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(21) International Application Number: PCT/NL92/00014 (22) International Filing Date: 21 January 1992 (21.01.92) (30) Priority data: 653,953 12 February 1991 (12.02.91) US (71) Applicant: SPECTRUM SCIENCES B.V. [NL/NL]; Zijdeweg 6, NL-2244 BG Wassenaar (NL). (72) Inventors: PINHAS, Hanna ; 20, Shrpinzak Steet, 58 331 Holon (IL). NIV, Yehuda ; 7/4, Shderot Chen, 76 100 Rehovot (IL). (74) Agent: DE BRUIJN, Leendert, C.; Nederlandsch Octro- oibureau, Scheveningseweg 82, P.O. Box 29720, NL-2502 LS The Hague (NL).		(81) Designated States: AT (European patent), BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, KR, LU (European patent), MC (European patent), NL (European patent), SE (European patent). Published <i>With international search report.</i>
(54) Title: IMAGING SYSTEM (57) Abstract Imaging apparatus including an image forming surface, image forming apparatus for defining an electrostatic latent image on the image forming surface, the latent image having image portions and background portions, development apparatus for developing the electrostatic latent image in a reversal mode, using electrically charged pigmented toner particles to form a developed image overlying the image portions, whereby the developed image on the image forming surface is at a first electrical potential and the background portions on the image forming surface are at a second electrical potential, discharge apparatus for partially discharging the image forming surface so that the developed image is at a third electrical potential and the background portions are at a fourth potential and an image receiving surface at a fifth potential, for receiving the developed image from the image forming surface, wherein the difference between the fourth potential and the fifth potential is low enough such that substantially no electrical discharge occurs between the image receiving surface and the background portions.		

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- 1 -

1 IMAGING SYSTEM2 FIELD OF THE INVENTION

3 The present invention relates generally to
4 electrostatic imaging and particularly to apparatus and a
5 method for treating a developed image before transfer.

6 BACKGROUND OF THE INVENTION

7 Systems for electrostatic image reproduction are known
8 in the art. These systems include apparatus for creating a
9 latent electrostatic image on an image forming surface, such
10 as a photoreceptor, through the definition of image and
11 background portions on the photoreceptor surface at
12 different electrical potentials, apparatus for developing
13 the latent image including contacting the latent image with
14 a toner including charged toner particles and apparatus for
15 transferring the developed electrostatic image to a final
16 substrate. This transfer may include the step of first
17 transferring the developed image to an intermediate transfer
18 member for subsequent transfer to the final substrate.

19 In general, transfer of the developed image from the
20 photoreceptor is aided by an electric field which is
21 generated by the electrical potential difference between a
22 substrate (which can be the final substrate or an
23 intermediate transfer member if one is present) and the
24 image portions on the photoreceptor underlying the developed
25 image. In order to assure good transfer the electric field
26 must be maintained within a given range. In so-called direct
27 copiers (or in "write-white" printers), projections of the
28 image areas of the original (i.e., those areas which are
29 black) on a photoreceptor do not discharge corresponding
30 image portions of the photoreceptor. Projections of the
31 background areas, which are lighter, discharge the voltage
32 on corresponding background portions of the photoreceptor.
33 The potential difference between the background portions
34 (which are near zero volts) and the image portions are of
35 the order of 500 to 1000 volts. In order to assure good
36 transfer, the potential generally required on the substrate
37 is substantially greater than this potential difference,
38 causing electrical discharge between the background portions
39 and the substrate.

- 2 -

1 It is known for this direct imaging case to irradiate
2 the photoconductor, before transfer of the image therefrom,
3 with strong light which penetrates through the developed
4 image and discharges the charged regions underlying the
5 developed image. The electrical potential on the paper or
6 intermediate transfer member can then be greatly reduced,
7 avoiding or greatly reducing discharge and damage to the
8 photoreceptor and/or the surface of the intermediate
9 transfer member. Examples of this process are shown in U.S.
10 Patents 3,784,300, 4,039,257 and 4,853,736 the disclosures
11 of which are incorporated herein by reference.

12 **SUMMARY OF THE INVENTION**

13 It is an object of a preferred embodiment of the
14 invention to reduce electrical discharge between the
15 substrate and the image forming surface.

16 There is therefore provided, in a preferred embodiment
17 of the invention, imaging apparatus including an image
18 forming surface, preferably a photoconductive image forming
19 surface, image forming apparatus for defining an
20 electrostatic latent image on the image forming surface, the
21 latent image having image portions and background portions,
22 development apparatus for developing the electrostatic
23 latent image in a reversal mode, using electrically charged
24 pigmented toner particles to form a developed image
25 overlying the image portions, whereby the developed image on
26 the image forming surface is at a first electrical potential
27 and the background portions on the forming surface are at a
28 second electrical potential, discharge apparatus for
29 partially discharging the image forming surface so that the
30 developed image is at a third electrical potential and the
31 background portions are at a fourth potential and an image
32 receiving surface at a fifth potential, operative for
33 receiving the developed image from the image forming
34 surface, wherein the difference between the fourth potential
35 and the fifth potential is low enough such that
36 substantially no electrical discharge occurs between the
37 image receiving surface and the background portions.

38 There is further provided in accordance with a
39 preferred embodiment of the invention, imaging apparatus

- 3 -

1 including an image forming surface, preferably a
2 photoconductive image forming surface, image forming
3 apparatus for defining an electrostatic latent image on the
4 image forming surface, the latent image having image
5 portions and background portions, development apparatus for
6 developing the electrostatic latent image in a reversal
7 mode, using electrically charged pigmented toner particles
8 to form a developed image overlying the image portions,
9 whereby the developed image on the image forming surface is
10 at a first electrical potential and the background portions
11 on the image forming surface are at a second electrical
12 potential, an image receiving surface at a third potential,
13 different from the first potential by an image transfer
14 potential difference for receiving the developed image from
15 the image forming surface and discharge apparatus for
16 changing at least one of the first potential and the second
17 potential to change the difference therebetween whereby the
18 absolute value of the potential difference between the
19 second potential and the third potential is reduced to a
20 value below 360 volts.

