

12 **EUROPEAN PATENT APPLICATION**

21 Application number: 83108180.7

51 Int. Cl.³: G 03 G 15/09

22 Date of filing: 18.08.83

30 Priority: 27.08.82 JP 148805/82
27.08.82 JP 148807/82

43 Date of publication of application:
07.03.84 Bulletin 84/10

84 Designated Contracting States:
DE FR GB

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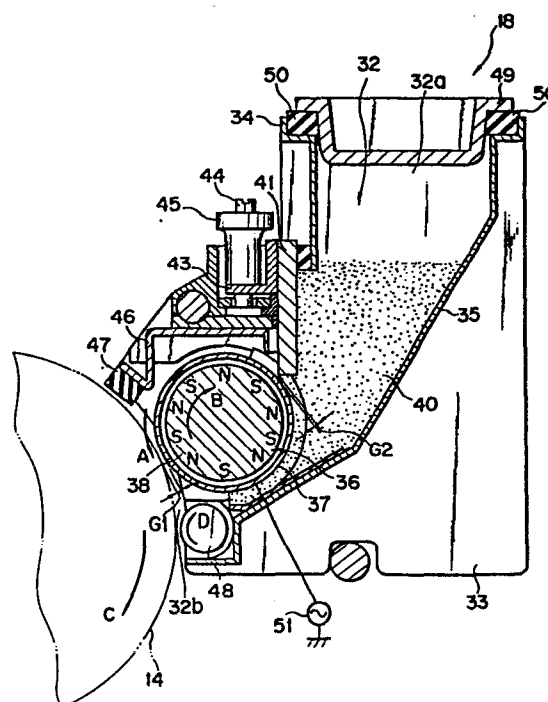
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54 **Developing device and developing method.**

57 A developing device (18) develops an electrostatic latent image formed on a photosensitive layer of a photosensitive drum (14) by a toner (40) and is provided with a developing roller (36) which rotatably faces the photosensitive layer and is adopted to rotate with the toner (40) thereon forming a toner layer (42), such that the toner (40) is transferred to the photosensitive layer to develop the electrostatic latent image, and a doctor blade (41) which is spaced from the developing roller (36), for regulating the thickness of the toner layer (42) formed on the developing roller (36). The toner (40) consists of an electrically insulating toner whose surface potential (V_t) on the developing roller (36) has polarity opposite to that of charges on the electrostatic latent image and absolute value greater than 20 (volts) and smaller than 90 (volts).

FIG. 3



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Developing device and developing method

The present invention relates to a method and a device for developing an electrostatic latent image, and more specifically to a method and a device for developing an electrostatic latent image into a visible
5 image by means of an electrically insulating developing agent.

Methods for developing an electrostatic latent image using a one-component developing agent are disclosed in patents in several countries. Many of
10 these methods use an electrically conductive magnetic toner for the developing agent. It is difficult, however, to form a conductive magnetic toner image on ordinary paper by corona transfer. It is therefore necessary to use special paper with increased electric
15 resistance for the copying paper. If an electrically insulating toner is used for the developing agent, then the toner image can be transferred even to ordinary paper. However, according to the electrostatic latent image developing method using the one-component devel-
20 oping agent which does not contain so-called carrier particles and can be transferred to ordinary paper, it is not always possible to stably charge the insulating toner and to obtain good and stable image quality.

One conventional method for charging electrically
25 insulating toners uses corona discharge. In this method, it is hard to uniformly charge the toner

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particles. In the corona charging method, pollutants (e.g, ammonia) in the air may possibly be ionized so that the insulating toner may be charged by the ions of the pollutants sticking thereto. If the ions of the pollutants in the air stick to the toner, then the toner is contaminated increasing adhesion between toner particles and lowering the electric resistance of the toner. As a result, developed images are uneven in quality and image transfer is adversely affected.

10 Thus, the charging method using corona discharge involves some awkward problems. Other conventional charging methods are based on frictional charging or contact charging. According to these methods, however, the electrically insulating toner sticks to a charging member for frictional charging or contact charging. If the toner covers the whole surface of the charging member, the member loses its durability, and it becomes difficult to stably charge the toner for a long time. As a result, the developing density is lowered and the quality of images obtained is deteriorated. Thus, according to the charging methods based on frictional charging or contact charging, it is hard to obtain a stable developing density and good image quality with high reliability.

25 In many of the developing devices recently used in electrophotographic apparatuses and the like, a magnetic brush formed from a one-component magnetic toner is used as a magnetic developing agent. Fig. 1 shows a typical example of one such prior art developing device. This developing device is provided with a developing roller 4 which consists of a magnet roller 2 opposed to a photosensitive body 1 as an object to be developed and having a plurality of magnetic poles, and a cylindrical sleeve 3 enclosing the magnet roller 2. The magnet roller 2 rotates clockwise or in the direction indicated by arrow a, while the sleeve 3 rotates counterclockwise or in the direction indicated by arrow b. Thus, a layer 5a

(magnetic brush) of a magnetic toner 5 is formed on the outer peripheral surface of the sleeve 3. The toner layer 5a is rubbed against the surface of the photo-sensitive body 1, regulated in thickness by a doctor blade 6 as a developing agent regulator which is disposed above the top portion of the sleeve 3. The magnetic toner 5 is carried in the direction indicated by arrow c which corresponds to the direction of arrow b.

In Fig. 1, numeral 8 designates the flow of the magnetic toner 5 (toner loop) in a toner hopper 7.

In the prior art developing device, a key to satisfactory copying performance or good image quality is to keep the gap between the doctor blade 6 and the sleeve 3 constant and to form a uniform toner layer on the surface of the sleeve 3.

When the conventional developing device of this type was tested by continuous development, copy images obtained were subject to the following defects.

(I) White stripes in black solid portions (white parallel lines extending along the course of the image being carried):

These white stripes were caused when the magnetic toner 5 stuck to the tip portion of the doctor blade 6, so that the amount of the toner 5 being carried was reduced at the position of sticking. In general, the magnetic toner sticks to the doctor blade 6 from the following causes.

(1) Mechanical or electrostatic force.

(2) Dust or paper dust caught in the developing device blocks the space between the doctor blade 6 and the sleeve 3 to form a nucleus to which the magnetic toner 5 is to stick.

(II) Fogging (darkening of white ground):

An insufficiently charged toner was included in the magnetic toner 5 forming the toner

layer 5a (magnetic brush).

(III) Lines perpendicular to the course of the image being carried were unclear:

Since the magnetic brush 5a was rotated only in one direction (arrow C), fine lines formed from a less adhesive portion of the magnetic toner 5 and extending at right angles to the course of the image were swept off by the magnetic brush 5a.

(IV) Variation in density:

(1) Stress on the magnetic toner deforms the magnetic toner to change its characteristics.

(2) Uneven charging of the magnetic toner.

(3) The image density depends on the amount of the toner 5 in the toner hopper 7. The less the amount, the lower the density will be.

(4) Blocking of the magnetic toner 5 between the doctor blade 6 and the sleeve 3.

The present invention is contrived in consideration of the aforementioned circumstances, and is intended to provide a developing method and a developing device capable of stably forming visible images of high quality which can be transferred to ordinary paper.

In order to attain the above object, the present invention is characterized by using an electrically insulating developing agent whose surface potential (V_t) on developing agent supplying means has polarity opposite to that of charges on an electrostatic latent image and an absolute value greater than 20 (volts) and smaller than 90 (volts). According to the invention, moreover, the shape and location of the tip end of a developing agent regulator for regulating the thickness of a layer of the magnetic developing agent on the outer peripheral surface of the developing agent supplying means are set properly.

