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EP 0 398 262 A2 ⁽⁵⁴⁾ **Electrophotographic apparatus.**

⁽⁵⁷⁾ An electrophotographic apparatus of the type in which a photosensitive member is charged by atmospheric discharge, is equipped with an air filter including a substrate comprising at least one metal selected from the group consisting of aluminum, iron, aluminum alloy and iron alloy, and a coating layer formed on the substrate comprising an ozone remover. The substrate is effective in removing NO_x and HNO₃ and has a long life while not hindering the ozone-removing action of the ozone remover disposed thereon, whereby the apparatus can show excellent electrophotographic performances even after successive use while preventing deterioration due to ozone, NO_x and HNO₃ produced by the atmospheric discharge.

ELECTROPHOTOGRAPHIC APPARATUS

FIELD OF THE INVENTION AND RELATED ART

The present invention relates to an electrophotographic apparatus, particularly relates to an electrophotographic apparatus chiefly comprising a charging means, an exposure means and a developing means and also equipped with an air filter when atmospheric discharge generating a so-called corona product, such as O_3 , NO_x or HNO_3 , is used as the charging means in the electrophotographic apparatus.

At present, as the electrophotographic apparatus, a copying machine, laser beam printer (LBP), microreader printer, etc., are manufactured. Such as electrophotographic apparatus includes means for charging, exposure, developing, transfer, cleaning, whole exposure, etc., respectively disposed around an electrophotosensitive member.

As the electrophotosensitive member, a photosensitive member comprising an organic photoconductor (OPC) which is inexpensive, pollution-free and high sensitive or a photosensitive member comprising amorphous silicon (a-Si) which is pollution-free, high-durable and high-stable are being adopted as the mainstream.

In such an electrophotographic apparatus, as a charging method, non-contact methods using a corona discharge, etc. and contact methods using a conductive brush, conductive roller, etc. are used. However, because all these methods are those utilizing the atmospheric discharge method, the corona products of ozone, etc. are generated. Particularly, when the corona charging method using the corona discharge is used, a large amount of ozone is generated to adhere to the electrophotosensitive member, whereby deterioration of the electrophotosensitive member and degradation of electrophotographic characteristics are induced. Accordingly, methods for lessening the influence of ozone on the electrophotosensitive member by emitting the ozone out of the apparatus as quickly as possible with an exhaust fan and an air filter using activated carbon or by disposing an ozone-decomposing catalyst intermediately on an exhaust passage for removing ozone, have been taken.

However, in recent years, progress of the electrophotography is remarkable to provide high-quality images, pictorial full-colored images and computer-graphic images, so that requirements for uniformity of images are markedly severe. Further, by the provision of a high-speed and high-durability electrophotographic apparatus, it has become possible to take a lot of copies at a time. In such conditions, image defects in the form of a belt arise in a direction perpendicular to the rotating direction of the electrophotosensitive member, i.e., in the generatrix direction of the electrophotosensitive member. The image defects are observed as image unevenness represented by a difference in reflection density of 0.05 or more. On investigation of the cause of the image defects, we have found that a part of the electrophotosensitive member (i.e., the hatched portion of the electrophotosensitive member in Figure 1) stopping at a position immediately below a primary charger and in the exhaust passage has received some damage when the electrophotographic apparatus is not operated. In such a case, the electrophotographic apparatus using the OPC photosensitive member causes, e.g., a partial decrease in chargeability (i.e., white dropout of an image in normal development and a black streak of an image in reversal development) and the electrophotographic apparatus using the a-Si photosensitive member causes an image blur (i.e., a decrease in resolution).

On our study, we have found that the above-mentioned drawbacks are principally caused by NO_x , particularly HNO_3 resulting from the atmospheric discharge, such as the corona discharge. This is based on a confirmation by means of infrared analysis that the part around the photosensitive member under the primary charger deteriorated because of the action of HNO_3 . In general, ozone density under the primary charger is one to several tens ppm and NO_x density (converted into NO_2 density) under the primary charger is 0.01 - 0.1 ppm. On the other hand, though NO_x and HNO_3 are not removed by means of a conventional ozone-removing filter, it has been considered that there would be no problem if they are emitted out of an apparatus together with ozone by means of an exhaust fan because of their low densities, so that no particular consideration has been paid on disposition thereof.