21 There is further provided in accordance with a
22 preferred embodiment of the invention, imaging apparatus
23 including an image forming surface preferably a
24 photoconductive image forming surface, image forming
25 apparatus for defining an electrostatic latent image on the
26 image forming surface, the latent image comprising image
27 portions and background portions, development apparatus for
28 developing the electrostatic latent image in a reversal
29 mode, using electrically charged pigmented toner particles
30 to form a developed image overlying the image portions,
31 whereby the developed image on the image forming surface is
32 at a first electrical potential and the background portions
33 on the image forming surface are at a second electrical
34 potential, an image receiving surface at a third potential,
35 different from the first potential by an image transfer
36 potential difference, for receiving the developed image from
37 the image forming surface and discharge apparatus for
38 changing at least one of the first potential and the second
39 potential to change the difference therebetween such that

- 4 -

1 the potential difference between the second potential and
2 the third potential is reduced to a value low enough so that
3 substantially no electrical discharge occurs between the
4 image receiving surface and the background portions.

5 In a preferred embodiment of the invention the
6 discharge apparatus includes a light source for discharging
7 the background portions of the photoconductive image forming
8 surface. In a preferred embodiment of the invention the
9 light source includes a light emitting diode array
10 preferably including diodes which emit colored light wherein
11 the colored light includes colors that are complementary to
12 the colors of the pigmented toner.

13 In a preferred embodiment of the invention the light
14 source includes a light source and at least one colored
15 filter which preferably produces colored light which
16 includes colors that are complementary to the colors of the
17 pigmented toner.

18 In a preferred embodiment of the invention the
19 development apparatus utilizes liquid toner including the
20 toner particles and carrier liquid and wherein the
21 development means includes an electrified squeegee roller
22 for compacting the image and removing excess liquid.

23 BRIEF DESCRIPTION OF THE DRAWINGS

24 The present invention will be more fully understood and
25 appreciated from the following detailed description, taken
26 in conjunction with the drawings in which:

27 Fig. 1 is a generalized schematic illustration of a
28 portion of an imaging system constructed and operative in
29 accordance with a preferred embodiment of the invention.

30 Fig. 2 is a schematic illustration of the electrical
31 potential on an image forming surface after development of a
32 latent image thereon;

33 Fig. 3 shows the potential of background portions of
34 the image forming surface as a function of the illuminating
35 lamp voltage;

36 Fig. 4 shows A: the potential of the developed image
37 and B: the optimal transfer potential on the intermediate
38 transfer member, each as a function of the illuminating lamp
39 voltage; and

- 5 -

1 Fig. 5 shows the difference between A: the optimal
2 transfer potential and the potential of background portions
3 of the image forming surface and B: the optimal transfer
4 potential and the potential of the developed image, each as
5 a function of the illuminating lamp voltage.

6 **DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS**

7 Reference is now made to Fig. 1 which illustrates a
8 portion of a multicolor electrostatic imaging system
9 constructed and operative in accordance with a preferred
10 embodiment of the present invention. As seen in Fig. 1 there
11 is provided an image bearing photoconductor surface 12
12 typically found on a rotating photoconductive drum 10. Drum
13 10 is driven in any appropriate manner (not shown) in the
14 direction of arrow 18 past charging apparatus 14, preferably
15 a corotron, adapted to charge surface 12 of photoconductive
16 drum 10.

17 An image to be reproduced is focused by imaging
18 apparatus 16 upon charged surface 12 at least partially
19 discharging photoconductive drum 10 in the portions impinged
20 upon by light to form an electrostatic latent image.

21 The electrostatic latent image normally includes image
22 portions at a first electrical potential and background
23 portions at another electrical potential. The present
24 invention is especially useful where the image portions are
25 discharged and the background portions remain at full
26 charge. This type of discharge is referred to herein as
27 "reversal" or "write-black" image formation.

28 Surface 12 typically comprises an organic
29 photoconductor such as the Emerald OPC manufactured by IBM,
30 or other suitable photoconductor. Photoconductor charging
31 apparatus 14 may be any suitable charging apparatus such as
32 is well known in the art. Imaging apparatus 16 may be
33 modulated laser beam scanning apparatus, an optical focusing
34 device for imaging an original on a drum or other imaging
35 apparatus such as is known in the art.

36 Also associated with photoconductive drum 10 are a
37 multicolor liquid developer spray assembly 20, a developing
38 assembly 22, color specific cleaning blade assemblies 34,
39 an electrified squeegee 26, and discharge apparatus 28 which

- 6 -

1 are operative to develop the latent image to form a
2 developed liquid toner image for transfer to an intermediate
3 transfer member 30.

4 Developing assembly 22 preferably includes a
5 development roller 38. Development roller 38 is preferably
6 spaced by about 40-150 micrometers from photoconductive drum
7 10 at a development region 44 and is charged to an
8 electrical potential intermediate that of the image and
9 background portions of photoconductive drum 10. Development
10 roller 38 is thus operative, to apply an electric field in
11 development region 44 to aid development of the latent
12 electrostatic image. In a typical system the background
13 portions are at -900 Volts, the image portions are at -180
14 Volts and the development roller 38 is at -500 volts when a
15 liquid developer comprising negative toner particles is
16 utilized.

17 Development roller 38 typically rotates, as indicated
18 by arrow 40, in the same sense as drum 10. This rotation
19 provides for the surface of drum 10 and development roller
20 38 to have oppositely directed velocities at development
21 region 44. The rotation speed of development roller 38 is
22 chosen such that development roller 38 acts inter alia as a
23 metering device. This metering effect ensures that very
24 little liquid carries past development region 44.

25 Multicolor liquid developer spray assembly 20 provides
26 a spray of liquid toner containing electrically charged
27 pigmented toner particles which can be preferably directed
28 onto a portion of the roller 38 or alternatively onto a
29 portion of photoconductive drum 10 or directly into
30 development region 44.

31 A preferred toner for use in the present invention is
32 prepared by mixing ten parts of Elvax II 5950T (E.I. du
33 Pont) and five parts of Isopar L (Exxon) at low speed in a
34 jacketed double planetary mixer connected to an oil heating
35 unit set at 130°C for one hour. 5 parts of Isopar L are
36 added to the mix and the whole is mixed for a further hour
37 at high speed. Ten parts of Isopar L, preheated to 110°C,
38 are added, and mixing is continued without heating until the
39 temperature of the mixture drops to 40°C. Ninety grams of

- 7 -

1 the resultant product is transferred to a 01 attritor (Union
2 Process) together with 7.5 g. of Mogul L (Cabot) and 120 g.
3 Isopar L. The mixture is ground for 24 hours with water
4 cooling ($\approx 20^{\circ}\text{C}$). The resultant toner particles have a
5 median (by weight) diameter of about $2.1\ \mu\text{m}$. The resultant
6 material is diluted to a non-volatile solids content of 1.5%,
7 using Isopar L and charge director as known in the art is
8 added to charge the toner particles.

