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Banks et al.

[11] **3,862,420**

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[54] **SYSTEM TO PREVENT THE FORMATION OF PARTICULATE MATERIAL IN CORONA UNITS**

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[52] **U.S. Cl.** ..... **250/324**, 317/262 A

[51] **Int. Cl.** **G03g 15/00**

[58] **Field of Search** ..... 250/324, 325, 326; 317/262 A; 55/274, 275

[56] **References Cited**

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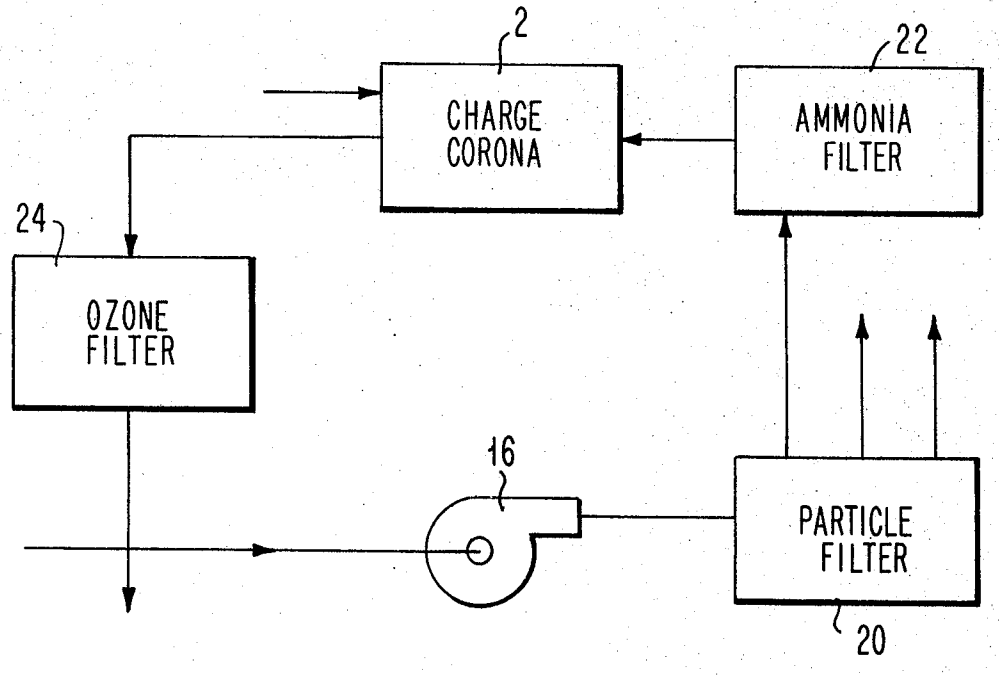
[57] **ABSTRACT**

Apparatus is disclosed for supplying air to a corona discharge device to eliminate contamination within the corona unit and associated apparatus. Before introduction of the air into the corona device, the air is first passed through a particle filter to eliminate dust particles and then through an ammonia filter to prevent the formation of particulate material within the corona device. The ammonia filter contains a chemically active material to react with the ammonia in the air and apparatus is provided to sense end-of-life of the ammonia filter.