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According to one aspect of the present invention, there is provided a developing method comprising steps of opposing developing agent supplying means for supplying a developing agent to an electrostatic latent image-forming surface of an image carrier; applying the charged developing agent to the surface of the developing agent supplying means; and opposing the developing agent on the developing agent supplying means to the electrostatic latent image forming surface to develop an electrostatic latent image formed on the electrostatic latent image-forming surface as the developing agent supplying means moves, said developing agent consisting of an electrically insulating developing agent whose surface potential (V_t) on the developing agent supplying means has polarity opposite to that of charges on the electrostatic latent image and an absolute value greater than 20 (volts) and smaller than 90 (volts).

According to the other aspect of the present invention, there is provided a developing device which develops an electrostatic latent image formed on an electrostatic latent image-forming surface of an image carrier by a developing agent, comprising: developing agent supplying means rotatably facing the electrostatic latent image-forming surface and adapted to rotate with the developing agent thereon forming a developing agent layer, such that the developing agent is transferred to the electrostatic latent image forming surface to develop the electrostatic latent image; and a regulating member spaced from the developing agent supplying means, for regulating the thickness of the developing agent layer formed on the developing agent supplying means, said developing agent consisting of an electrically insulating developing agent whose surface potential (V_t) on the developing agent supplying means has polarity opposite to that of charges on the electrostatic latent image and an absolute value greater than 20 (volts) and smaller than 90 (volts).

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

5 Fig. 1 is a side view showing an outline of a prior art developing device;

Fig. 2 is a side view schematically showing an electronic copying apparatus incorporating a developing device of one embodiment according to the present invention;

10 Fig. 3 is a side sectional view of the developing device shown in Fig. 2;

Fig. 4 is a side sectional view for illustrating the operation of the developing device of Fig. 3;

Fig. 5 is a side view for illustrating an angle α ;

15 Fig. 6 is a side view for illustrating an angle β and a distance l ;

Figs. 7A and 7B are a side view and a bottom view, respectively, showing a flat surface formed on a doctor blade;

20 Fig. 8 is a graph showing the relationships between the weight of toner, image density, and surface potential of toner;

Fig. 9 is a graph showing the relationship between the surface potential of toner and the back ground;

25 Fig. 10 is a graph showing the relationship between the surface potential of toner and the image density; and

30 Fig. 11 is a graph showing the relationship between the loading torque of the developing roller and the weight of the toner received in the toner hopper.

One embodiment of the developing device according to the present invention used in an electronic copying apparatus will now be described in detail with reference to the accompanying drawings of Figs. 2 to 10.

35 Fig. 2 schematically shows the construction of the electronic copying apparatus using the developing device according to the one embodiment of the invention. In

Fig. 2, numeral 11 designates a housing which carries an original table 12 thereon. The original table 12 is reciprocated by a motor 13 built in the housing 11. A cylindrical photosensitive drum 14 as an image carrier is rotatably supported in the substantially central portion of the interior of the housing 11. The photosensitive drum 14 rotates in synchronism with the reciprocation of the original table 12. An exposure system 17 including a lamp 15, a convergent light transmitting body 16, etc., is disposed between the photosensitive drum 14 and the original table 12. The exposure system 17 irradiates an original paper put on the original table 12, and leads a reflected light from the original paper onto the photosensitive drum 14 to form an electrostatic latent image of the original paper thereon. A developing device 18 described in detail later, a transfer corona discharger 19, a deelectrifier 20, a cleaner 21, and a charger 22 are arranged successively in the rotating direction (clockwise) of the photosensitive drum 14, starting at the position of image formation. A conveyor path 25 for copying paper 24 as a recording medium lies at the bottom portion of the interior of the housing 11, passing through a transfer section 23 which is defined between the photosensitive drum 14 and the transfer corona discharger 19. The starting end portion of the conveyor path 25 is coupled to a paper feed section 28 including a manual feed guide 26 and a paper feeder 27, while its terminal end portion leads to a paper discharge tray 30 via a fixing device 29. The conveyor path 25 is provided with conveyor rollers 31.

The surface of the photosensitive drum 14 is first charged with electricity by the charger 22. Then, charges on the irradiated surface portion of the photosensitive drum 14 are selectively erased by image exposure by the exposure system 17. Thus, an electrostatic latent image is formed on the surface of the

photosensitive drum 14. Subsequently, magnetic toner is applied to the electrostatic latent image by the developing device 18 to develop the latent image into a visible image. Thus, a developing agent image is formed. The developing agent image is transferred by corona discharge of the transfer corona discharge 19 to the copying paper 24 which is fed from the paper feed section 28 and guided by a guide plate.

Fig. 3 shows the construction of the developing device 18. In Fig. 3, numeral 32 designates a toner hopper as a developing agent storage tank. The toner hopper 32 is integrally composed of a pair of side frames 33 (only one is shown) and wall plates 34 and 35 fixed to the side frames 33 at both longitudinal edge portions, and has a supplying opening 32a and a developing opening 32b.

A developing roller 36 as developing agent supplying means is housed in the toner hopper 32, partially exposed through the developing opening 32b. The developing roller 36 is formed of a cylindrical rotating body 37 (hereinafter referred to as a sleeve) made of aluminum, stainless steel or some other material, and a magnet roller 38 contained in the sleeve 37. In the developing roller 36, the sleeve 37 rotates in the direction indicated by arrow A, while the magnet roller 38 rotates in the direction indicated by arrow B in synchronism with the rotation of the sleeve 37.

A first narrow gap G1 is defined between the outer peripheral surface of the sleeve 37 and that of the photosensitive drum 14 which rotates in the direction indicated by arrow C. Magnetic toner 40 as a magnetic developing agent in the toner hopper 32 is attracted to the outer peripheral surface of the sleeve 37 by the magnetic force of the magnet roller 38, and is carried in the direction of arrow A. Then, the toner 40 is passed through a second narrow gap G2 between the sleeve 37 and a doctor blade 41 as a developing agent regulator

which extends vertically. Thus, a toner layer 42 with a uniform thickness is formed on the sleeve 37. The doctor blade 41 is integrally fitted with a doctor blade adjusting bracket 43. The bracket 43 is moved
5 vertically by means of a fine adjustment screw 44 to set the second gap G2 to a prescribed width. The bracket 43 positioned in this manner is fixed by a doctor blade fixing nut 45.

10 A toner guard 46 and a sealing member 47 are attached to the upper portion of the developing opening 32b. A sub-magnet roller 48 is disposed at the lower portion of the developing opening 32b so as to be rotated in the direction indicated by arrow D. The sub-magnet roller 48 collects the magnetic toner 40
15 attached to non-imaged surface portions of the photo-sensitive drum 14, and also magnetically attracts the magnetic toner 40 scattering downward from the developing opening 32b so that the magnetic toner 40 is collected on the developing roller 36. The supplying
20 opening 32a of the toner hopper 32 is closed by a lid 49. The lid 49 and a sealing member 50 attached thereto prevent the magnetic toner 40 from scattering through the opening 32a.