9 Other appropriate liquid toners may alternatively be
10 employed. For colored liquid developers, carbon black is
11 replaced by color pigments as is well known in the art. In
12 an alternate preferred embodiment of the invention the
13 latent image is developed using powder toner as is known in
14 the art.

15 Color specific cleaning blade assemblies 34 are
16 operatively associated with development roller 38 for
17 separate removal of residual amounts of each colored toner
18 remaining thereon after development. Each one of blade
19 assemblies 34 is selectably brought into operative
20 association with development roller 38 only when toner of a
21 color corresponding thereto is supplied to development
22 region 44 by spray assembly 20. The construction and
23 operation of cleaning blade assembly 34 is more fully
24 described in PCT International Publication number WO
25 90/14619, the disclosure of which is incorporated herein by
26 reference.

27 Each of cleaning blade assemblies 34 includes a
28 toner directing member 52 which serves to direct the toner
29 removed by the cleaning blade assemblies 34 from the
30 development roller 38 to respective collecting tanks 54, 56,
31 58 and 60 and thus to prevent contamination of the various
32 developers by mixing of the colors. The toner thus collected
33 is recycled to corresponding toner reservoirs (not shown)
34 for reuse. A final toner collection member 62 always engages
35 the development roller 38 and the toner collected thereby is
36 supplied to a clear liquid reservoir (not shown) via a
37 collecting tank 64 and a separator (not shown) which is
38 operative to separate relatively clean carrier liquid from
39 the various colored toner particles. The separator may be

- 8 -

1 typically of the type described in PCT International
2 Publication Number WO90/10896 the disclosure of which is
3 incorporated herein by reference.

4 An electrically biased squeegee roller 26 such as that
5 described in U.S. Patent 4,286,039, the disclosure of which
6 is incorporated herein by reference, is preferably urged
7 against the surface of drum 10 and is operative to remove
8 substantially all of the liquid carrier from the background
9 portions and to compact the image and remove liquid carrier
10 therefrom in the image portions. Squeegee roller 26 is
11 preferably formed of resilient slightly conductive polymeric
12 material, and is charged to a potential of several hundred
13 to a few thousand volts with a polarity such that an
14 electric field is created between squeegee roller 26 and
15 drum 10 which drives the charged toner particles toward drum
16 10. Squeegee roller 26 is also operative to further charge
17 the toner particles and photoconductor surface 12 as
18 described below.

19 Transfer of the developed image to an intermediate
20 transfer member 30 (or to a final substrate) from drum 10
21 generally requires the imposition of an electric field
22 between drum 10 and the surface of intermediate transfer
23 member 30. It has been found that if a potential sufficient
24 to effect substantially complete transfer of the developed
25 image is impressed on intermediate transfer member 30, then
26 a high potential difference is established between the
27 intermediate transfer member and background portions on the
28 drum 10 causing electrical discharge therebetween.

29 In a preferred embodiment of the invention, discharge
30 apparatus 28, which is described in more detail below, is
31 operative to irradiate drum 10 with light characterized by a
32 predetermined intensity and spectrum to reduce electrical
33 discharge between drum 10 and intermediate transfer member
34 30.

35 Intermediate transfer member 30 may be any suitable
36 intermediate transfer member as is known in the art such as
37 those described in PCT International Publication WO
38 90/08984 the disclosure of which is incorporated herein by
39 reference, and is maintained at a voltage and temperature

- 9 -

1 suitable for electrostatic transfer of the image thereto
2 from drum 10 and therefrom to a final substrate 72 such as
3 paper.

4 Intermediate transfer member 30 is preferably
5 associated with a pressure roller 71 for transfer of the
6 image onto final substrate 72 preferably by heat and
7 pressure. In a preferred embodiment of the invention
8 intermediate transfer member 30 is coated with a non-stick,
9 preferably a silicone, coating to aid in subsequent transfer
10 of the developed image therefrom to substrate 72.

11 Cleaning apparatus 32 is operative to clean the
12 photoconductor surface 12 and includes a cleaning roller 74,
13 a sprayer 76 to spray a non polar cleaning liquid to assist
14 in the cleaning process and a wiper blade 78 to complete the
15 cleaning of surface 12. Cleaning roller 74, which may be
16 formed of any synthetic resin known in the art for this
17 purpose, is driven in a direction of rotation indicated by
18 arrow 80 which is the same as the direction of rotation of
19 drum 10.

20 Any residual charge left on the surface of drum 10 is
21 removed by flooding surface 12 with light from a
22 neutralizing lamp assembly 36.

23 In accordance with a preferred embodiment of the
24 invention, after developing each image in a given color, the
25 single color image is transferred to intermediate transfer
26 member 30. Subsequent images in different colors are
27 sequentially transferred in alignment with the previous
28 image onto intermediate transfer member 30. When all of the
29 desired images have been transferred thereto, the complete
30 multi-color image is transferred from transfer member 30 to
31 substrate 72.

32 Alternatively, each single color image is transferred
33 to the substrate directly after its transfer to intermediate
34 transfer member 30. In this case the substrate is fed
35 through the machine once for each color or is held on
36 pressure roller 71 and contacted with intermediate transfer
37 member 30 during each image transfer operation.

38 Reference is now made to Fig. 2 which illustrates
39 typical post-development electrical potentials (before

- 10 -

1 application of squeegee roller 26) on the surface of drum 10
2 at background portions 110 ($\approx$ -900 volts) and image portions
3 112 ($\approx$ -180 volts) and on the surface of the developed image
4 114 ($\approx$ -450 volts). These potentials are not fixed values but
5 rather depend on charge on the photoconductor before
6 development, spectrum and intensity of the image projected
7 by imaging apparatus 16, photoconductor response
8 characteristics, process speed, development roller 38
9 potential, the toner charge, mobility and viscosity and
10 other factors.