15 Claims, 5 Drawing Figures



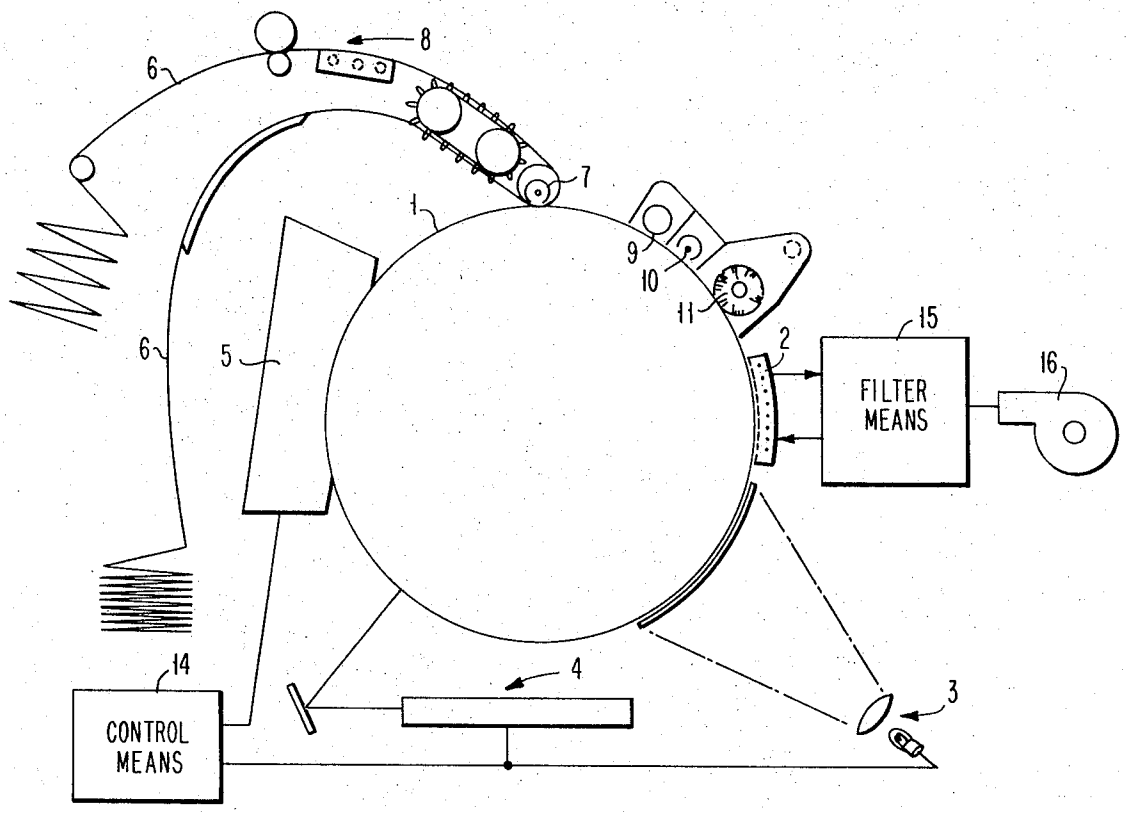

8
6
7
1
9
10
11
15
16
6
5
2
FILTER MEANS
14
CONTROL MEANS
4
3

FIG. 1

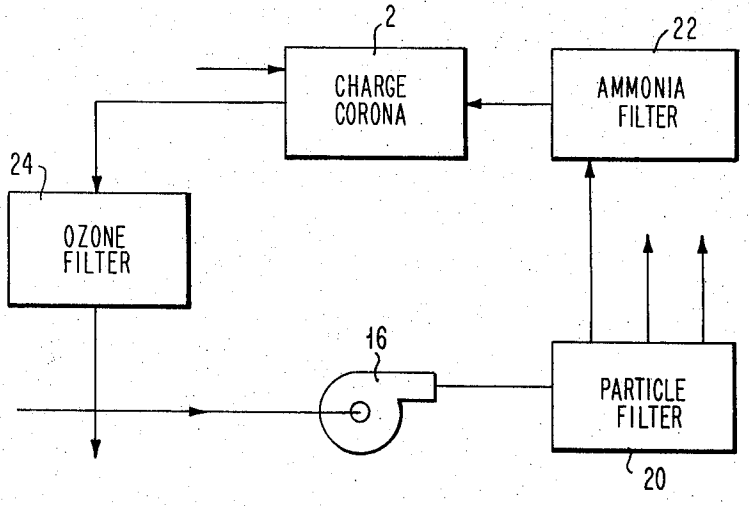

2
CHARGE CORONA
22
AMMONIA FILTER
24
OZONE FILTER
16
PARTICLE FILTER
20

FIG. 2

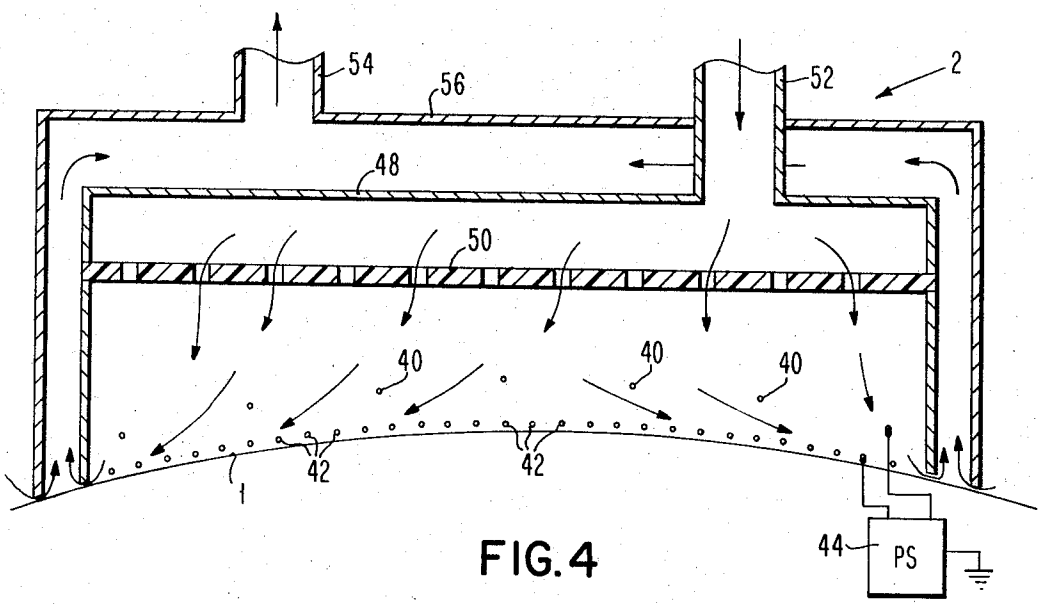


FIG. 4

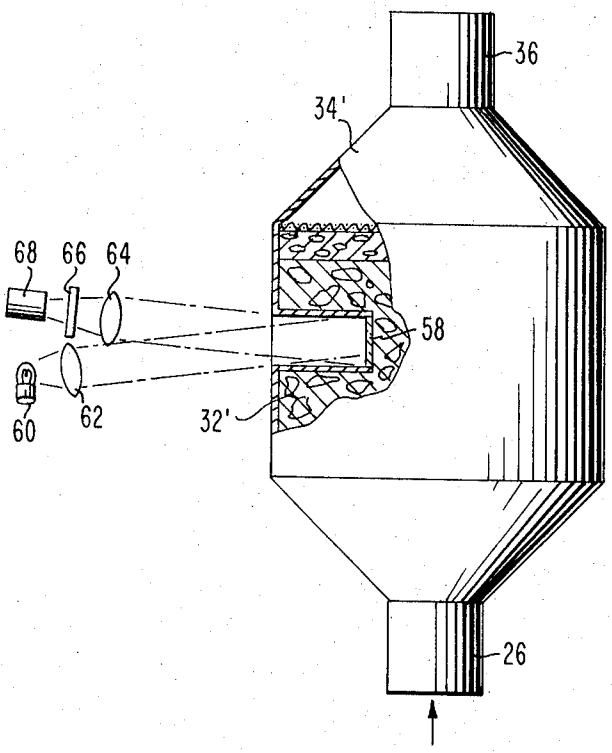


FIG. 5

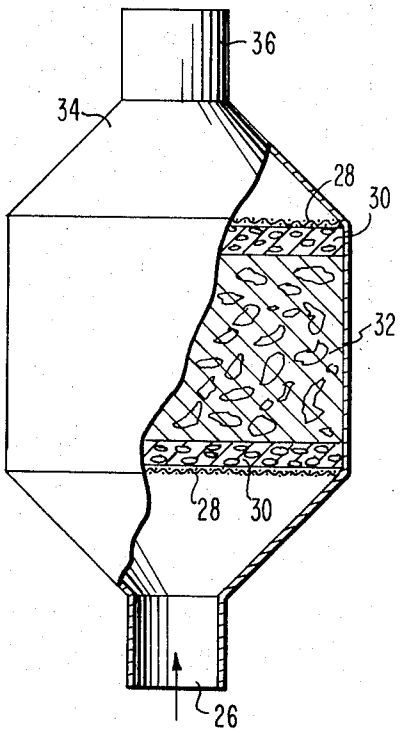


FIG. 3

SYSTEM TO PREVENT THE FORMATION OF PARTICULATE MATERIAL IN CORONA UNITS

BACKGROUND OF THE INVENTION

This invention relates to corona discharge devices and more particularly to a method and apparatus for eliminating certain particulate deposition within corona discharge devices.

Corona discharge devices have been widely used in prior art systems as ion generators for electrostatic charging. These prior art corona discharge devices have had, after a period of usage, a particulate material collect on the insulating surfaces of the corona unit as well as the non-corona electrodes such as screens or a conductive backing electrode. The growth of the particulate material on the screens or backing electrodes increases the arc probability and also changes the charge efficiency of the corona device. At high humidities the wet particulate material further increases the chance of electrical shorts and corrosion of corona components. The particulate material may also contaminate nearby components such as the photoconductor in an electrophotographic imaging system for example. The problem of