However, though ozone entirely becomes extinct if once it is removed, NO_x is supposed to be transformed into a stable substance, such as NO_2 or HNO_3 to remain for a long time because a large amount of NO_2 or HNO_3 is physically adsorbed to a member having a large surface area such as the ozone-removing filter. Further, it is reasonably considered that once adsorbed NO_2 or HNO_3 is desorbed and flown backward in the apparatus when the apparatus is stopped. It is possible that NO_x or HNO_3 emitted out of the apparatus fills a room to recirculate in the apparatus. Further, it is possible that a part of the air containing NO_x or HNO_3 once passed through the filter is again taken in the apparatus.

The substrates of the conventional ozone-removing-filters have been generally made of paper, cloth and ceramics such as alumina, silica or chromium oxide, and have been properly used in view of use, cost, etc. Further, as ozone removers disposed on the substrates, activated carbon and an oxide such as titanium oxide, silica or magnesium dioxide have been generally used. However, though a conventional filter
 5 comprising the above substrate and the above ozone remover formed thereon shows ozone-removing effect, it shows no effect of removing NO_x and HNO₃.

SUMMARY OF THE INVENTION

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An object of the invention is to provide an electrophotographic apparatus capable of preventing a part of a photosensitive member beneath a primary charger and is an exhaust passage from causing a local decrease in chargeability or image blurring to obtain a high-quality image.

According to the present invention, there is provided an electrophotographic apparatus of the type in
 15 which a photosensitive member is charged by atmospheric discharge, which apparatus is equipped with an air filter including: a substrate comprising at least one metal selected from the group consisting of aluminum, iron, aluminum alloy and iron alloy; and a coating layer comprising an ozone remover formed on the substrate.

These and other objects, features and advantages of the present invention will become more apparent
 20 upon a consideration of the following description of the preferred embodiments of the present invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

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Figure 1 is a schematic structural view of an electrophotographic apparatus according to the present invention;

Figure 2 is a schematic view of an air filter having a roll structure of corrugated board;

Figure 3 is a schematic view of an air filter formed by molding;

30 Figure 4 is a schematic view of an air filter having a honeycomb structure formed from a metal foil; and

Figure 5 is a block diagram of a facsimile machine using an electrophotographic apparatus of the invention as a printer.

DETAILED DESCRIPTION OF THE INVENTION

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We have studied effective materials for removing NO_x and HNO₃. As a result, we have found that aluminum, iron, aluminum alloy or iron alloy is very effective in removing NO_x and HNO₃ and has a long life. Then, we have directed our attention to the property of NO_x and HNO₃ which have film permeability
 40 with respect to a polymer film, etc., and have prepared an air filter comprising: a substrate made of aluminum or iron powder coated on the conventional substrate or preferably made of aluminum or iron formed; and a coating layer thereon including a conventional ozone remover. In a specific instance, when an electrophotographic apparatus of the invention equipped with such an air filter was used for an experiment, the air filter did not cause a lowering in ozone-removing rate at all but showed a high removing ability for
 45 NO_x and HNO₃ (As described later, the removing ability for HNO₃ has been evaluated by a durability test using an actual electrophotographic apparatus because there is no means for directly measuring HNO₃ density).

The air filter according to the present invention provides decreased densities of NO_x and HNO₃ in exhaust gas and prevents NO_x and HNO₃ from desorbing flowing backward or recirculating in the
 50 electrophotographic apparatus by chemical adsorbing NO_x and HNO₃ once adsorbed on the surface of the air filter. Further, the air filter also has an ozone-removing ability more than that of a conventional air filter.

The substrate used in the air filter comprising aluminum, iron, aluminum alloy or iron alloy. More specifically, the substrate may comprise a layer of at least one metal of aluminum, iron, aluminum alloy and iron alloy coating a surface of a supporting member made of a material other than aluminum, iron,
 55 aluminum alloy and iron alloy, such as paper, cloth or ceramics; or a structure of a metal plate or metal foil per se comprising at least one metal selected from the group consisting of aluminum, iron, aluminum alloy and iron alloy.

The above aluminum alloy and iron alloy may contain a metal such as Fe, Ni, Cr, Cu, Sn, Zn or Mg, as

other alloy components. A content of aluminum and/or iron in the above alloys may be 10 wt. % or above, preferably be 20 wt. % or above.