11 To assure good transfer of the charged toner particles
12 in the developed image from drum 10 to intermediate transfer
13 member 30 a suitable potential difference must be maintained
14 between the surface of intermediate transfer member 30 and
15 image portions 112 on the surface of drum 10. The magnitude
16 of this potential difference is dependent on a number of
17 factors such as the type of toner, the toner layer charge
18 and thickness and the relative affinity of the toner for
19 surface 12 and the surface of intermediate transfer member
20 30. The magnitude of this potential difference is not
21 believed to be a function of the absolute potential on image
22 portions 112, and a range of potential differences, near an
23 optimum potential difference, give good results.

24 It is desirable to reduce the potential difference
25 between the surface of intermediate transfer member 30 and
26 background portions 110 of surface 12 to reduce electrical
27 discharge therebetween. This electrical discharge is
28 believed to cause deterioration of the non-stick properties
29 of the silicone surface coating of intermediate transfer
30 member 30 and damage to the photoconductor.

31 It might have been thought that flooding drum 10 with
32 high intensity light would discharge background portions 110
33 and be operative to significantly reduce the discharge. The
34 present inventors have found, however, that light which
35 penetrates the developed image to image portions 112 which
36 underlie the developed image causes not only a reduction in
37 the potential of image portions 112, as expected, but can
38 actually cause image portions 112 to become positively
39 charged in the presence of the negatively charged toner

- 11 -

1 image overlying them. Since the potential of intermediate
2 transfer member 30 must also be adjusted to account for the
3 change in potential of image portions 112, it has been found
4 that the potential difference between background portions
5 110 and the surface of intermediate transfer member 30 still
6 causes electrical discharge.

7 In such a case and in a particular example thereof,
8 without any light treatment but after subjecting the image
9 to squeegee roller 26, the optimum transfer potential of
10 intermediate transfer member 30 is -400 volts and the
11 potential of background portions 110 is -1220 volts,
12 resulting in a 820 volt potential difference therebetween.
13 The developed image is at a potential of -960 volts.

14 After irradiation of drum 10 with strong light, the
15 potential at the developed image falls to -250 volts, and
16 the optimum transfer potential is +400 volts. The background
17 had a potential of about -130 volts resulting in a potential
18 difference between the background portions of the drum and
19 the intermediate transfer member of 530 volts. At this
20 potential difference electrical discharge still occurs. It
21 is believed that for even stronger irradiation, the
22 potential difference increases further until a saturation
23 value is reached.

24 As previously noted, discharge apparatus 28, is
25 operative to irradiate drum 10 with light characterized by a
26 predetermined intensity and spectrum to reduce electrical
27 discharge between drum 10 and the surface of intermediate
28 transfer member 30. The present inventors have found that
29 controlled irradiation of drum 10 before transfer of the
30 developed image therefrom can allow for optimal transfer of
31 the image without electrical discharge between background
32 portions 110 and intermediate transfer member 30. This
33 controlled irradiation is chosen to be strong enough to
34 substantially discharge background portions 110 to a
35 potential near zero and weak enough so that the attenuated
36 light which passes through the developed image changes the
37 potential of image portions 112 underlying the developed
38 image to a substantially lesser degree.

39 Reference is made to Figs. 3-5 which illustrate the

- 12 -

1 effect of various amount of light on the various potentials
2 in the system, in accordance with a preferred embodiment of
3 the invention.

4 Curve "A" of Fig. 3 shows the potential on background
5 portions 110 after illuminating drum 10 with light of
6 varying intensities from a light source comprising a row of
7 miniature incandescent lamps. The light intensity is
8 referenced by the voltage on the light source (i.e. the
9 lamps). Curve "B" shows the potential on background portions
10 110 which are subjected to squeegee roller 26 electrified to
11 a potential of -2400 volts before they are illuminated.

12 Curve "A" of Fig. 4 shows the potential on the
13 developed image 114 as a function of light source voltage,
14 after subjecting the image to squeegee roller 26 at a
15 potential of -2400 volts. As used herein the term "developed
16 image" includes an image which may have been subjected to a
17 squeegee roller or to other post-formation treatment, other
18 than irradiation by light. If the squeegee roller is not
19 used, then for zero light intensity, the potential on the
20 developed image is approximately 500 volts more positive
21 than shown on curve A, i.e., about -450 Volts.

22 It is believed that the potential change caused by the
23 electrified squeegee roller is in part the result of
24 charging of image portions 112 of drum 10 and in part the
25 result of the addition of further negative charge to the
26 already negatively charged toner particles.

27 It is noted, however, that irradiation by light causes
28 a change only in the potential of image portions 112 and is
29 not believed to be effective in changing the charge on the
30 toner particles. Thus any change in the image potential of
31 developed image 114 which is caused by light is believed to
32 be caused by changes in the potential of image portions 112.

33 Also plotted in Fig. 4 as curve "B" is the potential on
34 the intermediate transfer member for "optimal" transfer of
35 the image from the drum to the intermediate transfer member.

36 Curve "A" of Fig. 5 is the potential difference between
37 background portion 110 and the intermediate transfer member
38 30 at the optimal transfer potential as a function of light
39 source voltage (i.e., curve "B" of Fig. 3 minus curve "B" of

- 13 -

1 Fig. 4). Curve "B" of Fig. 5 is the potential difference
2 between developed image 114 and intermediate transfer member
3 ("ITM") 30 as a function of light source voltage (i.e.,
4 curve "A" of Fig. 4 minus curve "B" of Fig. 4). It should be
5 noted that the image-ITM potential difference is essentially
6 constant, within the ± 50 volt estimated error in measurement
7 of surface potential. This constancy of potential difference
8 required for optimal transfer supports the above mentioned
9 premises that the potential difference required for transfer
10 is not a function of the absolute image portion potential
11 and that light does not change the charge of the toner
12 particles.

13 Furthermore the image transfer "quality" does not
14 appear to be a function of the light level. On the other
15 hand, as the light level is increased the potential
16 difference between the intermediate transfer member 30 and
17 the background portions 110, which starts at a high value,
18 first falls to a minimum value and then rises again as the
19 light level is further increased.

20 It should be noted that the potential of image portion
21 112 is believed to be several hundred volts lower (i.e.,
22 more positive) than the potential of the image 114 so that
23 the potential difference between image portion 112 and the
24 ITM is believed to be in the range of approximately 70-350
25 volts.