particulate material deposition within corona discharge devices has been solved in prior art systems by periodic cleaning of the corona devices which may be accompanied by periodic restringing of the corona wires. The mechanism which causes particulate deposition within the corona discharge device is not completely understood, and the deposition varies depending upon whether a positive or negative corona discharge is produced. However, one reason for the prior art practice was because of the belief that all components of the particulate material are totally generated in the normal operation of the corona devices, since it was believed that the corona units generate from the normal gases in air, ozone, oxides of nitrogen, and ammonia which combine to produce the particulate material. In systems utilizing corona devices in which the components of the system are required to have maintenance free operation for a long period of time, the prior art solution is no longer suitable. In investigating alternatives to the prior art practices, it was discovered that the internally generated particulate material comprises but a small percentage of the total particulate material. It was discovered that oxides of nitrogen were generated in relatively large amounts by both positive and negative corona discharges and that these oxides react readily with ammonia to form ammonium nitrate particulate which appears to be the particulate formed with the greatest concentration. However, the quantity of the ammonium nitrate particulate formed could not be attributed to the internal generation of ammonia within the corona since the concentration was much too low for the ammonium nitrate particulates. It was discovered that the formation of particulate materials is greatly affected by the level of ammonia in the ambient air which may be introduced to the corona discharge device.

SUMMARY OF THE INVENTION

It is therefore the principle object of this invention to produce a corona discharge device which is free of the deposition of particulate material and thus capable of producing maintenance free operation for a long period of time.

Briefly, according to the invention, apparatus is provided for supplying a flow of air to a corona discharge device over a path which includes filtering means comprising a chemically active material to react with certain components in the flow of air to prevent the formation of particulate material in the corona device and associated apparatus.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view of an electrophotographic apparatus embodying the present invention;

FIG. **2** is a block diagram of the air filtering system embodying the present invention;

FIG. **3** is a view partially in section of the ammonia filter;

FIG. **4** is a cross-sectional view of the charge corona showing the air path through the corona unit;

FIG. **5** is a partial cross-section view of the ammonia filter showing the addition of a use level sensing device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

