  
13 subsequent layer in at least one color, said at least one  
14 subsequent layer being transferred to the intermediate  
15 transfer member onto the opaque layer to form multiple  
16 layers on the intermediate transfer member; and
  - 17 (e) transferring the multiple layers to a polymer  
18 surface.
- 19  
20 2. A process according to claim 1 wherein the opaque layer  
21 is the lowest layer of the multiple layers on the  
22 intermediate transfer member.
- 23  
24 3. A printing process for forming high contrast color  
25 images on polymer surfaces, comprising:
  - 26 (a) forming a colored layer of liquid toner comprising  
27 polymer based toner particles and a carrier liquid, on an  
28 imaging surface;
  - 29 (b) transferring the layer to an intermediate transfer  
30 member;
  - 31 (c) heating the layer on the intermediate transfer  
32 member to a temperature at which the toner particles at  
33 least partially coalesce;
  - 34 (d) repeating (a) to (c) sequentially for at least a  
35 substantially opaque liquid toner layer, said substantially  
36 opaque layer being transferred to the intermediate transfer

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REPLACEMENT SHEET

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1 member onto the colored layer to a plurality of layers on  
2 the intermediate transfer member; and  
3 (e) transferring the plurality of layers to a polymer  
4 surface.

5

6 4. A printing process according to claim 3 and including  
7 repeating (a) to (c) sequentially prior to (d) for at  
8 least one subsequent layer in at least one different color,  
9 said colored and opaque layers forming multiple layers on  
10 the intermediate transfer member.

11

12 5. A process according to claim 3 or claim 4 wherein the  
13 opaque layer is the uppermost layer of the multiple layers  
14 on the intermediate transfer member prior to transfer to the  
15 polymer surface.

16

17 6. A process according to any of the preceding claims  
18 wherein the colored layers are in the form of an image.

19

20 7. A process according to any of the preceding claims  
21 wherein the opaque liquid toner contains a white pigment.

22

23 8. A process according to claim 7 wherein the white  
24 pigment is  $\text{TiO}_2$ .

25

26 9. A process according to any of the preceding claims  
27 wherein forming a layer comprises:

28

(i) charging a chargeable imaging surface;

29

(ii) selectively discharging portions of the charged

30

imaging surface to form a predefined electrostatic image;

31

and

32

(iii) developing a layer of charged opaque white toner

33

particles onto the selectively discharged portions of the

34

imaging surface thereby providing a developed image

35

corresponding to the latent image.

36

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REPLACEMENT SHEET

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1 10. A process according to any of the preceding claims  
2 wherein the polymer surface is the surface of a transparent  
3 film.

4

5 11. A process according to any of the preceding claims  
6 wherein the polymer surface is coated.

7

8 12. A process according to claim 11 wherein the coating is  
9 an ionomer.

10

11 13. A process according to claim 12 wherein the ionomer has  
12 a low molecular weight.

13

14 14. A process according to claim 12 wherein the ionomer has  
15 a high molecular weight.

16

17 15. A process according to claim 11 wherein the coating is  
18 an ethylene vinyl acetate polymer.

19

20 16. A process according to any of the preceding claims  
21 wherein the polymer surface is polypropylene.

22

23 17. A process according to any of claims 1-15 wherein the  
24 polymer surface is polyethylene.

25

26 18. A process according to any of the preceding claims  
27 wherein the transfer of the multiple layers to the polymer  
28 surface is effected with heat and pressure.

29

30 19. A process according to any of the preceding claims  
31 wherein at least one of the at least one color layers is a  
32 color halftone separation.

33

34 20. A process according to any of the preceding claims in  
35 which the toner particle layers form films on the  
36 intermediate transfer member.

This Sheet Has Been Replaced



REPLACEMENT SHEET

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1

2 21. A printing process comprising:

3 (a) forming a liquid toner image comprising toner  
4 particles based on a first polymer and a carrier liquid, on  
5 an imaging surface;

6 (b) transferring the image to a surface coated with a  
7 second polymer; and

8 (c) fusing and fixing the image to the surface coating,  
9 wherein

10 the second polymer is either an ionomer or an ethylene  
11 vinyl acetate polymer.

12

13 22. A process according to claim 21 wherein the first  
14 polymer is an ionomer.

15

16 23. A process according to claim 22 wherein the first  
17 polymer is a high molecular weight ionomer.

18

19 24. A process according to claim 22 wherein the first  
20 polymer is a low molecular weight ionomer.

21

22 25. A process according to claim 21 wherein the first  
23 polymer is ethylene vinyl acetate.