26 For a particular range of light intensities, the
27 potential difference between background portions 110 and the
28 surface of intermediate transfer member 30 is reduced below
29 the minimum producing discharge. As is well known, the
30 discharge voltage between two flat surfaces has a high value
31 for very small and for very large spacings between the
32 surfaces. For intermediate spacings the discharge voltage
33 reaches a minimum, which for air at standard pressure is
34 approximately 360 volts (at a spacing of approximately 8
35 micrometers). The curve of discharge voltage as a function
36 of spacing is generally known as the Paschen curve and the
37 minimum voltage is called the "minimum of the Paschen
38 Curve". For flat surfaces, discharge cannot occur if the
39 potential difference between the surfaces is less than the

- 14 -

1 minimum of the Paschen Curve. While it is especially
2 preferred to utilize a background-ITM voltage lower than
3 this lowest minimum value, it is believed that somewhat
4 higher potential differences, while they may cause some
5 discharge, do not cause substantial enough discharge to
6 substantially damage the photoconductor or the non-stick
7 coating of the intermediate transfer member.

8 As can be seen from Fig. 5, for the particular case
9 discussed, there is a range of lamp voltages (and
10 corresponding light intensities), which results in
11 background-ITM potential differences below 360 volts. It is
12 believed that this is a relatively safe value for
13 substantial elimination of discharge. Optimally, the amount
14 of light is adjusted to give a minimum potential difference.

15 The light source employed in the discharge apparatus 28
16 in the above described experiments is a row of 14 series
17 connected 0.79 watt incandescent lamps (@ 7.86 VAC each),
18 spaced 26 mm apart and spaced 8 mm from the drum. The drum
19 velocity is 60 cm/sec and a black image having a
20 transmission optical density of approximately 0.7 is used.

21 In a preferred embodiment of the invention light having
22 a color which is complementary to the color of the image on
23 the drum 10 is used to illuminate drum 10. In this case the
24 amount of light transmitted through the image to image
25 portion 112 is substantially reduced and for a particular
26 light intensity, the background-ITM potential difference may
27 be reduced to a very low value. The source of light may be a
28 series of light emitting diodes which emit colored light
29 complementary to the color of the toner particles in the
30 image. Alternatively, other sources of colored light such as
31 cold cathode discharge sources can be utilized in the
32 practice of the invention. Alternatively, a source of white
33 light with appropriately colored filters is utilized to
34 produce the complementary colors.

35 The amplitude of each of the sources is preferably
36 matched to the toner optical density and photoreceptor
37 characteristics by varying the intensity of the white light
38 or by use of neutral density filters.

39 The white light may be from incandescent lamps or may

- 15 -

1 be from fluorescent lamps.

2 It should be noted that the lower the transparency of
3 the pigments used (i.e., the higher the density of the image
4 for the given color), the lower the effect on the potential
5 of the portions of the drum underlying the image. For very
6 dense images, the possibility exists that very low, even
7 zero, potential difference between the surface of the
8 intermediate transfer member and the background portion of
9 drum 10 can be achieved at the optimum transfer voltage.
10 Under certain circumstances the minimum of the curve of
11 background-ITM potential difference can reverse sign.

12 While the invention has been described utilizing a drum
13 photoconductor, a roller developer, liquid toner and for
14 transfer utilizing an intermediate transfer member, it is
15 understood that the invention can be practiced utilizing a
16 belt developer and/or a belt photoconductor, any appropriate
17 liquid or dry toner as is known in the art and/or direct
18 transfer from drum 10 to substrate 72.

19 Furthermore, while the invention has been described
20 utilizing a controlled source of light for differentially
21 discharging the image and background portions of the image
22 forming surface, other means for selectively discharging are
23 within the scope of the invention.

24 For a positively chargeable photoconductor, using
25 positive toner particles in a reverse development mode,
26 similar results will be obtained, with only the signs of the
27 potentials reversed.

28 It will be appreciated by persons skilled in the art
29 that the present invention is not limited by what has been
30 particularly shown and described hereinabove. Rather the
31 scope of the present invention is defined only by the claims
32 which follow:

- 16 -

CLAIMS

- 1
2 1. Imaging apparatus comprising:
3 an image forming surface;
4 image forming means for defining an electrostatic
5 latent image on said image forming surface, said latent
6 image comprising image portions and background portions;
7 development means for developing the electrostatic
8 latent image in a reversal mode, using electrically charged
9 pigmented toner particles to form a developed image
10 overlying said image portions, whereby said developed image
11 on said image forming surface is at a first electrical
12 potential and said background portions on said image forming
13 surface are at a second electrical potential;
14 discharge means for partially discharging the image
15 forming surface so that said developed image is at a third
16 electrical potential and said background portions are at a
17 fourth potential; and
18 an image receiving surface at a fifth potential,
19 operative for receiving said developed image from said image
20 forming surface, wherein the difference between said fourth
21 potential and said fifth potential is low enough such that
22 substantially no electrical discharge occurs between said
23 image receiving surface and said background portions.
24
- 25 2. Imaging apparatus comprising:
26 an image forming surface;
27 image forming means for defining an electrostatic
28 latent image on said image forming surface, said latent
29 image comprising image portions and background portions;
30 development means for developing the electrostatic
31 latent image in a reversal mode, using electrically charged
32 pigmented toner particles to form a developed image
33 overlying said image portions, whereby said developed image
34 on said image forming surface is at a first electrical
35 potential and said background portions on said image forming
36 surface are at a second electrical potential;
37 an image receiving surface at a third potential,
38 different from said first potential by an image transfer
39 potential difference for receiving said developed image from

- 17 -

1 said image forming surface; and

2 discharge means for changing at least one of said first
3 potential and said second potential to change the difference
4 therebetween whereby the absolute value of the potential
5 difference between said second potential and said third
6 potential is reduced to a value below about 360 volts.

7

8 3. Imaging apparatus comprising:

9 an image forming surface;

10 image forming means for defining an electrostatic
11 latent image on said image forming surface, the latent image
12 comprising image portions and background portions;

13 development means for developing the electrostatic
14 latent image in a reversal mode, using electrically charged
15 pigmented toner particles to form a developed image
16 overlying said image portions, whereby said developed image
17 on said image forming surface is at a first electrical
18 potential and said background portions on said image forming
19 surface are at a second electrical potential;

20 an image receiving surface at a third potential,
21 different from said first potential by an image transfer
22 potential difference, for receiving said developed image
23 from said image forming surface; and

24 discharge means for changing at least one of said first
25 potential and said second potential to change the difference
26 therebetween such that the potential difference between said
27 second potential and said third potential is reduced to a
28 value low enough so that substantially no electrical
29 discharge occurs between said image receiving surface and
30 said background portions.