In the developing device 18 constructed in this
25 manner, the magnetic toner 40 attracted to the sleeve 37 forms a toner layer 42 made uniform in thickness by the doctor blade 41. As the magnet roller 38 rotates, the magnetic toner 40 is carried on the sleeve 37 in the form of vertically raised fur. The toner 40 forming the
30 toner layer 42 is attracted to the electrostatic latent image on the surface of the photosensitive drum 14 through the first gap G1 for satisfactory development. Hereupon, an AC bias from a bias power source 51 is applied to the sleeve 37 of the developing roller 36 in
35 order to determine a proper changing ratio of original density-copy density characteristic (hereinafter referred to as a γ -characteristic). Alternatively,

however, the developing roller 36 may only be grounded without using the bias power source 51.

Fig. 4 shows the flow of the magnetic toner 40 (hereinafter referred to as a toner loop 52) in the toner hopper 32. The toner loop 52 is created by the rotation of the developing roller 36 and the doctor blade 41. The magentic toner 40 in the toner hopper 32 is applied to the outer peripheral surface of the sleeve 37 by the magnet roller 38 of the developing roller 36, and is carried toward the doctor blade 41 as the sleeve 37 and the magnet roller 38 rotate. Since there is the narrow second gap G2 between the doctor blade 41 and the sleeve 37, that part of the carried magnetic toner 40 near the surface of the sleeve 37 is carried to the side of the photosensitive drum 14, passing through the second gap G2. However, the remaining part of the magnetic toner 40 is separated from the sleeve 37 under the doctor blade 41, as shown in Fig. 4, and then drops by its own weight. The dropped toner 40 is attracted again to the surface of the sleeve 37 by the magner roller 38, and is carried in the aforesaid manner. Repeating this action, the magnetic toner 40 in the toner hopper 32 is gradually consumed in developing.

In the one-component development sytem using the magnetic toner 40, a key to satisfactory copying performance or good picture quality is to form a uniform toner layer on the surface of the sleeve 37.

According to one embodiment, therefore, the tip of the doctor blade 41 is slanted so that $0^\circ < \alpha < 90^\circ$ where α is an angle formed between the bottom end face of the doctor blade 41 forming the tip or edge thereof and a tangent which touches the circumference of the developing roller 36 at the intersection of the circumference and the extension of the bottom end face of the doctor blade 41, as shown in detail in Fig. 5.

Thus, with the angle α of the bottom end face of the doctor blade 41 set in this manner, the flow of the

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magnetic toner 40 near the lower end of the doctor blade 41 becomes smooth, and dust or paper dust caught in the developing device 18 is carried away together with the magnetic toner 40 without stagnating between the doctor blade 41 and the sleeve 37. Also, the magnetic toner 40 is prevented from electrostatically sticking to the surface of the doctor blade 41 by its own conveying force.

Accordingly, the quantity of magnetic toner 40 will never be reduced by sticking to the lower end of the doctor blade 41, thereby providing a satisfactory copy image without unevenness in density.

According to one embodiment, moreover, that edge of the bottom end face of the doctor blade 41 nearer to the developing roller 36 faces the circumference of the developing roller 36 in a manner such that $30^\circ < \beta < 90^\circ$ where β is an angle formed between a vertical line passing through the central axis of the developing roller 36 and a straight line connecting the central axis and the nearer edge of the bottom end face of the doctor blade 41, as shown in Fig. 6. Also, that edge of the bottom end face of the doctor blade 41 farther from the developing roller 36 is located so that $l \geq r$ where r is the radius of the developing roller 36, and l is the horizontal distance between the central axis of the developing roller 36 and that farther edge of the bottom end face of the doctor blade 41.

Shown in Fig. 11, under the condition given by $30^\circ < \beta < 90^\circ$, the toner loop 52 described with reference to Fig. 4 is reduced and the loading torque of the developing roller is kept constant even though the weight of the toner received in the toner hopper 32 varies, thereby producing the following effects.

(1) Uncharged toner 40 is prevented from being easily supplied to the sleeve 37, so that fogging is reduced.

(2) Stress on the magentic toner 40 can be reduced, so that the magnetic toner 40 can be prevented from

becoming finer particles thereby soiling the device, and the magnetic powder exposed on the surface of the toner layer 42 can be prevented from increasing. Thus, the surface of the photosensitive drum 14 will not be damaged.

5 (3) The magnetic toner can be uniformly charged with electricity for stably density by delaying the arrival of the magnetic toner 40 at the photosensitive drum 14 after the passage of the doctor blade 41. Also, the brush of the magnetic toner 40 is made flexible
10 improving the reproducibility of fine lines.

 (4) The driving torque of the magnet roller 38 is reduced.

 From the condition $\ell \geq r$, moreover, we obtain the following effects.

15 (1) The weight of the magnetic toner 40 in the toner hopper 32 has little direct effect on that portion of the outer peripheral surface of the sleeve 37 which is located under the doctor blade 41, so no influence is exerted on the amount of the magnetic toner 40 passing
20 through the doctor blade 41. Thus, the copy density will never be changed even if the amount of the magnetic toner 40 in the toner hopper 32 changes.

 (2) Since the weight of the magnetic toner 40 in the toner hopper 32 has little direct effect on that
25 portion of the outer peripheral surface of the sleeve 37 which is located under the doctor blade 41, the magnetic toner 40 will never stagnate at that portion.

 According to one embodiment, moreover, a flat surface 41a substantially parallel to the surface of the developing roller 36 is formed on that edge portion of
30 the doctor blade 41 which is located nearest to the developing roller 36, as shown in Figs. 7A and 7B.

 The doctor blade 41 is formed from a metal plate, such as an iron or stainless-steel plate. Usually,
35 metal plates have a degree of warp. If the doctor blade 41 is warped, however, the width of the second gap G2 will vary causing defective copy images.

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Thereupon, the formation of the flat surface 41a (cut portion) on the bottom edge of the doctor blade 41 reduces the influence of the warp improving the quality of images obtained.

5 Referring now to Figs. 7A and 7B, the relationships between the doctor blade 41 and the developing roller 36 will be described further in detail.

Fig. 7A is a side view of the doctor blade 41, and Fig. 7B is a bottom view of the doctor blade 41 taken in the direction of arrow E of Fig. 7A. The doctor blade 41 has a warp such that both end portions of the doctor blade 41 on one side thereof lie on an imaginary line v, while the central portion lies on an imaginary line w, as shown in Fig. 7B. On the other side of the doctor blade 41, both end portions of the doctor blade 41 lie on an imaginary line y, and the central portion on an imaginary line z. As a result, the width of the gap between the doctor blade 41 and the developing roller 36 varies from a value 42a to a value 42b. If one side edge of the warped doctor blade 41 is cut to form the flat surface 41a thereon, the lower or inner edge of the cut portion forms a straight line x. Thus, the gap between the doctor blade 41 and the developing roller 36 can have a fixed width 42c. Namely, the formation of the flat surface 41a (cut portion) on the one side edge of the doctor blade 41 makes the gap between the doctor blade 41 and the developing roller 36 less susceptible to the influence of the warp.

Using the developing device constructed in this manner, experiments were conducted on various toners with the results mentioned later. The surface potential of the toner on the sleeve 37 was measured under the following conditions.

Sleeve material: stainless steel.
35 Sleeve diameter: 31 ϕ .
Sleeve speed: 0 rpm.
Magnet speed: 300 rpm.

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Number of magnet poles: 10.

Magnetic force of magnet: 750 G.

Specimen weight: 2 g.

Under these conditions, the surface potential of
5 each toner 40 was measured by means of a surface
potential meter one minute after the toner 40 was
carried onto the sleeve 37.

