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(54) Development unit and image forming apparatus having the same.

(57) A development unit comprises a photosensitive body (15) for bearing a latent image, a process unit for forming the latent image on the photosensitive body (15), a developer supporting member (42) rotatably arranged opposite to the photosensitive body (15) and cylindrically formed by a thin plate (42b) having meshes (42a), a fur brush roller (44) formed in contact with the inner surface of the developer supporting member (42) for transporting the developer, a casing (47) for guiding the developer transported by the fur brush roller (44) to charge the developer by friction between the fur brush roller (44) and the casing, and a voltage applying mechanism (49) for applying, to the developer supporting member (42), a voltage which allows the developer to pass through the meshes (42a) and is lower than a voltage enough to supply the developer from the meshes (42a) to the photosensitive body (15) and supplying the developer transported by the fur brush roller (44) from the meshes (42a) to the photosensitive body (15) by physical pressure.

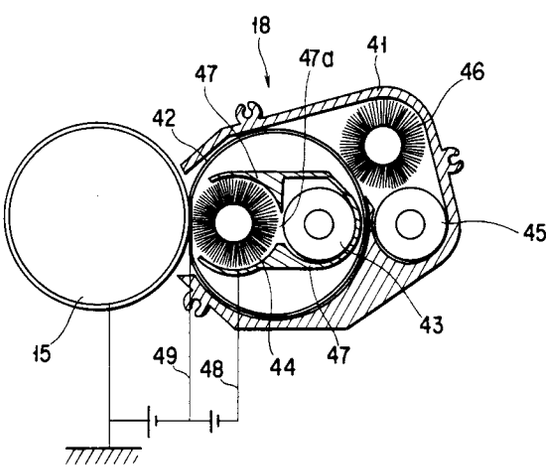

FIG. 2

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The present invention relates to a development unit for visualizing an electrostatic latent image or a magnetic latent image using a powdery toner and an image forming apparatus having the development unit, such as an electronic copying machine.

An electronic copying machine includes a rotatable photosensitive drum, and an electrostatic latent image is formed on the photosensitive drum by a latent image forming means. The electrostatic latent image is supplied with a developer by a development unit to make the latent image visible. The development unit includes a rotatable development roller and, for example, a monocomponent type developer is supplied to the electrostatic latent image by rotation of the development roller.

A metal blade is brought into contact with the development roller to charge the developer by friction between them and uniform the thickness of the developer on the development roller. However, the metal blade contacting the development roller causes a problem in which a stress is easily applied to the developer to make development unstable and lower the quality of an image.

It is accordingly an object of the present invention to provide a development unit by which a developer is charged without any stress and supplied to an electrostatic latent image, and an image forming apparatus having the development unit.

In order to attain the above object, there is provided a developing apparatus for developing a latent image on an image bearing body, comprising:

a thin plate having a surface and a back surface, arranged opposite to the image bearing body, for transporting a developer to the image bearing body, the thin plate having a plurality of meshes through which the developer passes;

means, arranged in contact with the back surface of the thin plate, for supplying the developer into the meshes; and

means for applying, to the thin plate, a voltage which allows the developer to pass through the meshes and is lower than a voltage enough to transport the developer from the thin plate to the image bearing body so that the developer is transported by the supplying means from the thin plate to the image bearing body by physical pressure.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic diagram showing a structure of an electrophotographic image forming apparatus according to an embodiment of the present invention;

Fig. 2 is a schematic diagram showing a structure of a development unit of the image forming apparatus shown in Fig. 1;

Fig. 3 is a graph showing a relationship between the ratio of the speed of a photosensitive body to that of a developer supporting member and the amount of toner of a toner image formed by the image forming apparatus shown in Fig. 1;

Fig. 4 is a graph showing a relationship between the ratio of the speed of the photosensitive body to that of a fur brush roller and the amount of toner of a toner image formed by the image forming apparatus shown in Fig. 1;

Figs. 5(A) and 5(B) are views of the developer supporting member of the development unit shown in Fig. 2, Fig. 5(A) showing an arrangement of meshes of the developer supporting member and Fig. 5(B) showing another arrangement of meshes of the developer supporting member; and

Fig. 6 is an enlarged view of toner which is being supplied by the development unit shown in Fig. 2.

An embodiment of the present invention will now be described, with reference to the accompanying drawings.