31

32 4. Apparatus according to claim 2 or claim 3 wherein said
33 image transfer potential difference is substantially the
34 same as the image transfer potential difference required in
35 the absence of said discharge means.

36

37 5. Apparatus according to any of the preceding claims
38 wherein said image forming surface is a photoconductive
39 image forming surface.

- 1
2 6. Apparatus according to claim 5 wherein said discharge
3 means includes a light source for discharging said
4 background portions of said photoconductive image forming
5 surface.
6
- 7 7. Apparatus according to claim 6 wherein said light
8 source includes a light emitting diode array.
9
- 10 8. Apparatus according to claim 7 wherein said light
11 emitting diode array includes diodes which emit colored
12 light and wherein said colored light includes colors that
13 are complementary to the colors of said pigmented toner.
14
- 15 9. Apparatus according to claim 6 wherein said light
16 source includes a light source and at least one colored
17 filter.
18
- 19 10. Apparatus according to claim 9 wherein said light
20 source and at least one colored filter produce colored light
21 which includes colors that are complementary to the colors
22 of said pigmented toner.
23
- 24 11. Apparatus according to any of the preceding claims
25 wherein said development means utilizes liquid toner
26 comprising said toner particles and carrier liquid and
27 wherein said development means includes an electrified
28 squeegee roller for compacting the image and removing excess
29 liquid.