The coating layer having an ozone-removing capacity is prepared, for example, in the following manner. An ozone remover comprising activated carbon or an ozone-decomposing catalyst such as titanium oxide, silica, cupric oxide or magnesium dioxide, as a main component; a binder such as clay or glass, as desired; and a dispersant, such as water for convenience of coating, are mixed and dispersed to prepare a coating liquid. The whole surface of the above-mentioned substrate is coated with the coating liquid by dipping and dried to provide the coating layer. The thickness of the coating layer may be 0.1 - 500 microns, preferably be 1 - 300 microns. Further, an intermediate layer such as an adhesive layer can be formed between the substrate and the coating layer.

The air filter used in the invention may preferably be in such a form that provides a large efficiency for removing O_3 , NO_x and HNO_3 and a decreased pressure loss, particularly be in a network structure. Such a network structure may include, e.g., a roll structure of corrugate board as shown in Figure 2; one having many perforations formed by molding as shown in Figure 3; and a honeycomb structure as shown in Figure 4. Among them, the honeycomb structure as shown in Figure 4 formed by using a metal foil comprising at least one metal of, e.g., aluminum, iron, aluminum alloy and iron alloy, as the substrate, may particularly be preferred. The wall thickness of the substrate of the air filter used in the invention as described above may be 10 - 1000 microns, preferably be 20 - 600 microns. Particularly, the wall thickness of the substrate using the metal foil may arbitrarily be selected in the range of about 20 - 400 microns and may be thinner than that of the conventional substrate using paper or ceramics, whereby the removing efficiency of O_3 , NO_x and HNO_3 is remarkably improved. Particularly, in a large-sized air filter, one comprising ceramics etc., with a small strength inevitably requires a large wall thickness to result in a decreased aperture rate and an increase in pressure loss. On the other hand, the metal foil is much better in this respect. Further, the substrate formed of a metal foil has advantages of low production costs etc. compared with one formed by molding. A substrate having a honeycomb structure can be formed by using the above-mentioned metal foil. The surface of the metal foil can be roughened in order to enhance the adhesive strength and enlarge the surface area, so that the removing rate of NO_x and HNO_3 is improved.

Figure 1 is a schematic structural view of an electrophotographic apparatus of the invention using the air filter. Referring to Figure 1, the electrophotographic apparatus includes a housing 1, on which an original cover 2b and an original stand 2a comprising a glass plate are disposed. An original 3 placed on the original stand 2a is irradiated with light from a lamp 4. Then, the reflected light passes through mirrors 5a, a lens 6 and a mirror 5b to reach a photosensitive drum 7 used as an image-carrying member, which comprises an amorphous silicon photosensitive layer formed on a cylindrical substrate by film formation. The above lamp 4, mirrors 5a and lens 6 are capable of moving in the direction of the upper left arrow shown in Figure 1 by a drive means (not shown) in the housing 1. The above photosensitive drum 7 is rotated in the direction of the arrow shown inside of the photosensitive drum in Figure 1 and uniformly charged by means of a primary charger 8 utilizing corona discharge. On the photosensitive drum, image exposure with the reflected light from the original 3 is effected to form an electrostatic latent image. The electrostatic latent image is developed by a developing unit 9 to form a toner image. The toner image is carried together with a recording material such as a plastic film (not shown) supplied from a register roller 10, to reach a position opposite to a transfer charger 11 utilizing corona discharge, and then the toner image is transferred to the recording material. Then, the resultant recording material with the toner image is separated from the photosensitive drum 7 by using a separation charger 12 utilizing corona discharge to be conveyed to a fixing device (not shown). Residual toner particles on the photosensitive drum 7 are removed by means of a cleaner 14, and residual charge on the photosensitive drum 7 is erased by emitting erasing light 15 to prepare for the next cycle. During the above-mentioned image forming process, air is exhausted to the outside of the apparatus by means of an exhaust fan 16. In this instance, an air filter 17a is disposed for treating the air. On the other hand, air is sent into the apparatus through an air filter 17b by means of a blowing fan 18.

In a case where the electrophotographic apparatus according to the present invention is used as a printer of a facsimile machine, light-image exposure is used as exposure for printing received data. Figure 5 shows a block diagram of an embodiment for explaining this case. Referring to Figure 5, a controller 21 controls a image-reading part 20 and a printer 29. The whole controller 21 is controlled by means of a CPU (central processing unit) 27. Read data from the image-reading part is transmitted to a partner station through a transmitting circuit 23, and on the other hand, the received data from the partner station is sent to the printer 29 through a receiving circuit 22. An image memory memorizes prescribed image data. A printer controller 28 controls the printer 29 and a reference numeral 24 denotes a telephone.