(Exmaple 1)

A toner 40 was prepared by mixing 2 % carbon black,
10 60 % magnetic powder (EPF 1,000 from Toda Kogyo, Co.),
and 0.4 % hydrophobic silica (R-972 from Nippon Aerosil,
Co.) by weight in styrene-acrylic copolymer, and
crushing and polarizing the resultant mixture. The
surface potential V_t of thie toner 40 was measured
15 under the aforesaid conditions. The result was

$V_t = -70$ volts.

Development was performed on the developing device using
this toner 40 and the photosensitive drum 14 of selenium
charged for positive polarity. As a result, the image
20 density did not change even after ten thousand copies
were made. The image quality was high and stable
without involving background (fogging) or trailing.
Moreover, the toner 40 could be satisfactorily trans-
ferred to ordinary paper under a high-humidity con-
25 dition. This was permitted because the charging of the
toner 40 based on the frictional charging or contact
charging between the toner 40 and the sleeve 37 and
between the toner particles balanced with the discharge
between the toner 40 and the sleeve 37, between the
30 toner particles, and within the toner 40, so that the
toner 40 used in the development was charged uniformly.

(Comparative Example 1)

A toner 40 similar to the one used in Example 1 was
prepared under the same conditions except the use of
35 4 % carbon by weight in the mixture and addition of
1.0 % charging controlling agent. The electrical
characteristics of this toner 40 were

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Vt = -20 volts.

When development was conducted with use of this toner 40 on the same developing device used in Example 1, background (fogging) was increased during continuous copying operation. The transfer efficiency was lowered under a high-humidity condition. The background (fogging) was increased probably because part of the toner 40 was charged for the opposite polarity due to the frictional charging between the photosensitive drum 14 and the toner 40 or polarization between the toner particles. The lowering of the transfer efficiency under the high-humidity condition can be attributed to reduction of the charge holding capability of the toner 40.

(Comparative Example 2)

15 A toner 40 similar to the one used in Example 1 was prepared under the same conditions except the exclusion of carbon from the composition. The electrical characteristic of this toner 40 was

Vt = -90 volts.

20 When development was conducted with use of this toner 40 on the same developing device used in Example 1, background (fogging) was caused in the initial stage, and the image density was lowered by continuous copying. Also, the image obtained was subject to trailing and voids. The initial fogging and trailing were caused probably because an uncharged portion of the toner 40 was applied to low-potential portions or ground portions of the latent image and edge-effect regions at the rear ends of solid portions. The continuous copying lowered the image density presumably because the toner 40, once charged, exhibited too high resistivity to be readily discharged, thereby destroying the balance between charging and discharge and increasing the amount of charges, or because highly charged toner stuck to the sleeve 37 to increase unevenly charged toner.

The voids (white stripes in black solid portions) were produced because the toner frictionally charged to

a high degree by the doctor blade 41 stuck to the doctor blade 41 and built up to vary the gap between the doctor blade 41 and the sleeve 37, thereby making the thickness of the developing agent layer uneven.

5 Fig. 8 shows the relationship between the weight of toner and image density and between the weight and surface potential of toner determined on the toners of Example 1 and comparative Example 2 used in the developing device. As seen from Fig. 8, both the image
10 density and surface potential for the toner of Example 1 are stable against the change of toner weight.

 Figs. 9 and 10 show several relationships obtained from the results of the experiments of Example 1 and Comparative Examples 1 and 2 using the photosensitive
15 drum of positive polarity. As seen from Fig. 9, if the surface potential of the toner reaches -20 volts or more, the background condition becomes unstable. As seen from Fig. 10, if the surface potential is lowered to -90 volts or less, the image density starts to
20 change. The trailing is restricted to a permissible degree when the surface potential is -90 volts or more. As a result, the proper range for the surface potential V_t of the toner may be given $-20 \text{ volts} > V_t > -90 \text{ volts}$.

 Although the electrostatic latent image carrier
25 according to the aforementioned embodiment has been described as being of positive polarity, it is to be understood that the present invention may also be applied to the case of a latent image carrier of negative polarity.

30 The developing method of the invention may suitably be adapted to the development of electrostatic latent images formed by the electrostatic recording method or other conventional methods, as well as the electro-
photography. Moreover, the method of the invention
35 may effectively be applied to development using other insulating toners (one-component) than the insulating magnetic toner.

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The developing device according to the one embodiment described above should preferably be used to obtain further stable images.

5 It is to be understood that various changes and modifications may be effected in the present invention by one skilled in the art without departing from the scope or spirit of the invention.

10 According to the present invention, as described in detail herein, stable images capable of being transferred to plain paper can be obtained by the use of an electrically insulating developing agent whose surface potential V_t on developing agent supplying means has polarity opposite to that of charges on an electrostatic latent image and an absolute value greater than
15 20 (volts) and smaller than 90 (volts).

According to the invention, moreover, the developing agent is frictionally charged on developing agent supplying means, and further charged in an electric field generated by the potential of an electrostatic
20 latent image. During continuous copying operation, charging and discharge of the developing agent are performed in balanced relation, so that a uniformly charged developing agent layer can be obtained constantly. Thus, the developing agent never blocks on the developing
25 agent regulator or the developing agent supplying means, ensuring the production of high-quality images.

Furthermore, better and more stable images may be obtained by properly setting the shape and location of the tip end of the developing agent regulator.

Claims:

1. A developing method comprising steps of
opposing developing agent supplying means (36) for
5 supplying a developing agent (40) to an electrostatic
latent image-forming surface of an image carrier (14);
applying the charged developing agent (40) to the sur-
face of the developing agent supplying means (36); and
opposing the developing agent (40) on the developing
10 agent supplying means (36) to the electrostatic latent
image forming surface to develop an electrostatic latent
image formed on the electrostatic latent image-forming
surface as the developing agent supplying means (36)
moves,
15 characterized in that said developing agent (40)
consists of an electrically insulating developing agent
whose surface potential (V_t) on the developing agent
supplying means (36) has polarity opposite to that of
charges on the electrostatic latent image and an absolute
20 value greater than 20 (volts) and smaller than 90 (volts).
2. The developing method according to claim 1,
characterized in that said electrically insulating
developing agent is a magentic developing agent.
3. A developing device (18) which develops an
25 electrostatic latent image formed on an electrostatic
latent image-forming surface of an image carrier (14) by
a developing agent (40), comprising:
developing agent supplying means (36) rotatably
facing the electrostatic latent image-forming surface
30 and adapted to rotate with the developing agent (40)
thereon forming a developing agent layer (42), such
that the developing agent (40) is transferred to the
electrostatic latent image-forming surface to develop
the electrostatic latent image; and
35 a regulating member (41) spaced from the developing
agent supplying means (36), for regulating the thickness
of the developing agent layer (42) formed on the

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developing agent supplying means (36),

characterized in that

said developing agent (40) consists of an electrically insulating developing agent whose surface potential (V_t) on the developing agent supplying means (36) has polarity opposite to that of charges on the electrostatic latent image and an absolute value greater than 20 (volts) and smaller than 90 (volts).

4. The developing device according to claim 3, characterized in that said developing agent supplying means includes a first surface with a given curvature, and said regulating member includes a tip portion facing the first surface such that an angle α formed between a second surface, among a plurality of surfaces forming the tip portion, which, in conjunction with the developing agent supplying means, defines a passage for the developing agent on the upper-course side with respect to the moving direction of the developing agent supplying means, and a third surface tangent to the first surface and containing the intersection of the first surface and the extension of the second surface, is set within a range $0^\circ < \alpha < 90^\circ$.