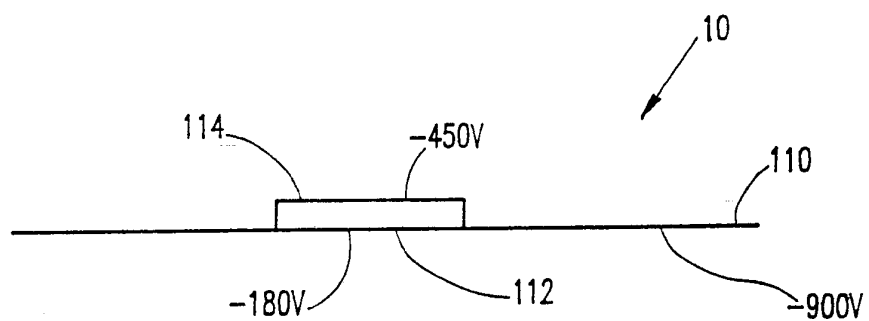


FIG.2

Figure 3

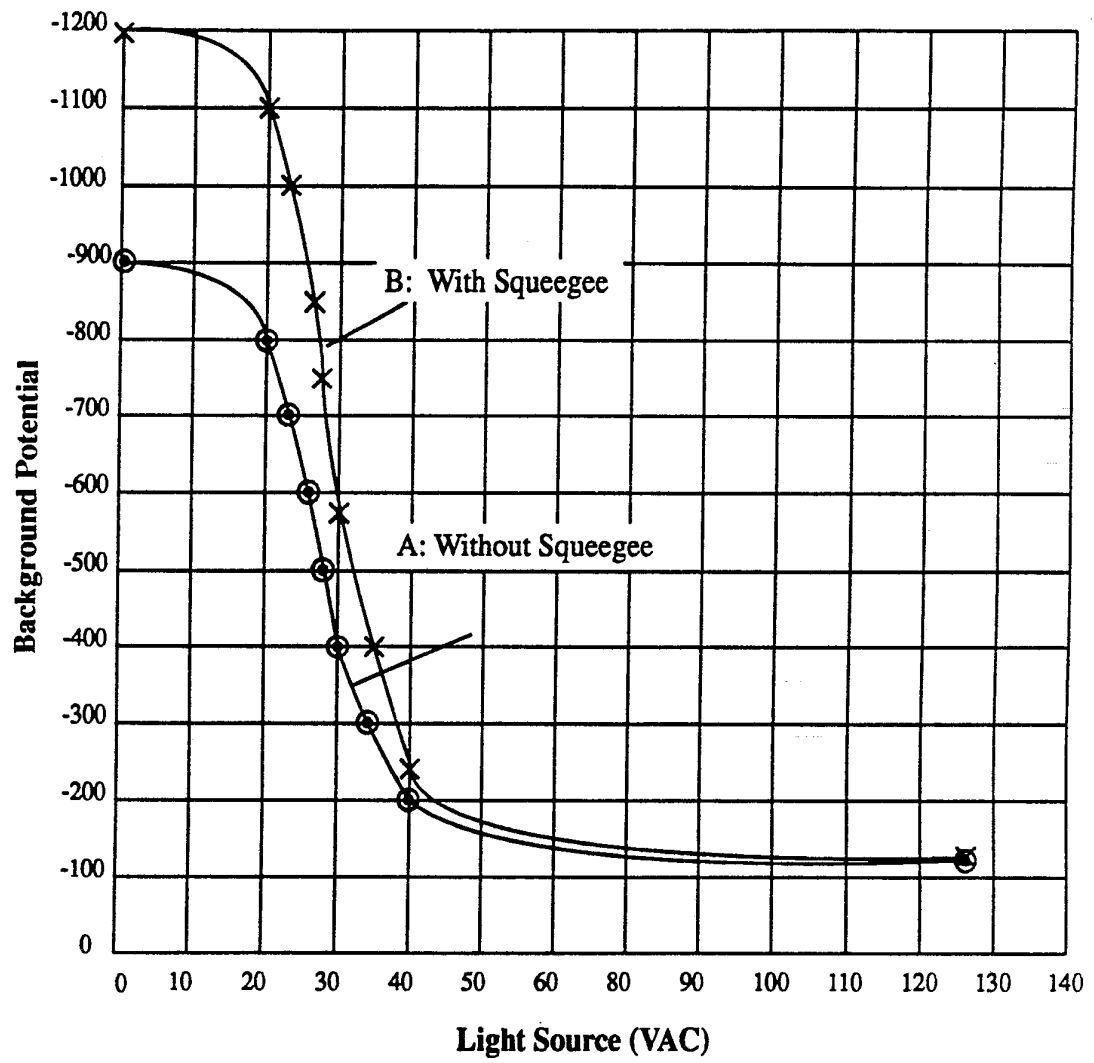


Figure 4

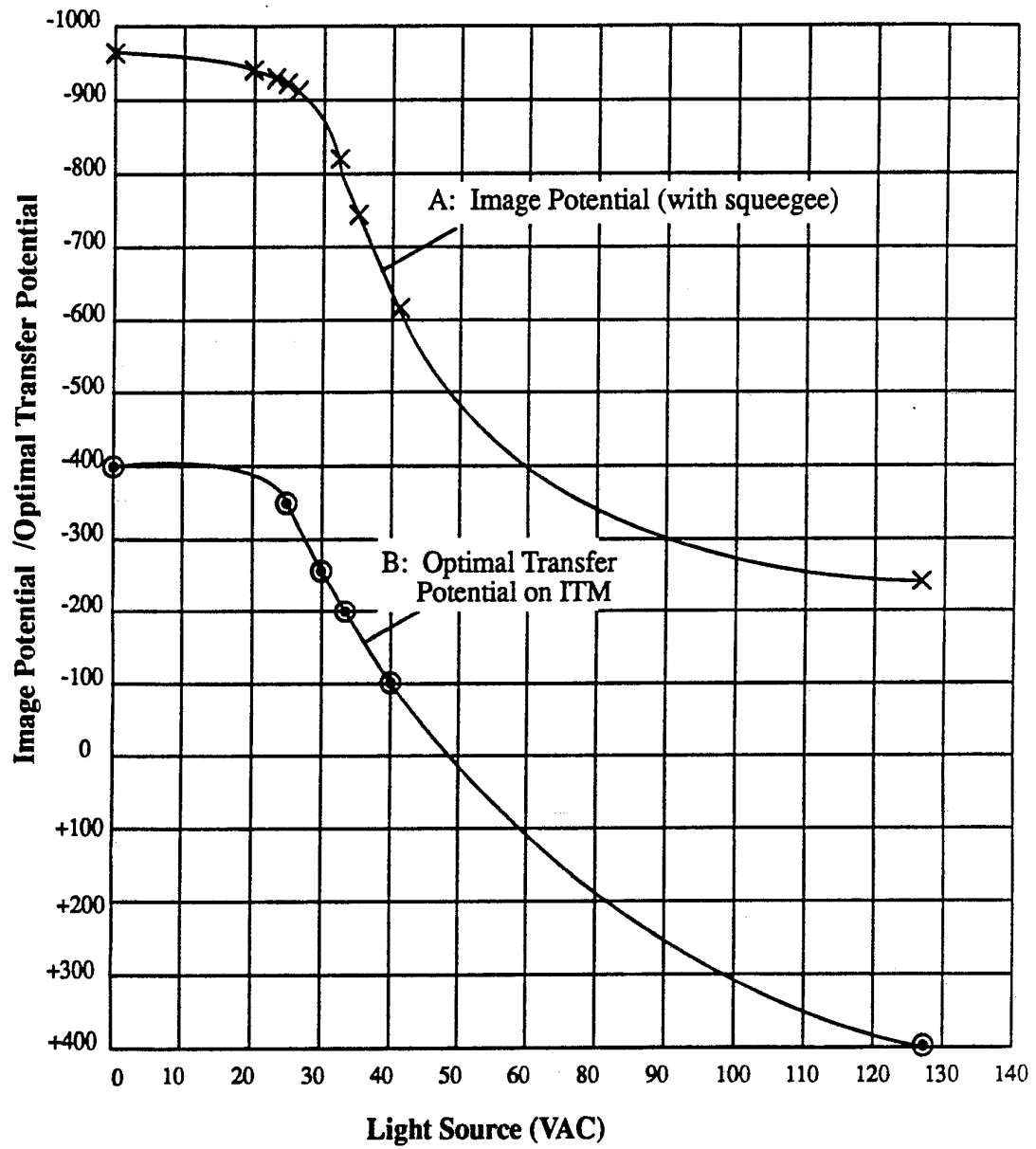
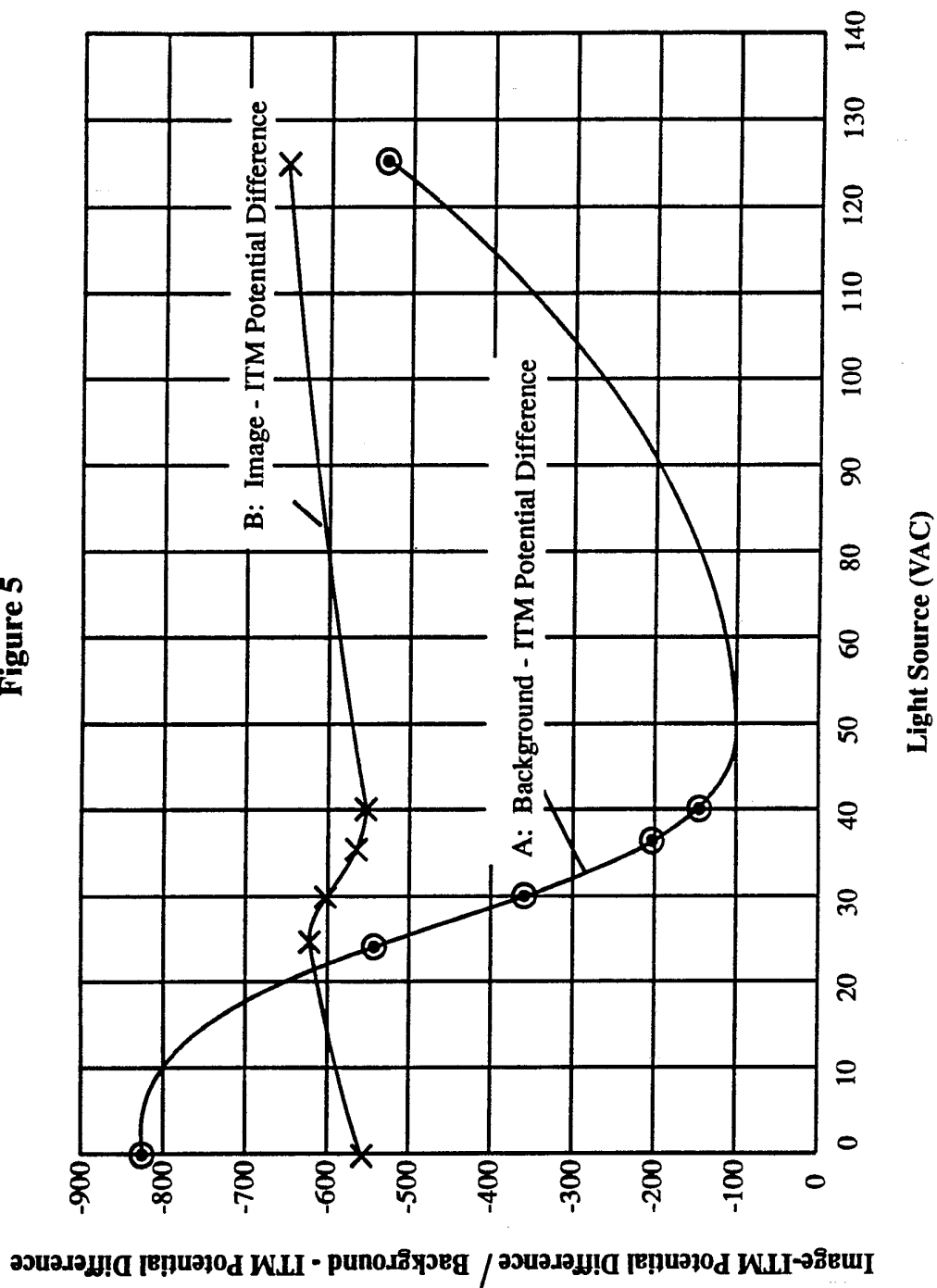