24

25 26. A process according to claim 21 wherein the polymer is  
26 a ethylene copolymer.

27

28 27. A process according to claim 21 wherein the polymer is  
29 a ethylene terpolymer.

30

31 28. A process according to any of claims 21-27, wherein  
32 the second polymer is an ionomer.

33

34 29. A process according to claim 28, wherein the second  
35 polymer is a high molecular weight ionomer.

36

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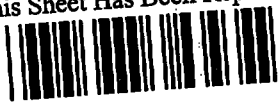
REPLACEMENT SHEET

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- 1 30. A process according to claim 28, wherein the second  
2 polymer is a low molecular weight ionomer.  
3
- 4 31. A process according to claim 28 wherein the second  
5 polymer is ethylene vinyl acetate.  
6
- 7 32. A process according to any of claims 21-31, wherein the  
8 substrate surface is a polypropylene film.  
9
- 10 33. A process according to any of claims 21-31, wherein the  
11 substrate surface is a polyethylene film.  
12
- 13 34. A printing process comprising:  
14 (a) forming a liquid toner image comprising toner  
15 particles based on a first polymer and a carrier liquid, on  
16 an imaging surface;  
17 (b) transferring the image to a surface coated with a  
18 second polymer; and  
19 (c) fusing and fixing the image to the surface coating,  
20 wherein the first polymer and the second polymer are both  
21 ionomers.  
22
- 23 35. A process according to claim 34 wherein the first  
24 ionomer is of a low molecular weight.  
25
- 26 36. A process according to claim 34 wherein the first  
27 ionomer is of a high molecular weight.  
28
- 29 37. A process according to any of claims 34-36, wherein the  
30 second ionomer is of a low molecular weight.  
31
- 32 38. A process according to any of claims 34-36 wherein the  
33 second ionomer is of a high molecular weight.  
34
- 35 39. A process according to any of claims 34-38 wherein the  
36 surface is a polypropylene film.

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REPLACEMENT SHEET

29 JAN 1997

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1

2 40. A process according to any of claims 34-38 wherein the  
3 surface is a polyethylene film.

4

5 41. A process according to any of the preceding claims  
6 wherein the imaging surface is the surface of a  
7 photoreceptor.

8

9 42. A toner particle comprising:

10 a polymer; and

11 flakes of metal.

12

13 43. A toner particles according to claim 42 wherein the  
14 flakes of metal have a dimension greater than about 4  
15 micrometers.

16

17 44. A toner particle according to claim 43 wherein the  
18 flakes of metal have a dimension greater than 6 micrometers.

19

20 45. A toner particle according to any of claims 42-44  
21 wherein the metal flakes comprise gold.

22

23 46. A toner particle according to any of claims 42-44  
24 wherein the metal flakes comprise silver.

25

26 47. A toner particle comprising:

27 a polymer; and

28 a fluorescent material.

29

30 48. A toner particles according to claim 47 wherein  
31 fluorescent material is in the form of particles having a  
32 size greater than 2 micrometers.

33

34 49. A toner particle according to any of claims 42-48  
35 wherein the polymer is a low molecular weight ionomer.

36



REPLACEMENT SHEET

29 JAN 1997

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1 50. An electrified toner particle according to any of  
2 claims 42-49.

3

4 51. A liquid toner comprising:

5 a plurality of toner particles according to any of  
6 claims 42-50; and

7 a carrier liquid.

8

9 51. A printed image printed with toner particles according  
10 to any of claims 42-50.

11

12 52. A printed image printed with a process utilizing a  
13 liquid toner according to claim 51.

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PRINTING ON TRANSPARENT FILM

ABSTRACT OF THE INVENTION

1  
2 A printing process for forming high contrast color  
3 images on polymer surfaces, comprising: (a) forming a layer  
4 of substantially opaque liquid toner comprising polymer  
5 based toner particles and a carrier liquid, on an imaging  
6 surface; (b) transferring the layer to an intermediate  
7 transfer member; (c) heating the layer on the intermediate  
8 transfer member to a temperature at which the toner  
9 particles at least partially coalesce; (d) repeating (a) to  
10 (c) sequentially for at least one subsequent layer in at  
11 least one color, said at least one subsequent layer being  
12 transferred to the intermediate transfer member onto the  
13 opaque layer to form multiple layers on the intermediate  
14 transfer member; and (e) transferring the multiple layers to  
15 a polymer surface.