The image received through a circuit 25 (the image data sent through the circuit from a connected

remote terminal) is demodulated by means of the receiving circuit and successively stored in an image memory 26 after a restoring-signal processing of the image data. When image for at least one page is stored in the image memory 26, image recording of the page is effected. The CPU 27 reads out the image data for one page from the image memory 26 and sends the image data for one page subjected to the restoring-signal processing to the printer controller 28. The printer controller 28 receives the image data for one page from the CPU 27 and controls the printer 29 in order to effect image-data recording. Further, the CPU 27 is caused to receive image for a subsequent page during the recording by the printer 29. As described above, the receiving and recording of the image are performed.

Hereinbelow, the present invention will be explained more specifically with reference to examples.

Examples 1 and 2

A substrate having a honeycomb structure as shown in Figure 4 was prepared by using a 50 micron-thick iron foil. The substrate had material properties including: a cell density of 140 cells/inch², an aperture rate of 75 %, a surface area of 20 cm²/cm³, sizes of 100 mm x 100 mm and a thickness of 5 mm. Then, activated carbon having a particle size of 100 microns and a binder consisting of clay and glass (activated carbon/binder = 10/1 by weight) were kneaded together with an appropriate amount of water to prepare a coating liquid. The whole surface of the above-prepared substrate was coated with the coating liquid by dipping and was dried to prepare a coating layer at a rate of 200 g/m² for removing ozone. The air filter thus prepared is referred to as a filter 1.

Separately, an iron substrate having a structure including many perforations as shown in Figure 3 was prepared by molding. The iron substrate had material properties including: a wall thickness of 0.3 mm, an aperture rate of 64 %, a cell density of 210 cells/inch², a pitch of 1.7 mm, a surface area of 18 cm²/cm³, sizes of 100 mm x 100 mm and a thickness of 5 mm. The catalyst layer was formed in the same manner as in the case of the filter 1. The air filter thus prepared is referred to as a filter 2.

Further, an air filter was prepared in the same manner as in the case of the filter 2 except that the iron substrate was replaced with an alumina substrate to provide a filter 3.

An exhaust port (the reference numeral 17a in Figure 1) of a color laser copying machine (CLC-1, manufactured by Canon K.K.) was equipped with each of the above-prepared air filters. Then, the measurement of the densities of O₃ and NO_x (converted into NO₂ density) in the exhaust air and examination of image characteristics after a durability test were performed. The above test is referred to as Example 1.

Separately, a ventilation port (the reference numeral 17b in Figure 1) of the blowing fan for blowing the primary charger of the above color laser copying machine was equipped with the above-prepared air filters, respectively. Then, the measurement and the examination were performed in the same manner as in Example 1 to provide Example 2.

In Examples 1 and 2, the exhaust density was measured after one hour from the start of a continuous copying test by means of a measuring apparatus (1003-AH, manufactured by Dylec Corp.) for O₃ density and a measuring apparatus (ECL-77A, manufactured by Yanagimoto Seisakusho K.K.) for NO_x density. The exhaust air was passed through the filter at a velocity of 0.8 m/sec. Further, the durability test was performed by using the above-mentioned copying machine as follows. The copying machine was first used for making 10,000 sheets by using a mode giving one A4-sized full-color copy every 30 seconds, thereafter leftstanding in the room for three days, and then used again for forming images, the states of which were observed for examination.

The results of Examples 1 and 2 are shown in Table 1 below.

Table 1

Ex.No.	Filter	O ₃ density (ppm)	NOx density (ppm)	Image defects after durability test* (After standing for 3 days)
1	1	0.15	0.017	None/Utterly None
	2	0.19	0.020	"
	3	0.19	0.030	Remarkably observed/Problem
2	1	0.11	0.010	None/Utterly None
	2	0.14	0.015	"
	3	0.14	0.030	Remarkably observed/Problem

*: Change in image density at a portion under a primary charger/Problem for practical use.

As is apparent from Example 1 in Table 1, in the electrophotographic apparatus of the invention using the air filters 1 and 2, NOx density was remarkably decreased compared with one using the conventional filter 3 (particularly, filter 1/filter 3 ratio of about 1/2) and there was no problem for practical use. On the other hand, the filter 3 was not acceptable for practical use. Further, O₃ density by the filter 1 particularly showed a lower value by about 20 % than by the filter 3. This is presumably because the filter 1 of the invention had a honeycomb structure of a metal foil which provided advantages of a small pressure loss and a large surface area.