Figure 5



INTERNATIONAL SEARCH REPORT

International Application No PCT/NL 92/00014

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: G 03 G 15/16														
II. FIELDS SEARCHED Minimum Documentation Searched⁷ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border: 1px solid black;">Classification System</th> <th style="border: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="border: 1px solid black; height: 40px; vertical-align: bottom;">IPC5</td> <td style="border: 1px solid black; vertical-align: bottom;">G 03 G</td> </tr> </table> Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched⁸			Classification System	Classification Symbols	IPC5	G 03 G								
Classification System	Classification Symbols													
IPC5	G 03 G													
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; border: 1px solid black;">Category *</th> <th style="border: 1px solid black;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="width: 15%; border: 1px solid black;">Relevant to Claim No.¹³</th> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">X</td> <td style="border: 1px solid black; vertical-align: top;">US, A, 4233381 (BENZION LANDA) 11 November 1980, see column 3, line 64 - column 4, line 30 -- </td> <td style="border: 1px solid black; vertical-align: top;">1-7, 11</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">X</td> <td style="border: 1px solid black; vertical-align: top;">US, A, 3784300 (FREDERICK W. HUDSON ET AL) 8 January 1974, see column 2, line 10 - line 25; column 5, line 10 - line 38 cited in the description -- </td> <td style="border: 1px solid black; vertical-align: top;">1-6</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">X</td> <td style="border: 1px solid black; vertical-align: top;">US, A, 4695152 (CHARLES J. URSO, JR.) 22 September 1987, see column 3, line 51 - column 4, line 10 -- </td> <td style="border: 1px solid black; vertical-align: top;">1-6</td> </tr> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	X	US, A, 4233381 (BENZION LANDA) 11 November 1980, see column 3, line 64 - column 4, line 30 --	1-7, 11	X	US, A, 3784300 (FREDERICK W. HUDSON ET AL) 8 January 1974, see column 2, line 10 - line 25; column 5, line 10 - line 38 cited in the description --	1-6	X	US, A, 4695152 (CHARLES J. URSO, JR.) 22 September 1987, see column 3, line 51 - column 4, line 10 --	1-6
Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³												
X	US, A, 4233381 (BENZION LANDA) 11 November 1980, see column 3, line 64 - column 4, line 30 --	1-7, 11												
X	US, A, 3784300 (FREDERICK W. HUDSON ET AL) 8 January 1974, see column 2, line 10 - line 25; column 5, line 10 - line 38 cited in the description --	1-6												
X	US, A, 4695152 (CHARLES J. URSO, JR.) 22 September 1987, see column 3, line 51 - column 4, line 10 --	1-6												
* Special categories of cited documents: ¹⁰ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family														
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border: 1px solid black; vertical-align: top;"> Date of the Actual Completion of the International Search 29th April 1992 </td> <td style="width: 50%; border: 1px solid black; vertical-align: top;"> Date of Mailing of this International Search Report 21. 05. 92 </td> </tr> <tr> <td style="border: 1px solid black; vertical-align: top;"> International Searching Authority EUROPEAN PATENT OFFICE </td> <td style="border: 1px solid black; vertical-align: top;"> Signature of Authorized Officer Natalie Weinberg </td> </tr> </table>			Date of the Actual Completion of the International Search 29th April 1992	Date of Mailing of this International Search Report 21. 05. 92	International Searching Authority EUROPEAN PATENT OFFICE	Signature of Authorized Officer Natalie Weinberg								
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International Searching Authority EUROPEAN PATENT OFFICE	Signature of Authorized Officer Natalie Weinberg													

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
X	US, A, 4506971 (KENNETH C. BUELL ET AL) 26 March 1985, see column 4, line 19 - line 23; abstract -- -----	1-6

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/NL 92/00014**

SA 56346

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 28/03/92
The European Patent office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4233381	11/11/80	CA-A- 1123889	18/05/82
		DE-A- 2939850	22/05/80
		FR-A-B- 2441201	06/06/80
		GB-A-B- 2034076	29/05/80
		JP-B- 3063074	27/09/91
		JP-A- 55067772	22/05/80
US-A- 3784300	08/01/74	AU-B- 465154	18/09/75
		AU-D- 4924072	23/05/74
		BE-A- 789340	27/03/73
		CA-A- 1000782	30/11/76
		CH-A- 557051	13/12/74
		DE-A-B-C 2250062	05/07/73
		FR-A- 2165384	03/08/73
		GB-A- 1379826	08/01/75
		JP-C- 1023533	28/11/80
		JP-A- 48074230	06/10/73
		JP-B- 55014428	16/04/80
		NL-A- 7213730	26/06/73
		SE-B-C- 377393	30/06/75
US-A- 4695152	22/09/87	JP-A- 61143783	01/07/86
US-A- 4506971	26/03/85	NONE	

For more details about this annex : see Official Journal of the European patent Office, No. 12/82