5. The developing device according to claim 4, characterized in that said developing agent supplying means has a central axis parallel to that of the image carrier.

6. The developing device according to claim 3, characterized in that said regulating member has a fourth surface extending parallel to the first surface on that edge thereof which is located nearest to the developing agent supplying means.

7. The developing device according to claim 6, characterized in that said fourth surface is formed of a flat surface.

8. The developing device according to claim 3, characterized in that said developing agent supplying means is substantially cylindrical.

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9. The developing device according to claim 8, characterized in that said regulating member is located on the opposite side of the developing agent supplying means to the image carrier so that an angle β formed
5 between a vertical line passing through the central axis of the developing agent supplying means and a straight line connecting the central axis and that portion of the regulating member which is located close to the developing agent supplying means, is set within a range
10 $30^\circ < \beta < 90^\circ$.

10. The developing device according to claim 9, characterized in that said developing agent supplying means is in the form of a cylinder having a radius r , and said regulating member extends along a vertical axis
15 so that the horizontal distance l between the central axis of the developing agent supplying means and that edge of the lower end portion of the regulating member which is located farthest from the image carrier is given by $l \geq r$.

FIG. 1

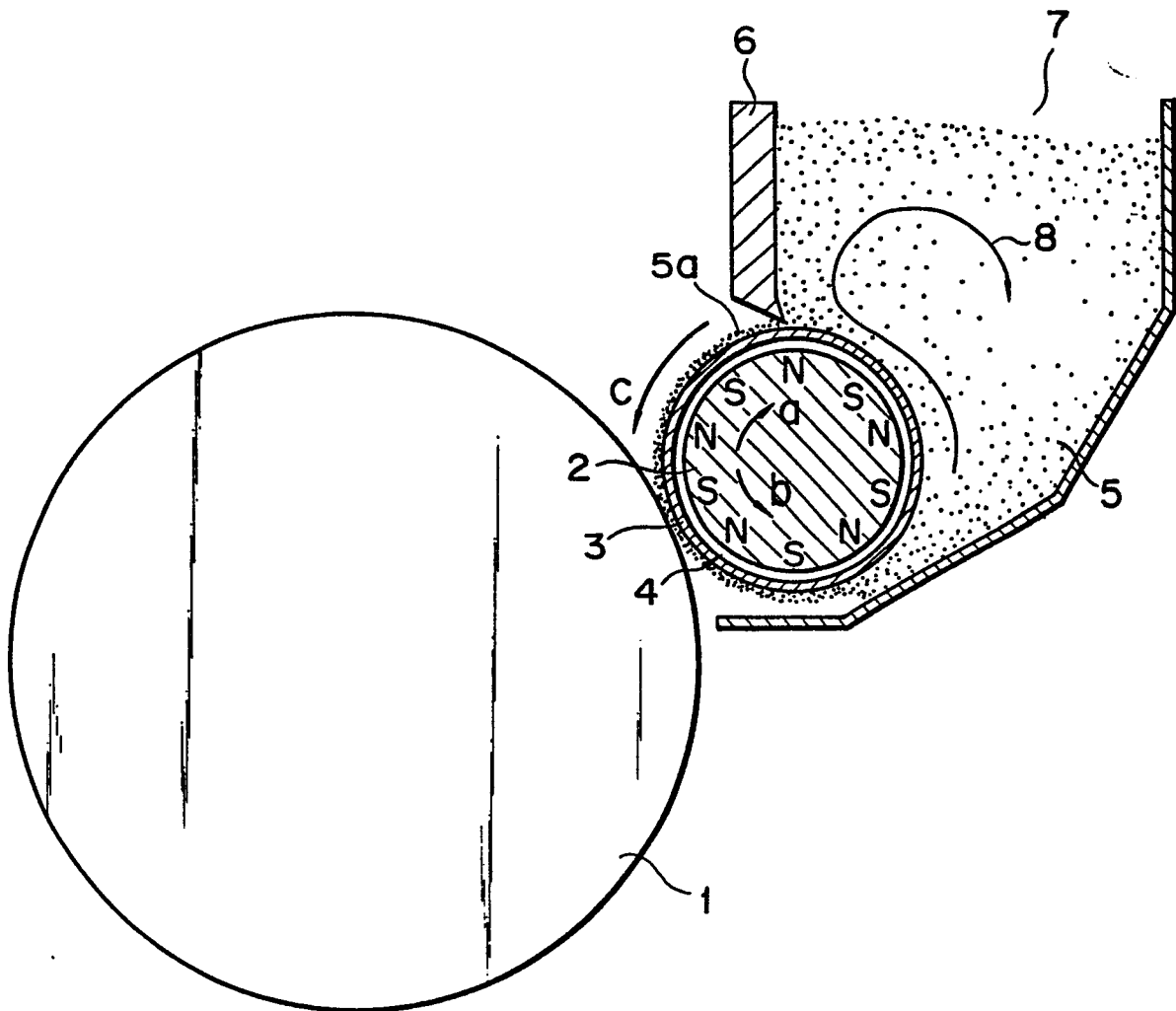


FIG. 2

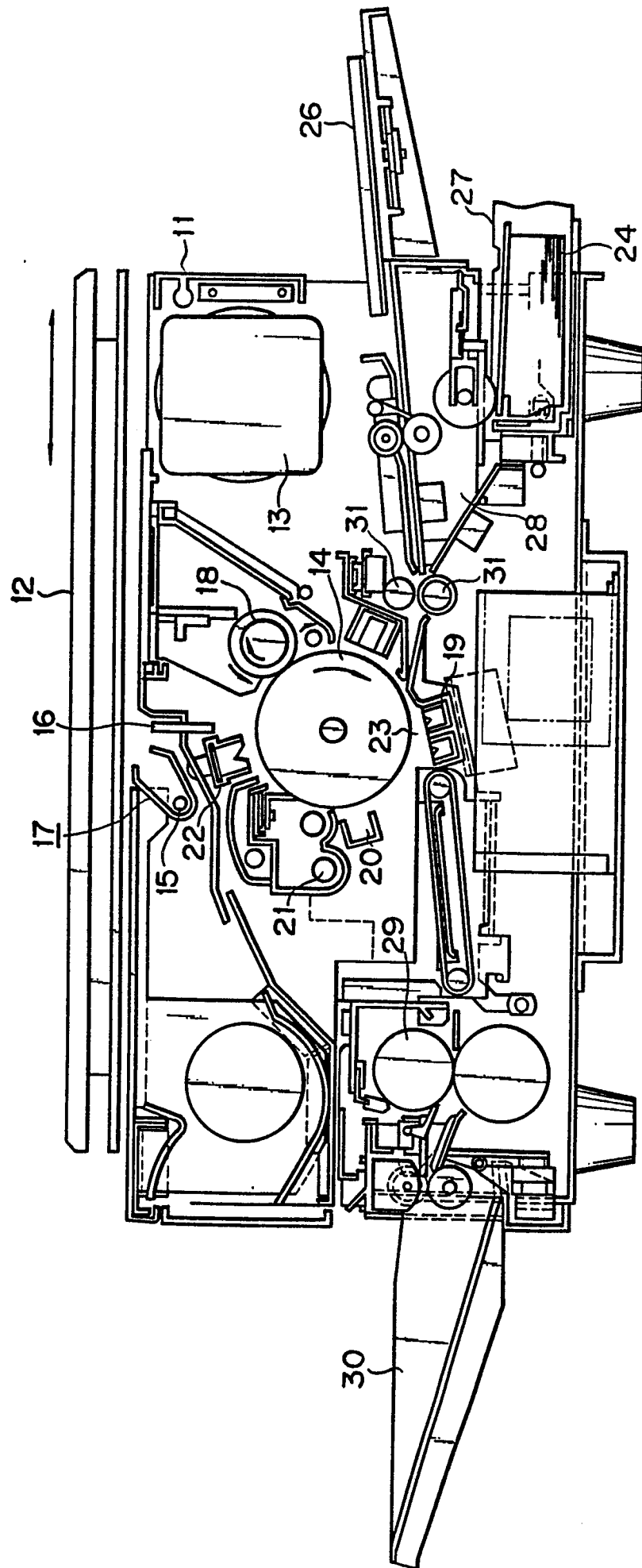


FIG. 3

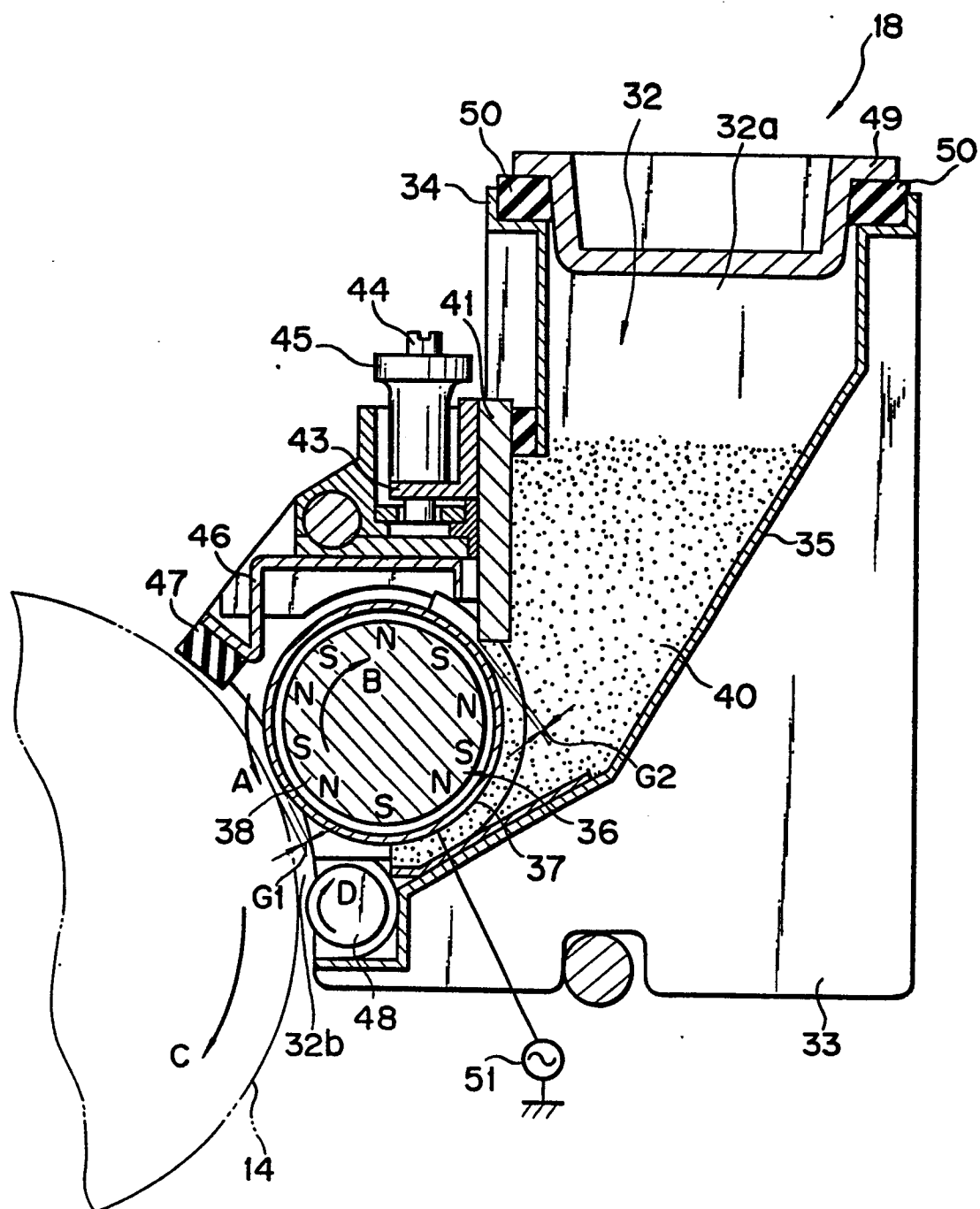


FIG. 4

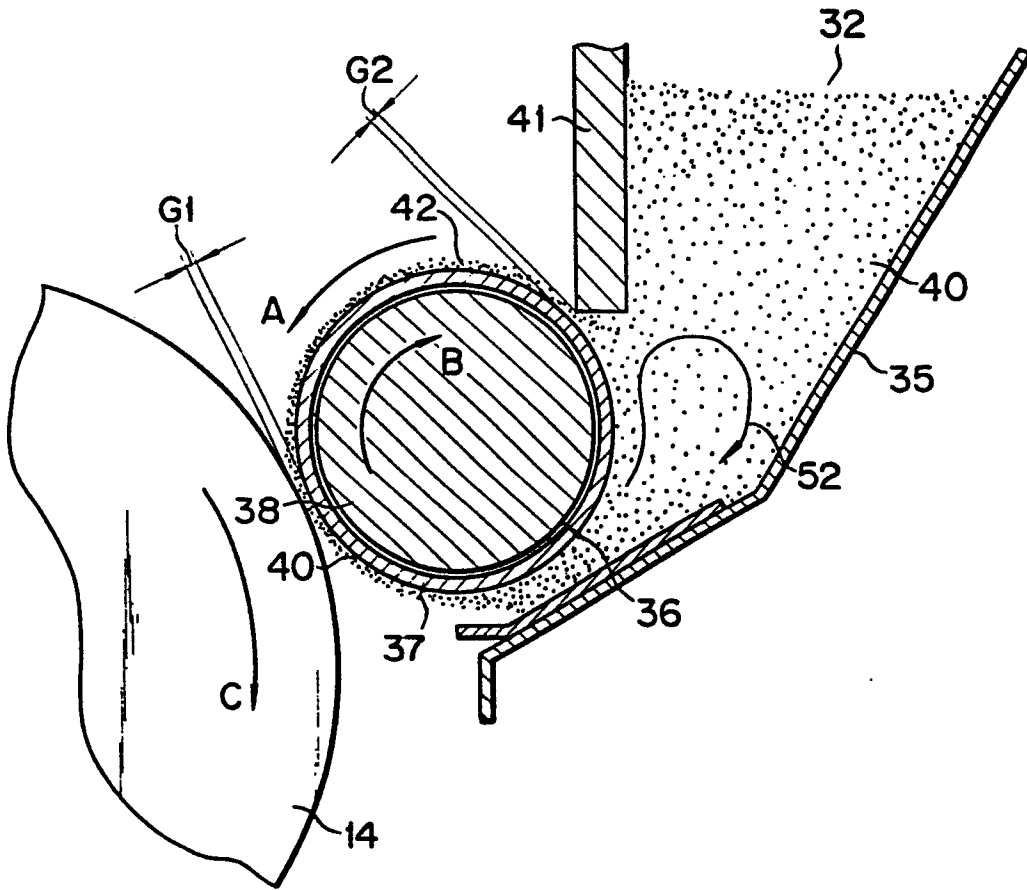


FIG. 5

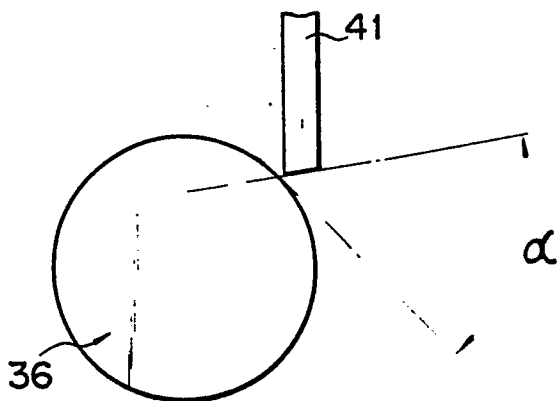


FIG. 6

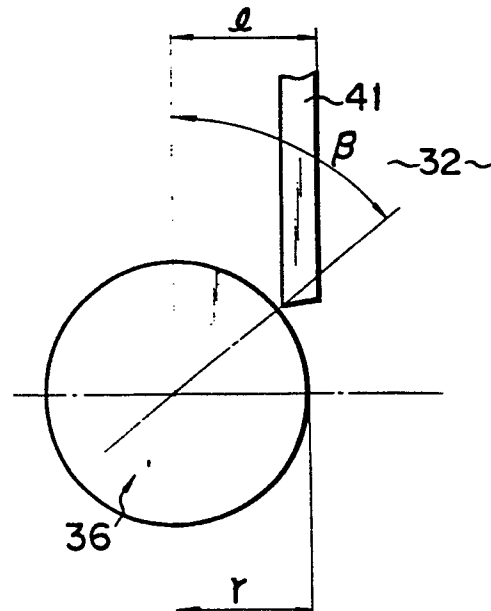


FIG. 7A

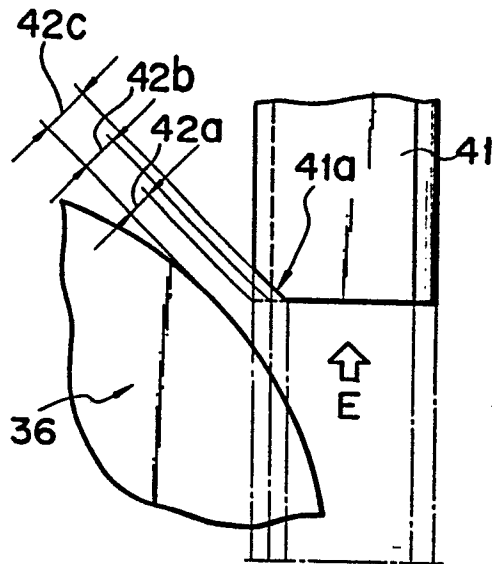
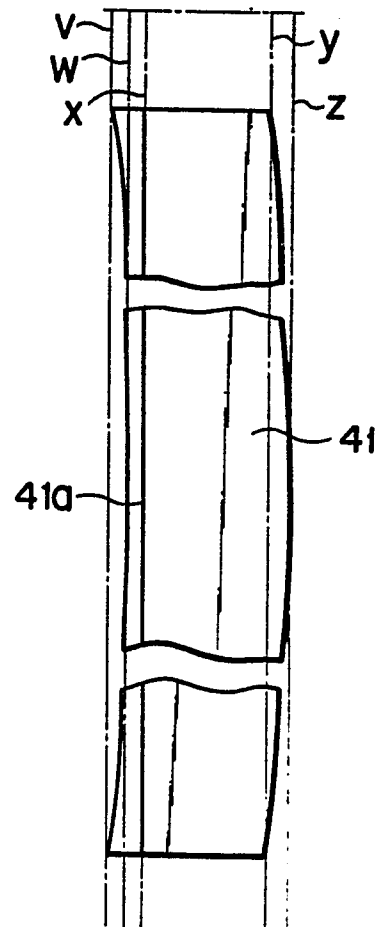
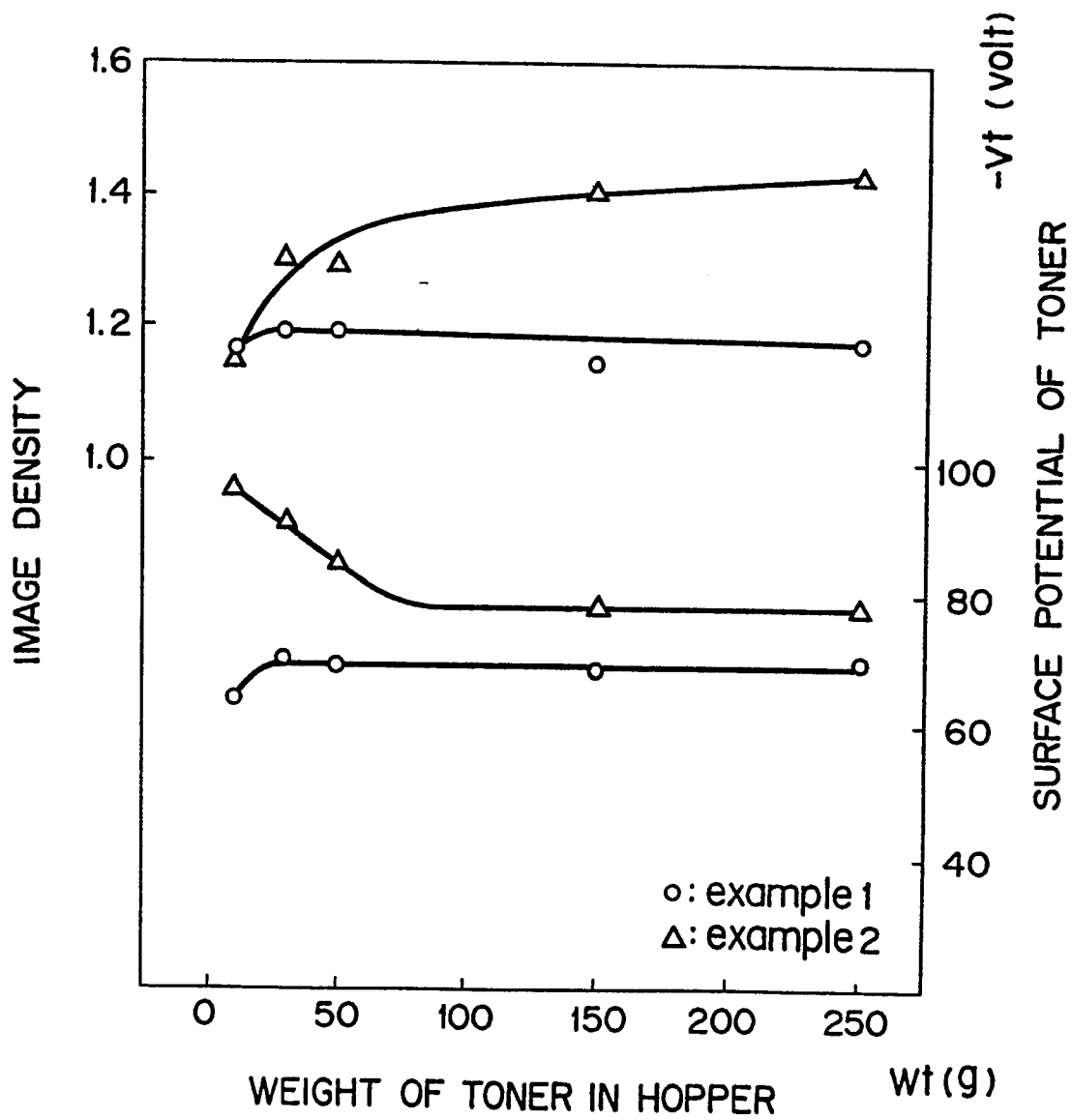