This invention is applicable in general to corona discharge devices utilized as ion generators for electrostatic charging. However, the embodiment of the invention described relates to an electrophotographic apparatus since the particulate material deposition problem may be particularly severe in this environment. In this electrophotographic apparatus shown in FIG. **1**, a rotatable drum **1** carries around its periphery of an electrophotographic photoconductive member upon which is directed an image which it is desired to be produced on continuous form web **6**. The surface of the photoconductor is uniformly charged to a predetermined polarity by corona discharge device **2**. The charged surface is exposed to a light image at the forms flash station **3** and/or exposure station **4** to produce a latent electrostatic image. The latent electrostatic image is developed by a suitable development unit **5** at which a toner carrier mixture is cascaded across the electrostatic image on the surface of the photoconductor as is known in the art. The toner has a charge such that it is attracted to the drum surface to render the image visible. The toned image is transferred to continuous form sheet **6** with the aid of transfer corona unit **7**. The transfer corona unit sprays ions on the backside of sheet **6** of a polarity opposite that of the toner, thereby attracting the toner image from drum **1** to sheet **6**. After the corona transfer the paper **6** is separated from the drum and fed past a fusing station **8** which serves to fuse and permanently fix the toner to the paper. Since transfer of all the image toner is not usually accomplished, residual toner usually remains on the drum surface after a transfer operation. At the cleaning station the photoconductor is exposed successively to an erase lamp **9**, a pre-clean corona **10** and a rotating cleaning brush **11**. The erase lamp discharges the photoconductor and the pre-clean corona produces a charge so that the residual image toner is attracted electrostatically to the cleaning brush which sweeps the toner from the photoconductor surface. This operation completes the cycling of the drum for producing the desired image.

Control means **14** is provided to supply electrical control signals to coordinate the operation of all components of the system. In this manner the position of the image on the drum can be coordinated so that the

proper action takes place at the stations around the drum at the proper time. In addition, control means **14** may also provide temporary storage for image data supplied to exposure station **4** if desired.

According to the present invention, the charge corona **2** has associated therewith a filtering means **15** and an air flow means **16** which produces a flow of air through the charge corona unit to reduce or eliminate three types of contamination within the corona unit, namely, corrosion, deposition of particulate materials and dust. In the embodiment shown, filtering means **15** comprises a particle filter which receives the air from air flow means **16.** In the embodiment shown, air flow means **16** comprises a suitable blower. Particle filter **20** is a device suitable for removing particles above about **1** micron in size from the flow of air and this filter is operable to greatly reduce the dust contamination in the charge corona. Air from particle filter **20** is passed to ammonia filter means **22** where any ammonia present in the air reacts chemically to produce virtually ammonia-free and dust-free air for introduction into the charge corona. The air is channeled through the charge corona so that the air flow tends to keep the corona wires clean. In addition, the flow path within the charge corona is set up so that any remaining toner particles near the photoconductor surface are kept away from the wires by the air flow and swept out of the corona unit along with the ozone that is normally generated within the corona unit. This air is directed through a suitable ozone filter **24** to remove the ozone generated within the charge corona unit and the air from the ozone filter can either be exhausted from the system or returned to the system for recycling.

A specific embodiment for ammonia filter **22** is shown in FIG. **3.** The air from particle filter **20** enters through port **26,** goes through a quantity of chemically active material **32** which is provided in housing **34** and continues to exit port **36.** Housing **34** is made from or coated with a material that is chemically inert relative to the chemically active material, and is designed to facilitate the flow of air through the filter. The chemically active material is held in position by a retaining member **28** and a spacer member **30** on either side of the chemically active material. Retaining member **28** comprises any suitable member which will physically constrain the chemically active material and permit the free flow of air through the member. A screen member with greater than 50 percent open area is suitable for the retainer member. Spacer member **30** comprises any suitable chemically inert material such as an open cell foam for example. In a particular embodiment a polyurethane foam having 40 to 80 pores per inch was found to be suitable. The retaininng member **28** and spacer member **30** perform the dual functions of holding the chemically active material in place and uniformly distributing the air flow across the filter.