Fig. 1 shows an inner structure of an electrophotographic image forming apparatus using a semiconductor laser, such as a laser printer.

The image forming apparatus (laser printer) is connected to a host system (not shown), which is an external output device such as a computer and a wordprocessor, through a transmission controller such as an interface circuit. Upon receiving a printing start signal from the host system, the image forming apparatus starts an image recording operation to record an image on paper serving as a material to which an image is transferred.

The structure of the image forming apparatus will be described in detail.

In Fig. 1, reference numeral 1 denotes a body of the image forming apparatus. An electrophotographic process unit 3 is arranged in the upper portion of the body 1, as an image forming means, and a cassette container 8 for containing paper feed cassettes 7a and 7b is arranged in the lower portion of the body 1. A concave paper discharge section 6 is formed in the front and upper portion of the body 1. A control panel 11 is formed on a left frame of the body 1 which is located on one side of the paper discharge section 6.

The electrophotographic process unit 3 performs a series of image forming operations such as charging, exposure, development, transfer, separation, cleaning, and fixing, and a drum-shaped photosensitive body 15 serving as an image bearing body is rotatably provided in substantially the central part of the unit 3. A charger 16 of scorotron and an exposer 17a of a laser exposure unit 17 serving as an exposure means (electrostatic latent image forming means) are arranged above the pho-

tosensitive body 15. A development unit 18 is provided on one side of the photosensitive body 15, and a transfer roller 19 is provided below the body 15. Further, a cleaner 20 including a blade and an auger is provided on the other side of the photosensitive body 15.

The body 1 includes a paper carrying section 24 for carrying paper, which is fed from the paper feed cassettes 7a and 7b by paper feeders 22 and 52, to the paper discharge section 6 through an image transfer section 23 between the photosensitive body 15 and the transfer roller 19. A pair of aligning rollers 25 and a pair of carrying rollers 26 are arranged on the upstream side of the image transfer section 23 of the paper carrying section 24, and a fixing unit 27 and a pair of paper discharging rollers 28 and 29, are arranged on the downstream side of the image transfer section 23.

When a printing start signal is received from the host system, the photosensitive body 15 is rotated and charged by the charger 16. The laser exposure unit 17 including a polygon mirror scanner 30A scans and exposes the photosensitive body 15 with a laser beam a modulated in response to dot image data supplied from the host system, thereby forming an electrostatic latent image corresponding to an image signal on the photosensitive body 15. This electrostatic latent image is developed by toner supplied from the development unit 18 as a developer, and thus visualized as a toner image.

Paper is picked up from the paper feed cassette 7a or 7b in synchronization with the toner image forming operation. This paper is aligned by the aligning rollers 25 and then sent to the image transfer section 23. The toner image formed on the photosensitive body 15 is thus transferred to the paper by means of the transfer roller 19. The paper is then sent to the fixing unit 27 through the paper carrying section 24. The fixing unit 27 includes a heat roller 31 having a heater lamp 12 and a pressure roller 32 pressed against the heat roller 31. The paper passes between the heat roller 31 and pressure roller 32, and the toner image is fused and fixed on the paper. After that, the paper is discharged to the paper discharge section 6 by the paper discharging rollers 28 and 29.

After the toner image is transferred to the paper, the toner remaining on the photosensitive body 15 is removed by the cleaner 20 of the blade. The removed toner is transported by the auger in the axial direction of the photosensitive body 15 and collected in a box (not shown).

The development unit 18 has a structure as shown in Fig. 2, and the structure will be described in detail.

In Fig. 2, reference numeral 41 indicates a development container, and a monocomponent toner is put into the container 41 as a developer. A developer supporting member 42 serving as a development electrode, which is formed like a cylinder by a thin plate 42b having meshes 42a, is rotatably provided in the development container 41. A casing 47 is arranged in the developer supporting member 47 as a guide means, and a first transport screw 43 serving as a supply means and a first fur brush roller 44 serving as a soft member are rotatably arranged in the casing 47. The first fur brush roller 44 contacts the inner surface of the developer supporting member 42. A second transport screw 45 serving as a transport means and a second fur brush roller 46 serving as a toner eliminating soft member are rotatably arranged outside the developer supporting member 42. The second fur brush roller 46 contacts the outer surface of the developer supporting member 42. The first and second transport screws 43 and 45 supply monocomponent toners in directions opposite to each other, and the toners are received by and supplied from both ends of each of the screws 43 and 45.