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18 Figure 1

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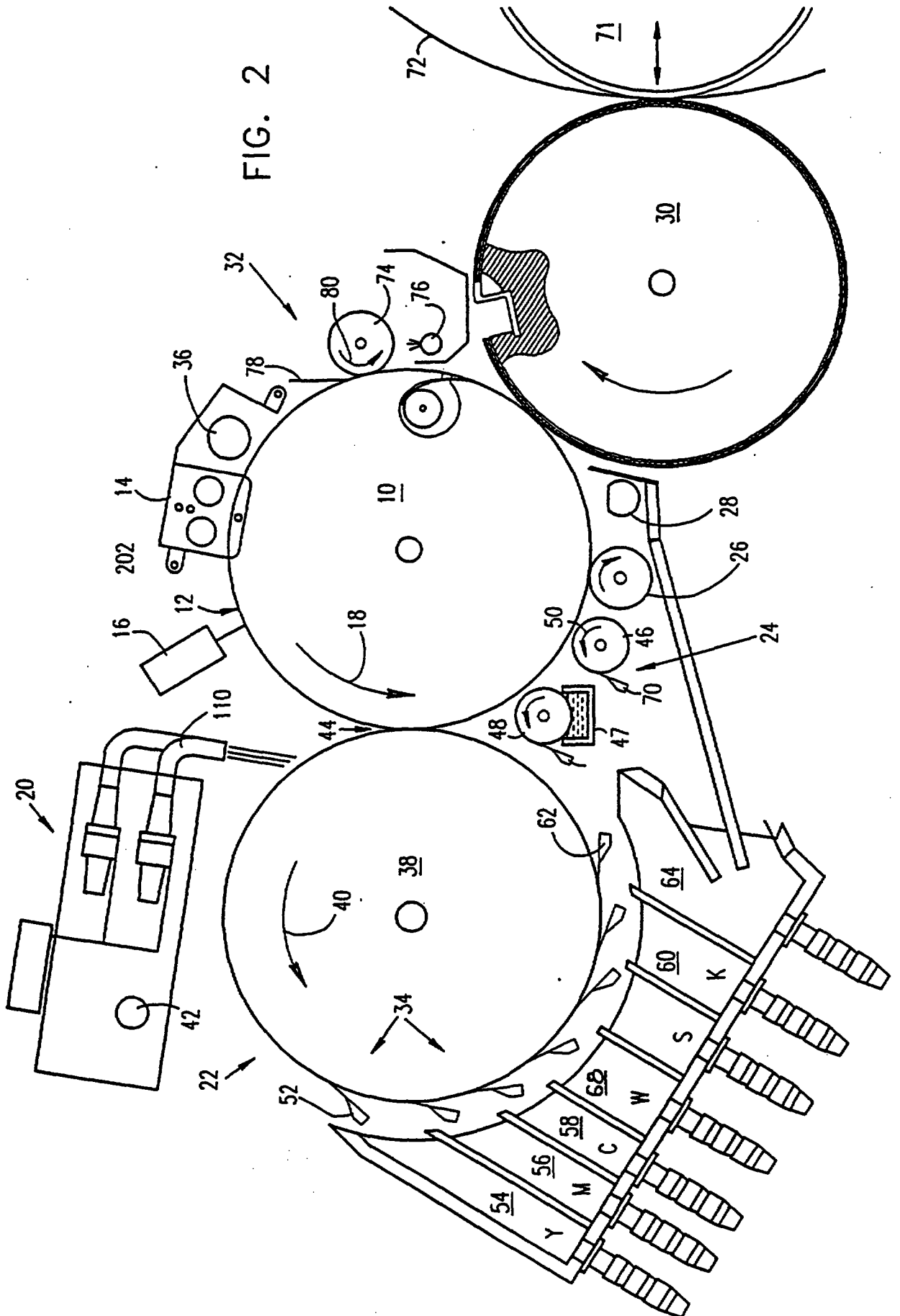
This Sheet Has Been Replaced

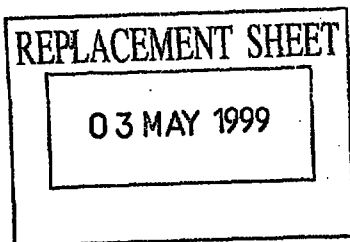




FIG. 1

FIG. 2





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CLAIMS

7610223 1100

REPLACEMENT SHEET

Description : paged .... to paged ....

✓ Claim(s) : paged .11. to paged .11.

Drawing(s) : paged .... to paged ....

✓ Abstract : paged .22. to paged .22.