The results in Example 2 are the same as in Example 1 and show that the removing rate of O₃ or NOx was further improved by equipping the ventilation port to the primary charger with a filter of the invention. It is supposed that O₃ and NOx were not completely removed out of the above copying machine by the exhaust fan, remained partially in the machine to be recirculated by the blowing fan etc., and another part was once removed out of the machine and taken in the machine again.

Further, it is supposed that the phenomenon of the image density under the primary charger becoming high was directly caused by the action of HNO₃. It is supposed that HNO₃ caused the above phenomenon because HNO₃, different from O₃ and NOx, adhered to various inside positions of the machine after the termination of copying and was desorbed little by little to move and act on a certain position of the photosensitive member for a long time. On the other hand, the air filter used in the invention has reactivity with HNO₃ (and further has good adsorption efficiency because of large surface area), whereby once adsorbed HNO₃ is hardly separated from the air filter. Though HNO₃ could not be quantitatively measured, it was possible to observe a marked removing effect for HNO₃ when the durability test was done by using an actual copying machine.

Example 3

An air filter 4 was prepared in the same manner as in the case of the filter 1 except that a 25 micron-thick aluminum foil substrate was used. The thus prepared filter 4 was examined in the same manner as in Example 2 to show the following results.

O₃ density: 0.12 ppm

NOx density: 0.012 ppm

Image after durability test: No image change was observed at a portion beneath the primary charger, and utterly no problem was recognized for practical use.

Example 4

An air filter 5 was prepared in the same manner as in the case of the filter 4 except that the activated carbon was replaced by a CuO/MnO₂ mixture catalyst. The thus prepared filter 5 was examined in the same manner as in Example 2 to show the following results.

O₃ density: 0.10 ppm

NOx density: 0.010 ppm

Image after endurance test: None/Utterly None

From the above results, it is found that the air filter used in the invention also has an excellent effect in combination with a catalyst-type ozone remover.

As described above, the electrophotographic apparatus according to the present invention has an excellent effect of removing NO_x, particularly HNO₃ without decreasing O₃ removing efficiency, prevents deterioration of copy image quality caused by HNO₃, and can provide images having no defects even after successive use.

An electrophotographic apparatus of the type in which a photosensitive member is charged by atmospheric discharge, is equipped with an air filter including a substrate comprising at least one metal selected from the group consisting of aluminum, iron, aluminum alloy and iron alloy, and a coating layer formed on the substrate comprising an ozone remover. The substrate is effective in removing NO_x and HNO₃ and has a long life while not hindering the ozone-removing action of the ozone remover disposed thereon, whereby the apparatus can show excellent electrophotographic performances even after successive use while preventing deterioration due to ozone, NO_x and HNO₃ produced by the atmospheric discharge.

Claims

1. In an electrophotographic apparatus of the type in which a photosensitive member is charged by atmospheric discharge; the improvement wherein the apparatus is equipped with an air filter including a substrate comprising at least one metal selected from the group consisting of aluminum, iron, aluminum alloy and iron alloy, and a coating layer comprising an ozone remover formed on the substrate.

2. An electrophotographic apparatus according to Claim 1, wherein the substrate comprises a metal plate or metal foil comprising at least one metal selected from the group consisting of aluminum, iron, aluminum alloy and iron alloy.