A first bias applying mechanism 48 serving as a first bias applying means is connected to the first fur brush roller 44 to apply a direct-current bias voltage to the first fur brush roller 44. Further, a second bias applying mechanism 49 serving as a second bias applying means is connected to the developer supporting member 42 to apply a direct-current voltage or a bias voltage generated by superimposing an alternate-current voltage on a direct-current voltage, to the developer supporting member 42. This bias voltage allows the toners to easily pass through the meshes 42a and is lower than a voltage enough to supply the toners to the photosensitive body 15.

In this embodiment, the amount of transported toner is set so that the toner always stops at a development nip portion of the first fur brush roller 44. The surplus toner moves on the developer supporting member 42 and is peeled off by the first fur brush roller 44. The peeled toner is mixed with a new toner by the second transport screw 45, and the mixed toner is transported again to the fur brush roller 44 by the first transport screw 43. In this embodiment, rayon or nylon scatteringly including carbon, which is conductive and has a thickness of 600D/100F and a density of 100000F/inch^2, is used as a material for the fur brush rollers 44 and 46.

Furthermore, a stainless plate or a nickel plate whose diameter ϕ is 30 mm and thickness is 0.15 mm, is suitable for the developer supporting member 42. The meshes of the developer supporting member 42 are circular and each has a diameter ϕ of 86 μm, and the distance between the centers of adjacent two meshes is 151 μm. These meshes can be formed by electric casting or etching.

If the surface of the developer supporting member 42 is coated with a resistive or insulating film of about 5 to 100 μm, the transfer (discharge) between the developer supporting member 42 and the photosensitive body 15 can be suppressed. To add a well-known charging control agent to the film as a component for improving the charging property is effective in enhancing the development characteristic.

The toner is negatively charged and its average diameter is 6 μm. The photosensitive body 15 is an organic photosensitive body whose diameter ϕ is 30 mm, circumferential speed Vp is 45 mm/s, and surface potential is -550V.

Moreover, a development bias voltage of -200V is applied to the developer supporting member 42, and a bias voltage of -300V is applied to the fur brush roller 44.

The rotation direction of the fur brush roller 44 is opposite to that of the photosensitive body 15.

Since the development container 41 is so constructed that the whole development container is pressed on the photosensitive body 15, the developer supporting member 42 is pressed on the body 15 and bent accordingly. Therefore, a nip of 2 mm or more is formed between the photosensitive body 15 and the developer supporting member 42.

The developer supporting member 42 rotates twice as fast as the photosensitive body 15 does, in a direction opposite to that of the photosensitive body 15. Fig. 3 shows a relationship between the ratio of circumferential speed Vd of the developer supporting member 42 to that Vp of the photosensitive body 15 and the amount of toner of a toner image formed on the photosensitive body 15. As shown in Fig. 3, there is no specific relationship between them and, when the ratio in circumferential speed is not more than 2, fog occurs in an area where no images are formed.

Fig. 4 shows a relationship between the ratio of circumferential speed Vb of the fur brush roller 44 and that Vp of the photosensitive body 15 and the formed toner image when the ratio of Vd of the developer supporting member 42 and Vp of the photosensitive body 15 is fixed to 2. It is apparent from Fig. 4 that the amount of toner exceeds 0.9 mg/cm^2 when the ratio in circumferential speed is 2 or more. Consequently, the ratio in circumferential speed has to be set to 2 or more in order to obtain the image density ID of 1.3 or more after the toner image is transferred to paper and fixed thereon.

The meshes 42a of the developer supporting member 42 are arranged as shown in Fig. 5(A) or 5(B). Needless to say, the meshes 42a shown in Fig. 5(A), which are arranged in a staggered fashion, are more efficient for development than those shown in Fig. 5(B).

As a result of the above, as shown in Fig. 6, toner t pushed out by the fur brush roller 44 stops at the nip, and toner t' on the area where no images are formed, moves to the developer supporting member 42 and largely remains on its outer surface.