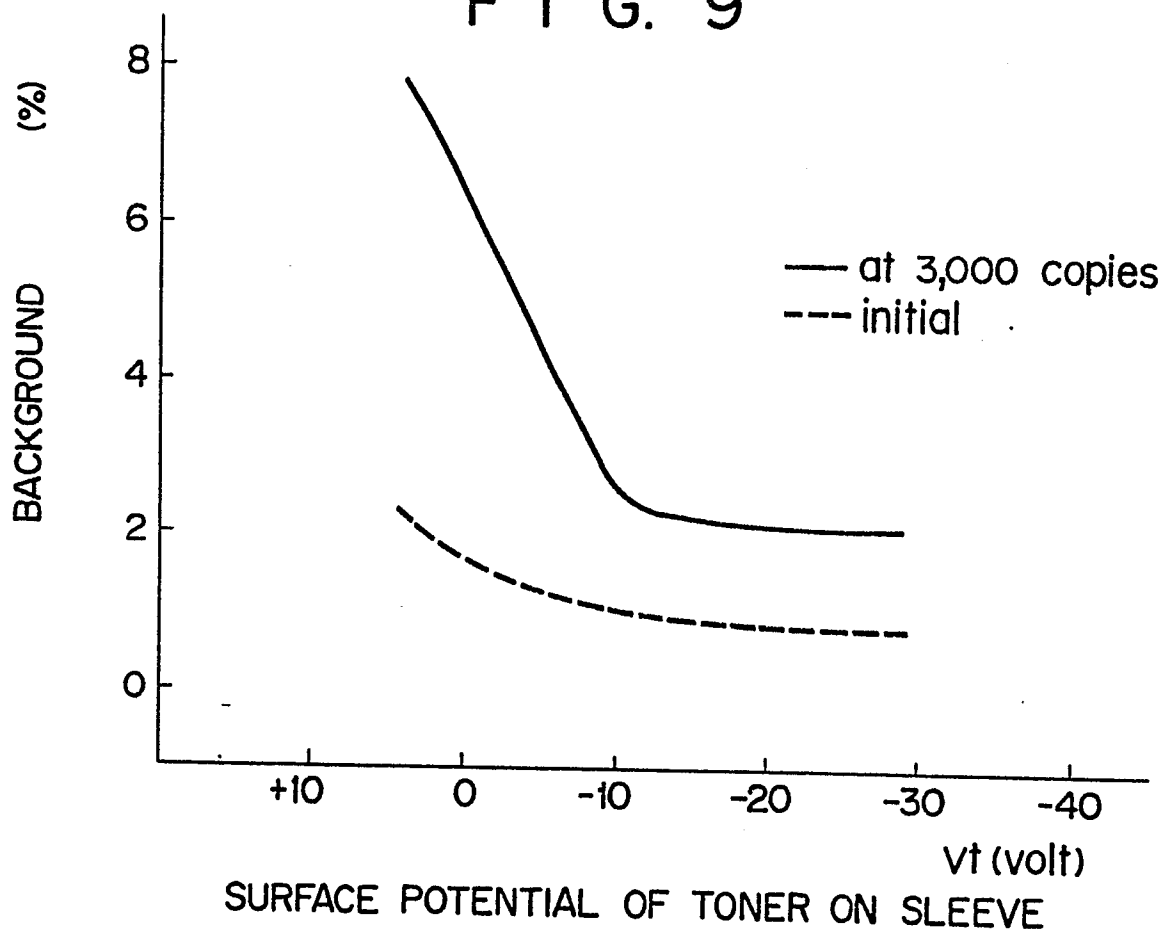
FIG. 7B



F I G. 8



F I G. 9



F I G. 10

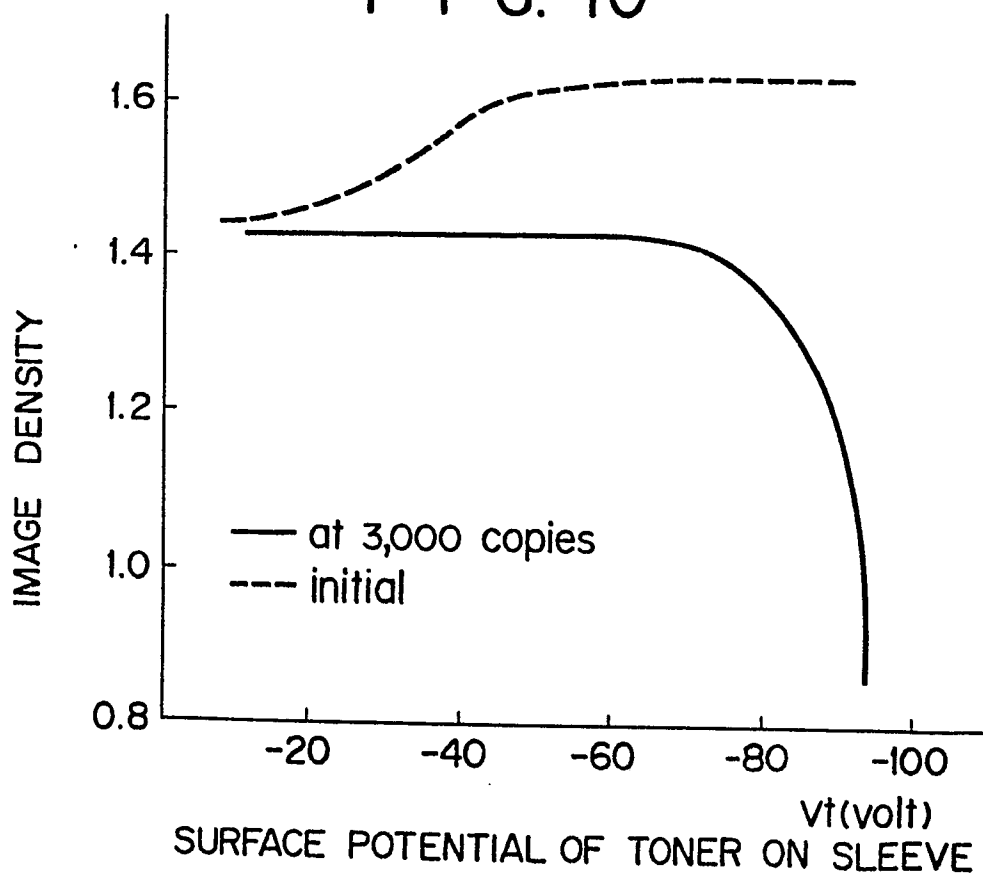


FIG. 11