The chemically active material comprises a suitable carrier material and an active ingredient such as an acid which reacts with certain components in the air. The carrier material should either be porous or have a high surface area and be compatible with an indicator if used. The active ingredient should react readily with the components to be removed from the air, have a low vapor pressure, and be chemically inert relative to the carrier material.

One suitable chemically active material is a carrier material comprising activated charcoal treated with a solution of sulfuric acid. The activated charcoal is soaked in sulfuric acid. The resultant material is then vacuum dried and, since sulfuric acid has a very low vapor pressure, a substantial amount of the sulfuric acid is adsorbed in the pores of filter material. A typical filter treated in this manner contains about 5 percent of sulfuric acid by weight. An alternate chemically active material is a carrier material comprising silica gel treated with a solution of phosphoric acid. The silica gel is soaked in phosphoric acid. The resultant material is vacuum dried and a substantial amount of phosphoric acid is adsorbed in the pores of the carrier material. A typical filter treated in this manner may contain about 15 percent of phosphoric acid by weight. This construction of the ammonia filter provides a large surface area for reacting with the ammonia present in the air to be supplied to the charge corona.

A specific embodiment of the charge corona is shown in FIG. **4.** The charge corona comprises a plurality of corona wires **40** spaced apart a predetermined distance and a plurality of screen wires **42** that are spaced apart a considerably shorter distance than the spacing between corona wires. A suitable power source **44** is provided to supply a corona generating potential such as several kilovolts for example to corona wires **40** and a lower potential to screen wires **42.** The voltages are referenced to the photoconductor backing electrode which is normally at ground potential. An inner housing **48** is provided which has end members extending close to the surface of the photoconductor to produce a controlled flow of air through the corona device. The portion of housing **48** which extends away from the photoconductor is divided by a perforated plate member **50** so that the part of the housing behind the plate member provides a manifold for the air directed to the charge corona. The air is directed from outlet port **36** to inlet **52** by suitable ducts and is forced through the holes in plate member **50** across the corona wires and screen wires toward the photoconductor surface. An outer housing **56** is provided on the charge corona and an air outlet **54** is provided so that a pressure differential can be established between the input air and the output air to cause a controlled flow of air substantially according to the arrows shown in the drawing. The result of the illustrated air flow is that all contaminating dust is carried away from the corona and screen wires and out through outlet **54.** In addition, the ozone that is generated within the charge corona is also carried away through this outlet.

Some additional air is pulled into the charge corona around the gap between outer housing **56** and the photoconductor surface to insure that the flow of air along with the dust and ozone contaminants are removed from the charge corona rather than being distributed to other parts of the machine due to escape from housing **56.**

With the above described apparatus the ammonia level in the air introduced to the charge corona is less than one part per billion and this is effective in eliminating the particulate deposition problem so that the charge corona can be operated for long periods of maintenance free operation.

The ammonia level in air varies considerably. In unpolluted air the average is about **6** parts per billion; however, the air near chemical processes which produce or use ammonia have much higher ammonia levels, perhaps as high as **5000** parts per billion. The

amount of the chemically active material in the filter determines the ammonia capacity of the filter. Since the ammonia level in air is variable, the life of the filter is also variable. In a system in which long intervals of maintenance-free operation are desired, a filter end-of-life indicator is desirable. An end-of-life indicator is provided in the embodiment shown in FIG. **5.** The indicator operates on the basis of the change in the pH of the system as the chemically active material goes, for example, from phosphoric acid to ammonium phosphate. The chemically active material is made from a suitable carrier material to which a suitable color indicator can be added to show when the pH of the system gets to the critical value. In the embodiment shown, a window **58** is provided in a recess within housing **34'** which is transparent to the spectrum of the light from light source **60.** Light source **60** is imaged on the window **58** by a suitable lens **62** and the light transmitted back through window **58** is collected by lens **64** and passed through a suitable color filter **66** to a photocell **68.** As a specific example, the carrier material is silica gel which has been treated as described above with phosphoric acid. A suitable color indicator material such as crystal violet is also introduced into the chemically active material **32'**. The material is normally light yellow; however, at the critical pH designated to indicate end-of-life of the filter, the color indicator material changes to dark violet so that the amount of light reaching photocell **68** changes and a suitable electrical signal can be generated by monitoring the photocell output signal. The signal generated from the photocell is used as a signal to the machine operator that the filter has reached the end of life. Since the filter is normally used up rather slowly, the indication could be set at some value less than 100 percent usage of the chemically active material so that some amount of operating time would be left after the signal is generated so that the filter could be changed at a convenient time in the operation of the machine.