The fur brush roller 46 has functions of introducing the toner into the meshes 42a and returning it to the second transport screw 45. During the development, the toner is supplied by rotation of the first transport screw 43 and then to the fur brush roller 44 through a hole 47a of a bulkhead of the casing 47. The toner is transported by rotation of the fur brush roller 44, and charged to a predetermined polarity by friction between the inner wall of the casing 47 and the fur brush roller 44. The toner charged to the predetermined polarity is further transported to a position opposing the developer supporting member 42. This toner is supplied to the photosensitive body 15 through the meshes 42a of the developer supporting member 42 by the pressure of the fur brush roller 44 and the electric field generated between the roller 44 and the member 42 thereby to develop an electrostatic latent image.

Since, as described above, the toner is rotated by rotation of the fur brush roller 44 and thus charged, a stress generated when the toner is charged can be reduced. Further, since the toner remaining on the developer supporting member 42 is removed by rotation of the fur brush roller 46, a stress applied to the toner can be decreased.

Consequently, the present invention has the advantage in which the stress applied to the developer when the developer is supplied and it is charged, can be reduced to perform a stable, uniform development operation.

Claims

1. A developing apparatus for developing a latent image on an image bearing body (15), characterized by comprising:

a thin plate (42b) having a surface and a back surface, arranged opposite to the image bearing body (15), for transporting a developer to the image bearing body (15), the thin plate (42b) having a plurality of meshes (42a) through which the developer passes;

means (44), arranged in contact with the back surface of said thin plate (42b), for supplying the developer into the meshes (42a); and

means (47) for charging the developer before the supplying means (44) supplies the developer into the meshes (42a); and

means (49) for applying, to said thin plate (42b), a voltage which allows the developer to

pass through the meshes (42a) and is lower than a voltage enough to transport the developer from the thin plate (42b) to the image bearing body (15) so that the developer is transported by said supplying means (44) from the thin plate (42b) to the image bearing body (15) by physical pressure.

2. The developing apparatus according to claim 1, characterized by further comprising a developer eliminating member (46) formed in contact with the surface of said thin plate (42b), for eliminating the developer remaining on said thin plate (42b) after the developer is supplied.

3. The developing apparatus according to claim 2, characterized by further comprising means (43) for supplying the developer to said supplying means (44).

4. The developing apparatus according to claim 3, characterized by further comprising means (45) for transporting/receiving the developer to/from said supplying means (43), and receiving the developer eliminated by said developer eliminating member (46) and supplying the developer to said supplying means (43).

5. The developing apparatus according to claim 1, characterized in that said voltage applying means (49) includes means for applying a direct-current voltage as the bias voltage and a voltage generated by superimposing an alternate-current voltage upon the direct-current voltage.

6. The developing apparatus according to claim 5, characterized in that said voltage applying means (49) includes means for applying a direct-current voltage to said supplying means (44).

7. An image forming apparatus for forming an image on an image bearing body (15), characterized by comprising:

means (17) for forming a latent image on the image bearing body (15);

a thin plate (42b) having a surface and a back surface, arranged opposite to the image bearing body (15), for transporting a developer to the image bearing body, the thin plate (42b) having a plurality of meshes (42a) through which the developer passes;

means (44), arranged in contact with the back surface of said thin plate (42b), for supplying the developer into the meshes;

means (47) for charging the developer before the supplying means supplies the developer into the meshes (42a); and

means (49) for applying, to said thin plate (42b) a voltage which allows the developer to pass through the meshes (42a) and is lower than a vlotage enough to transport the developer from the thin plate (42b) to the image bearing body (15) so that the developer is transported by said supplying means (44) from the thin plate (42b) to the image bearing body by physical pressure.

8. The image forming apparatus according to claim 7, characterized by further comprising a developer eliminating soft member (46) formed in contact with the surface of said thin plate (42b), for eliminating the developer remaining on said thin plate (42b) after the developer is supplied.

9. The image forming apparatus according to claim 8, characterized by further comprising means (43) for supplying the developer to said supplying means (44).

10. The image forming apparatus according to claim 9, characterized by further comprising means (45) for transporting/receiving the developer to/from said supplying means (43), and receiving the developer eliminated by said developer eliminating member (46) and supplying the developer to said supplying means (43).

11. The image forming apparatus according to claim 7, characterized in that said voltage applying means (49) includes means for applying a direct-current voltage as the bias voltage and a voltage generated by superimposing an alternate-current voltage upon the direct-current voltage.