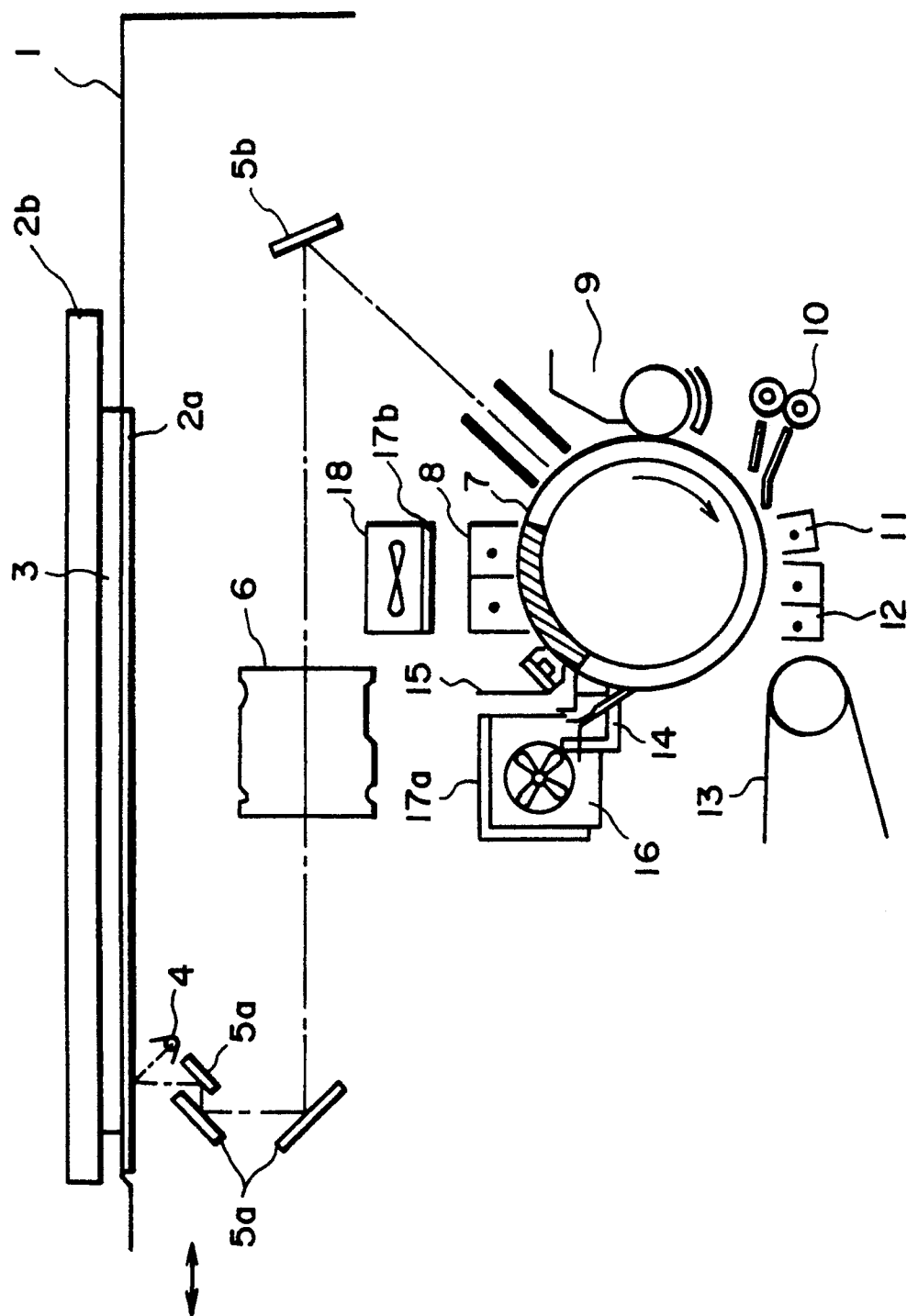
3. An electrophotographic apparatus according to Claim 1, wherein the substrate comprises a supporting member coated with at least one metal selected from the group consisting of aluminum, iron, aluminum alloy and iron alloy.

4. An electrophotographic apparatus according to Claim 1, wherein the air filter has a network structure.

5. An electrophotographic apparatus according to Claim 4, wherein the air filter has a honeycomb structure.

6. An electrophotographic apparatus according to Claim 5, wherein the substrate has a honeycomb structure formed from a metal foil.

7. A facsimile machine comprising: an electrophotographic apparatus equipped with a charging means utilizing atmospheric discharge and an air filter which includes a substrate comprising at least one metal selected from the group consisting of aluminum, iron, aluminum alloy and iron alloy and includes a coating layer comprising an ozone remover formed on the substrate; and a receiving means for receiving image data from a remote terminal.