DATE OF RECEIPT 3/5/99

1. A printing process for forming high contrast color images on polymer surfaces, comprising:
  - (a) forming a layer of substantially opaque liquid toner comprising polymer based toner particles and a carrier liquid, on an imaging surface;
  - (b) transferring the layer to an intermediate transfer member;
  - (c) heating the layer on the intermediate transfer member to a temperature at which the toner particles at least partially coalesce;
  - (d) repeating (a) to (c) sequentially for at least one subsequent layer in at least one color in image form, said at least one subsequent layer being transferred to the intermediate transfer member onto the opaque layer to form multiple layers on the intermediate transfer member; and
  - (e) transferring the multiple layers to a polymer surface of a transparent substrate.
2. A process according to claim 1 wherein the opaque layer is the lowest layer of the multiple layers on the intermediate transfer member prior to transfer to the intermediate transfer member.
3. A printing process for forming high contrast color images on polymer surfaces, comprising:
  - (a) forming a colored layer of liquid toner in image form comprising polymer based toner particles and a carrier liquid, on an imaging surface;
  - (b) transferring the layer to an intermediate transfer member;
  - (c) heating the layer on the intermediate transfer member to a temperature at which the toner particles at least partially coalesce;
  - (d) repeating (a) to (c) sequentially for at least a substantially opaque liquid toner layer, said substantially opaque layer being transferred to the intermediate transfer member onto the colored layer to form a plurality of layers on the intermediate transfer member; and
  - (e) transferring the plurality of layers to a polymer surface.
4. A printing process according to claim 3 and including repeating (a) to (c) sequentially prior to (d) for at least one subsequent layer in at least one different color, said colored and opaque layers forming multiple layers on the intermediate transfer member.
5. A process according to claim 3 or claim 4 wherein the opaque layer is the uppermost layer of the multiple layers on the intermediate transfer member prior to transfer to the polymer surface.
6. A process according to any of the preceding claims wherein the opaque layer is in the

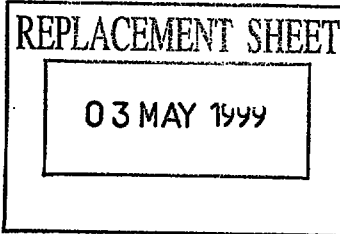


03 MAY 1999

form of an image.

7. A process according to any of the preceding claims wherein the opaque liquid toner contains a white pigment.
8. A process according to claim 7 wherein the white pigment is  $\text{TiO}_2$ .
9. A process according to any of the preceding claims wherein forming a layer comprises:
  - (i) charging a chargeable imaging surface;
  - (ii) selectively discharging portions of the charged imaging surface to form a predefined electrostatic image; and
  - (iii) developing a layer of charged opaque white toner particles onto the selectively discharged portions of the imaging surface thereby providing a developed image corresponding to the latent image.
10. A process according to any of the preceding claims wherein the polymer surface is the surface of a transparent film.
11. A process according to any of the preceding claims wherein the polymer surface is coated.
12. A process according to claim 11 wherein the coating is an ionomer.
13. A process according to claim 12 wherein the ionomer has a low molecular weight.
14. A process according to claim 12 wherein the ionomer has a high molecular weight.
15. A process according to claim 11 wherein the coating is an ethylene vinyl acetate polymer.
16. A process according to any of the preceding claims wherein the polymer surface is polypropylene.
17. A process according to any of claims 1-15 wherein the polymer surface is polyethylene.
18. A process according to any of the preceding claims wherein the transfer of the multiple layers to the polymer surface is effected with heat and pressure.
19. A process according to any of the preceding claims wherein at least one of the at least





one color layers is a color halftone separation.

20. A process according to any of the preceding claims in which the toner particle layers form films on the intermediate transfer member.

21. A process according to any of the preceding claims wherein the imaging surface is the surface of a photoreceptor.



PRINTING ON TRANSPARENT FILM

ABSTRACT OF THE INVENTION

1  
2 A printing process for forming high contrast color  
3 images on polymer surfaces, comprising: (a) forming a layer  
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5 based toner particles and a carrier liquid, on an imaging  
6 surface; (b) transferring the layer to an intermediate  
7 transfer member; (c) heating the layer on the intermediate  
8 transfer member to a temperature at which the toner  
9 particles at least partially coalesce; (d) repeating (a) to  
10 (c) sequentially for at least one subsequent layer in at  
11 least one color, said at least one subsequent layer being  
12 transferred to the intermediate transfer member onto the  
13 opaque layer to form multiple layers on the intermediate  
14 transfer member; and (e) transferring the multiple layers to  
15 a polymer surface.

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18 Figure 1

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