12. The image forming apparatus according to claim 11, characterized in that said voltage applying means (49) includes means for applying a direct-current voltage to said supplying means (44) soft member.

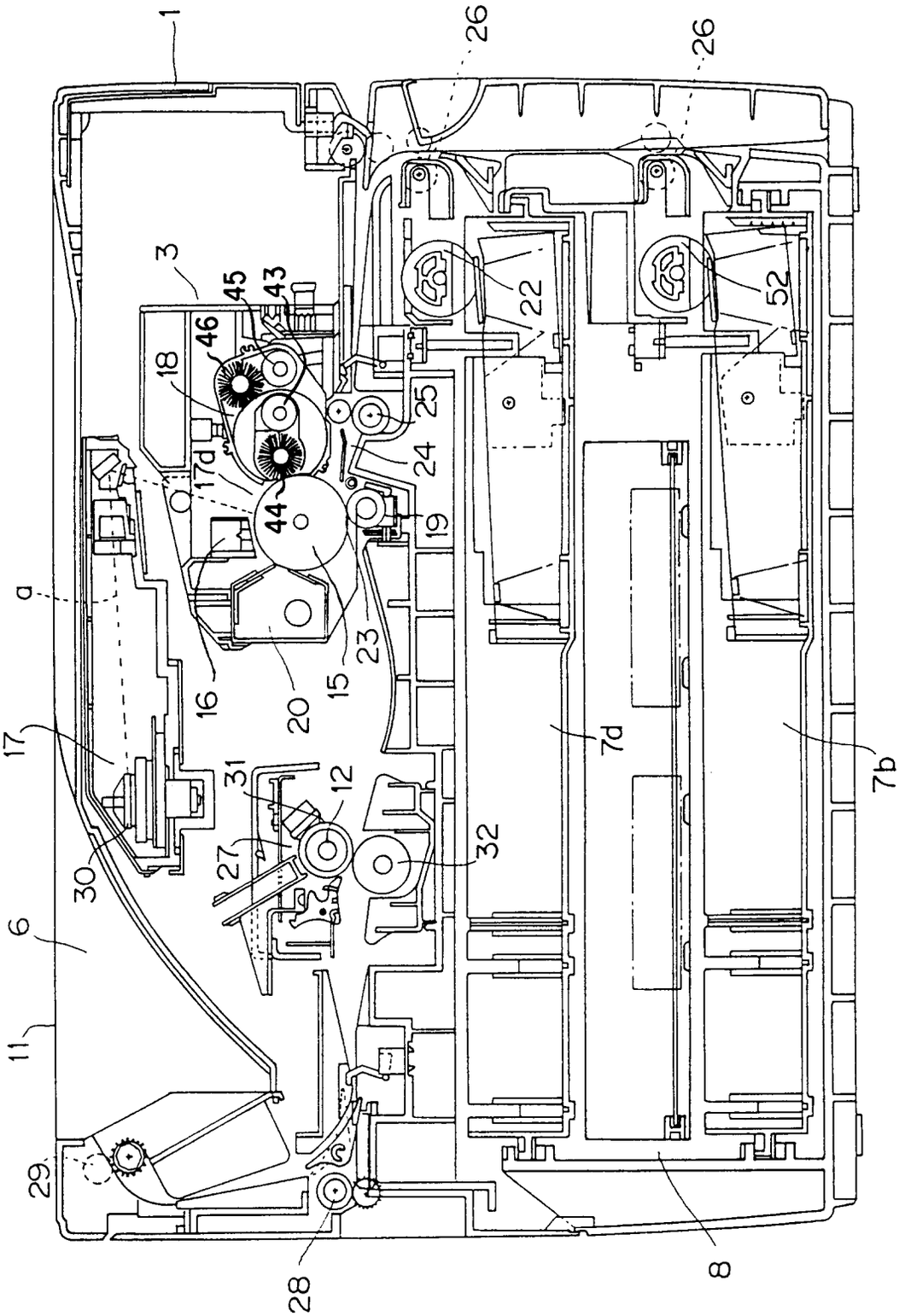
1
26
26
3
45
43
46
18
22
52
25
24
17d
44
19
a
23
16
20
15
17
31
12
7d
7b
27
32
30
6
11
29
28
8