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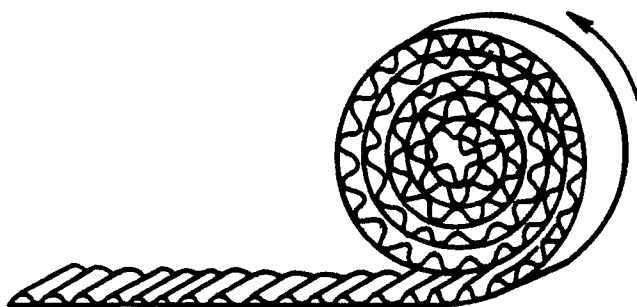


FIG. 2

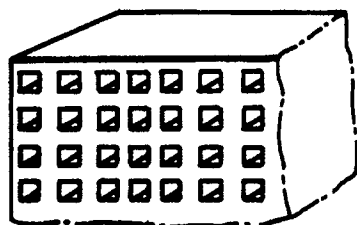


FIG. 3

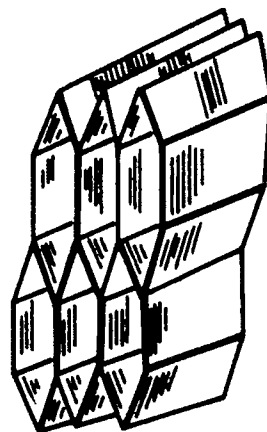


FIG. 4

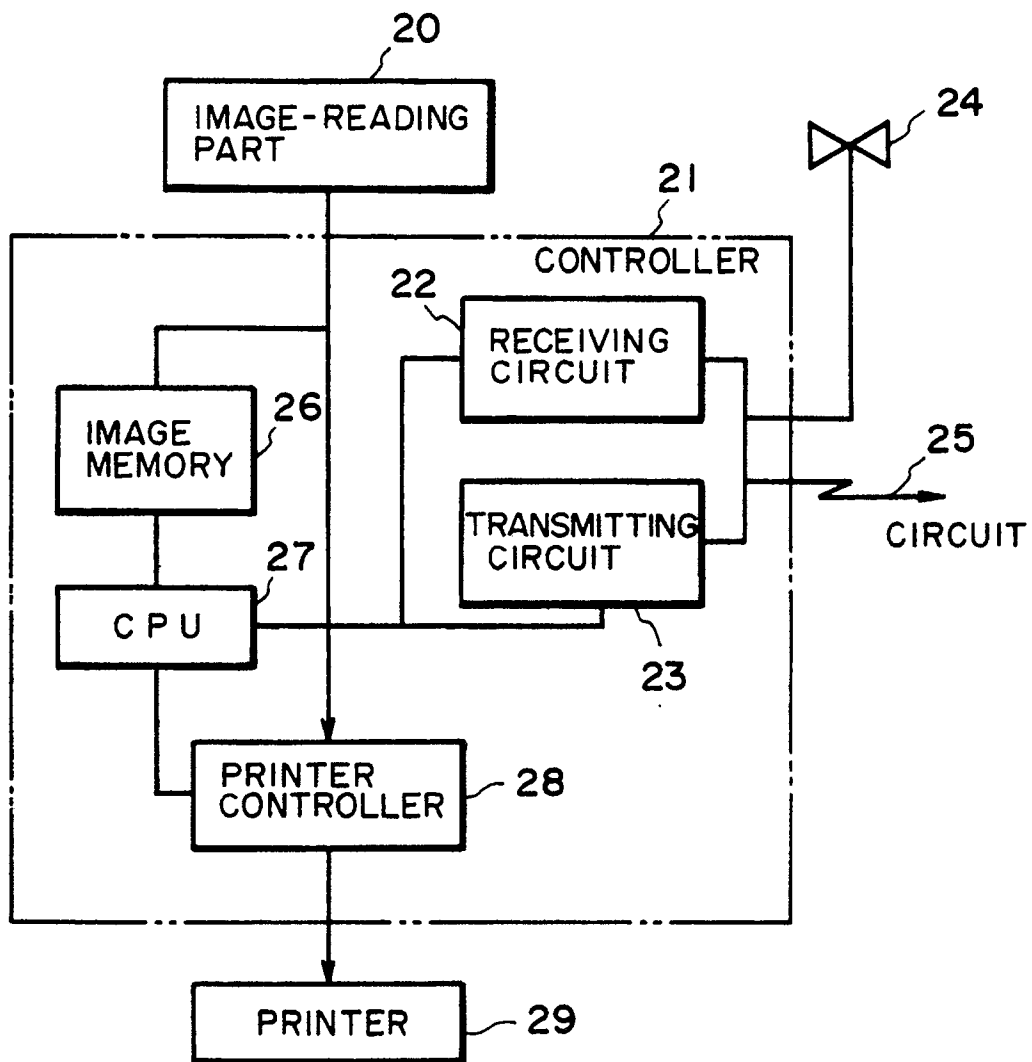


FIG. 5