The color change starts at the input side of the filter and progresses toward the output side. The vertical position of window **58** along the filter can be chosen at any particular position so that the indication corresponds to the desired usage level. An elongated transparent window may be mounted vertically in housing **34'** to provide a visual indication of the usage level of the filter. It is obvious that a light transmission system can be utilized for the filter end-of-life indicator wherein a color change or a density change can be sensed.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in the form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. Apparatus for producing charge on a surface comprising; comprising:

corona means for producing a charge on a surface;

means for producing a flow of air having undesired gaseous components therein to and through said corona means over a predetermined path;

filtering means positioned in said predetetermined path between said means for producing a flow of air and said corona means so that said air flows through said filtering means, said filtering means comprising a carrier material treated with an acid to form a chemically active material to produce a chemical reaction with certain of said undesired gaseous components in said flow of air to prevent the formation of particulate material in said corona means over an extended period of operation.

2. The apparatus according to claim **1** wherein one of said undesired gaseous components in said flow of air is ammonia and wherein said chemically active material produces a chemical reaction with the ammonia in said flow of air.

3. The apparatus according to claim **1** wherein said chemically active material comprises activated charcoal which is treated with sulfuric acid.

4. The apparatus according to claim **1** wherein said chemically active material comprises silica gel which is treated with phosphoric acid.

5. The apparatus according to claim **1** wherein said chemically active material comprises silica gel which is treated with phosphoric acid.

6. An electrophotographic apparatus for producing an image on a recording surface comprising:

corona means for producing a charge on a recording surface;

means for producing a flow of air having undesired gaseous components therein to and through said corona means over a predetermined path;

filtering means positioned in said predetermined path between said means for producing a flow of air and said corona means so that said air flows through said filtering means, said filtering means comprising a carrier material treated with an acid to form a chemically active material to produce a chemical reaction with certain of said undesired gaseous components in said flow of air to prevent the formation of particulate material in said electrophotographic apparatus over an extended period of operation.

7. The apparatus according to claim **6** wherein said chemically active material comprises activated charcoal which is treated with sulfuric acid.

8. The apparatus according to claim **6** wherein one of said undesired gaseous components in said flow of air is ammonia and wherein said chemically active material produces a chemical reaction with the ammonia in said flow of air.

9. The apparatus according to claim **6** additionally comprising means to sense when said filtering means reaches end-of-life.

10. The apparatus according to claim **9** wherein said sensing means comprises means for sensing a color change when said filtering means reaches end-of-life.

11. The apparatus according to claim **9** wherein said sensing means comprises means to sense when said chemically active material reaches a predetermined concentration.

12. The apparatus according to claim **11** wherein said means to sense when said chemically active material reaches a predetermined concentration comprises an indicator material within said filtering means which changes color at said predetermined concentration and means to sense the color change.

13. The apparatus according to claim **12** wherein said indicator material comprises crystal violet.

14. The apparatus according to claim **12** wherein said chemically active material comprises silica gel which is

treated with phosphoric acid and wherein said indicator material comprises crystal violet.

15. The apparatus according to claim **12** wherein said chemically active material comprises silica gel which is soaked in phosphoric acid and then vacuum dried and wherein said indicator material comprises crystal violet.

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