FIG. 1

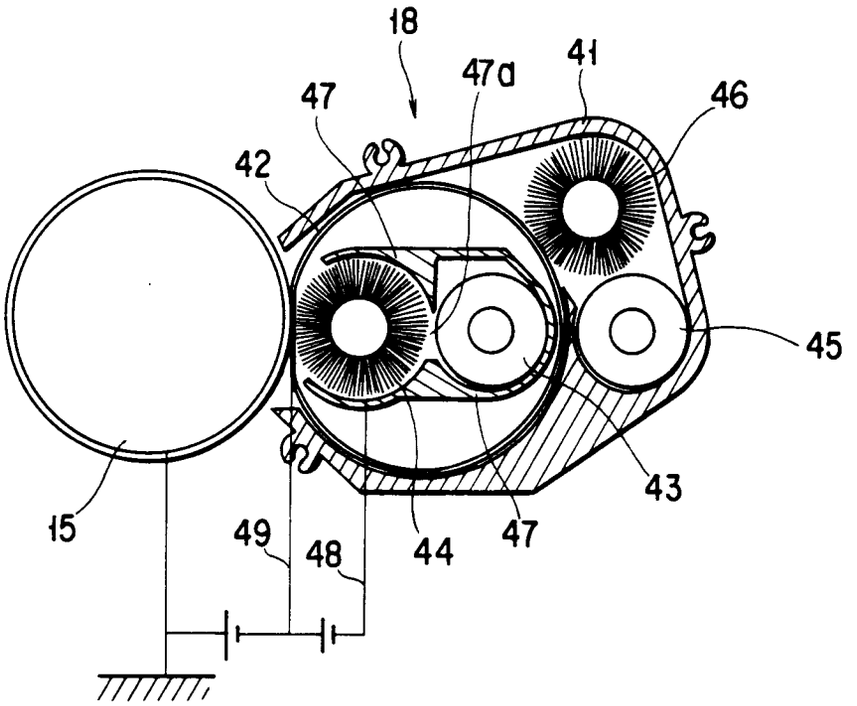

FIG. 2

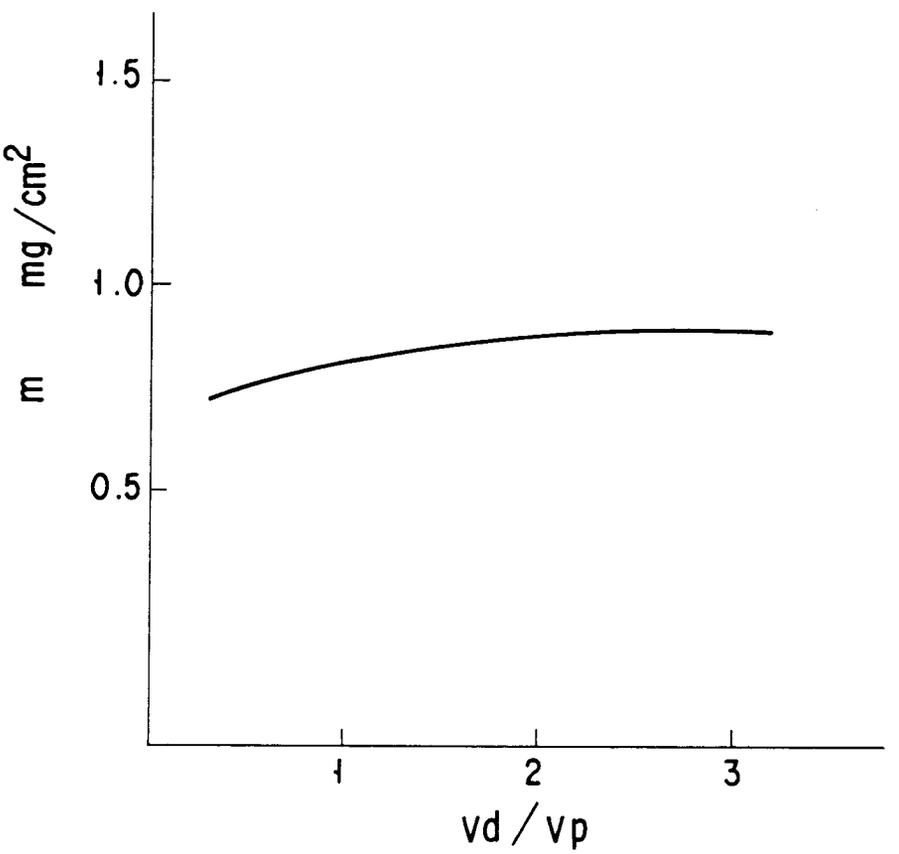

FIG. 3

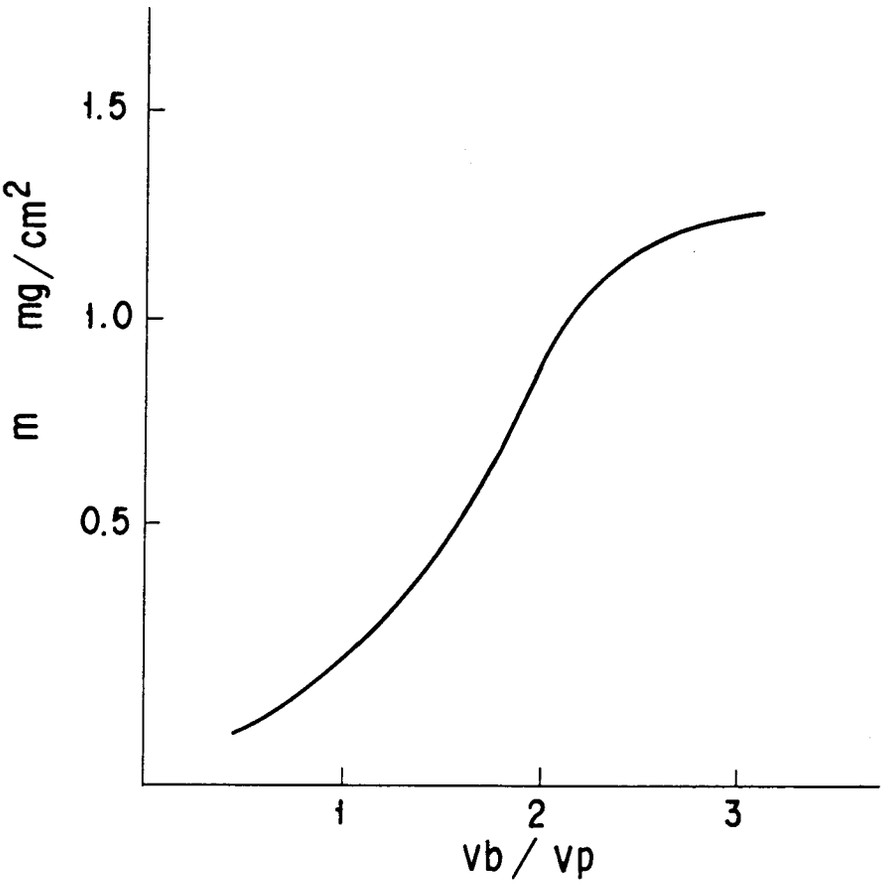

FIG. 4

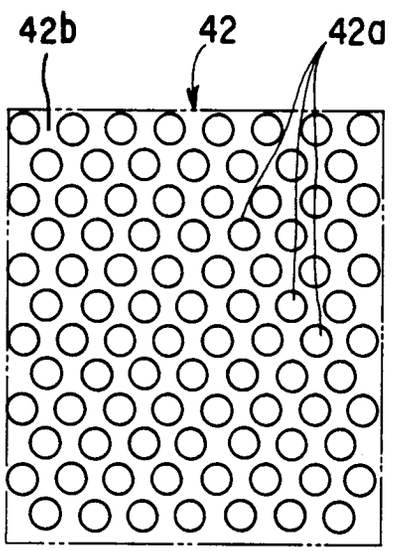

FIG. 5A

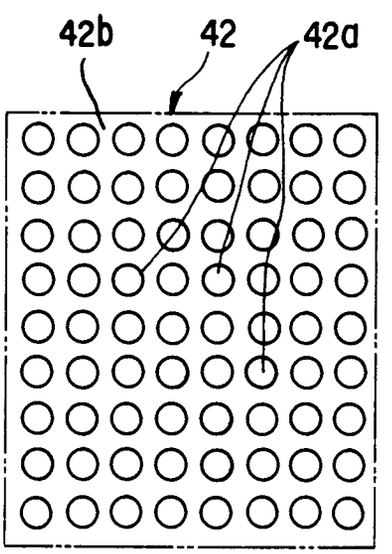

FIG. 5B

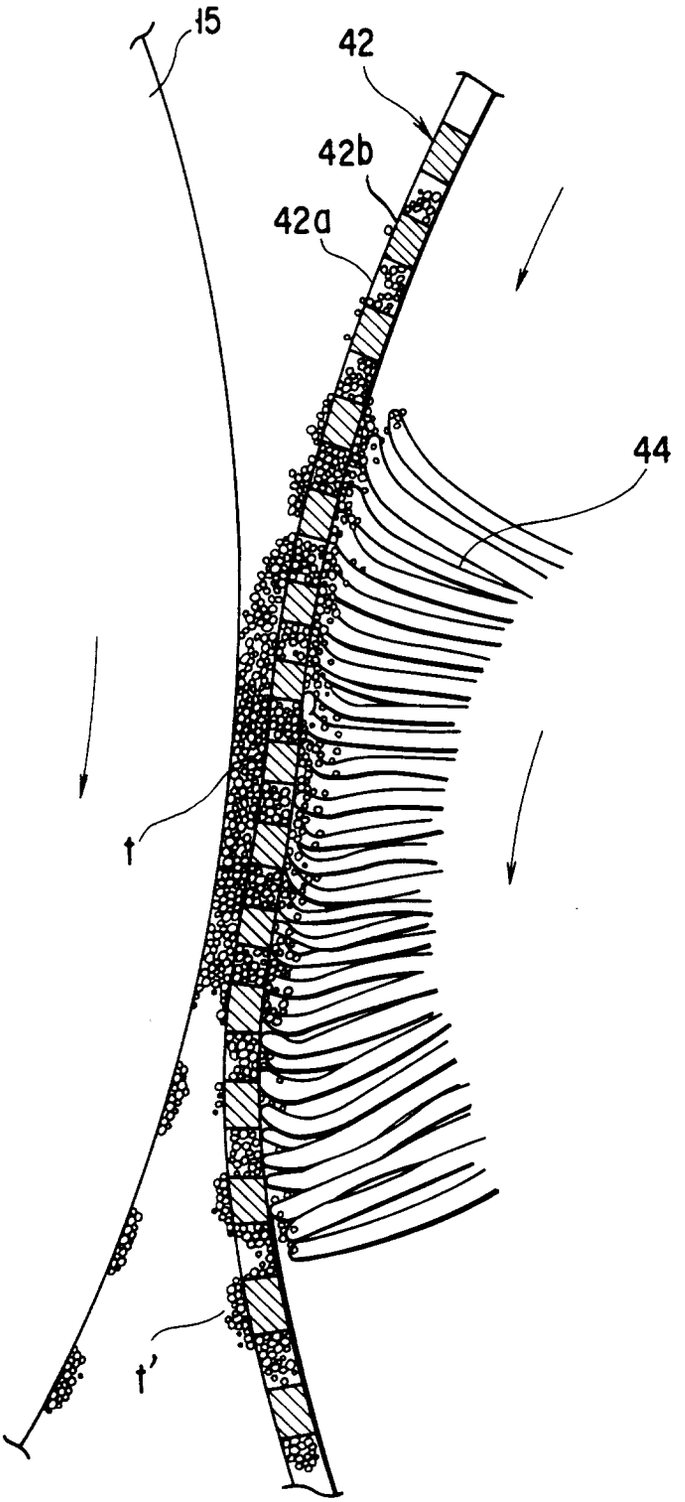

FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 10 2742

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-4 876 573 (KAMIMURA) * abstract * * column 3, line 36 - column 4, line 6 * * column 4, line 34 - line 59; figures 3,4 * ---	1,5-7, 11-12	G03G15/08
A	EP-A-0 469 902 (MITA) * column 1, line 1 - line 5 * * column 4, line 47 - column 5, line 10 * * column 6, line 10 - line 34; figures 1,2 * ---	1,3,4,7, 9,10	
A	US-A-3 893 413 (WEILER) * abstract * * column 4, line 4 - line 21 * * column 4, line 46 - line 52; figure 1 * ---	1,7	
A	EP-A-0 306 044 (MINOLTA) * page 2, paragraph 1 * * page 3, line 48 - line 58 * * page 5, line 12 - line 23; figure 1 * -----	1,7	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

G03G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 MAY 1993	GREISER N.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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