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Hayne

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[54] **CORONA GENERATING APPARATUS**

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[52] **U.S. Cl.** ..... **250/324,** 317/4, 317/262 A, 250/423

[51] **Int. Cl.** **H01j 37/26**

[58] **Field of Search** .... 250/49.5 ZC, 324, 325, 326; 317/162 A, 4; 313/231

[56] **References Cited**

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3,714,531	1/1973	Takahashi	250/49.5 ZC
3,471,695	10/1969	Hudson et al.	250/49.5 ZC
3,598,991	8/1971	Nost	250/495 ZC
3,324,291	6/1967	Hudson	250/495 ZC
2,836,725	5/1958	Vyverberg	250/495 ZC

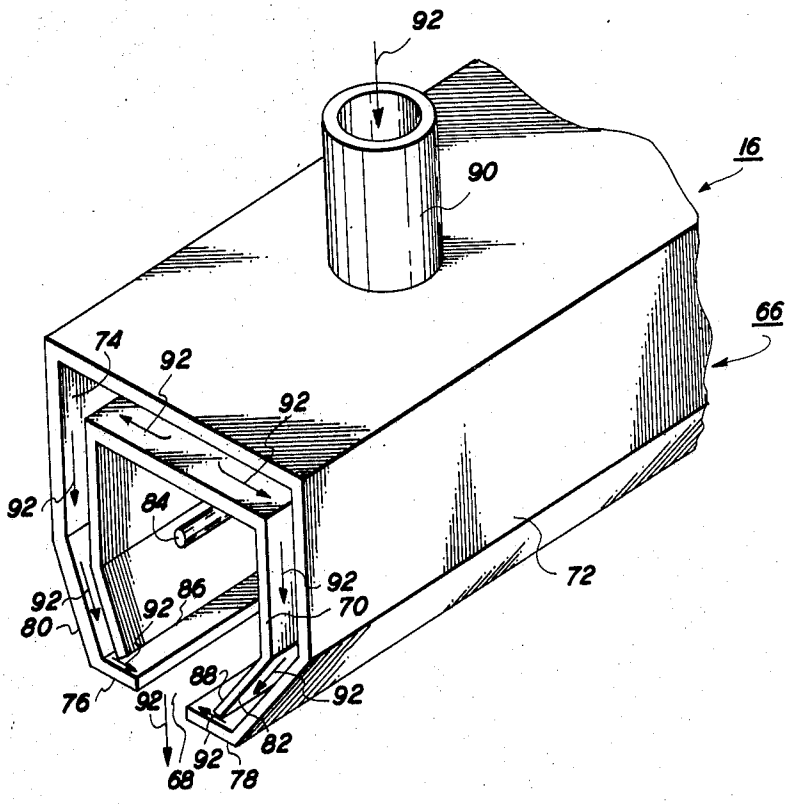
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[57] **ABSTRACT**

A corona generating apparatus in which the shield thereof includes a control portion arranged to regulate the corona discharge from the discharge electrode. The shield directs fluid-flow over the control portion for effecting the removal of particles therefrom.

The foregoing abstract is neither intended to define the invention disclosed in the specification, nor is it intended to be limiting as to the scope of the invention in any way.

8 Claims, 2 Drawing Figures



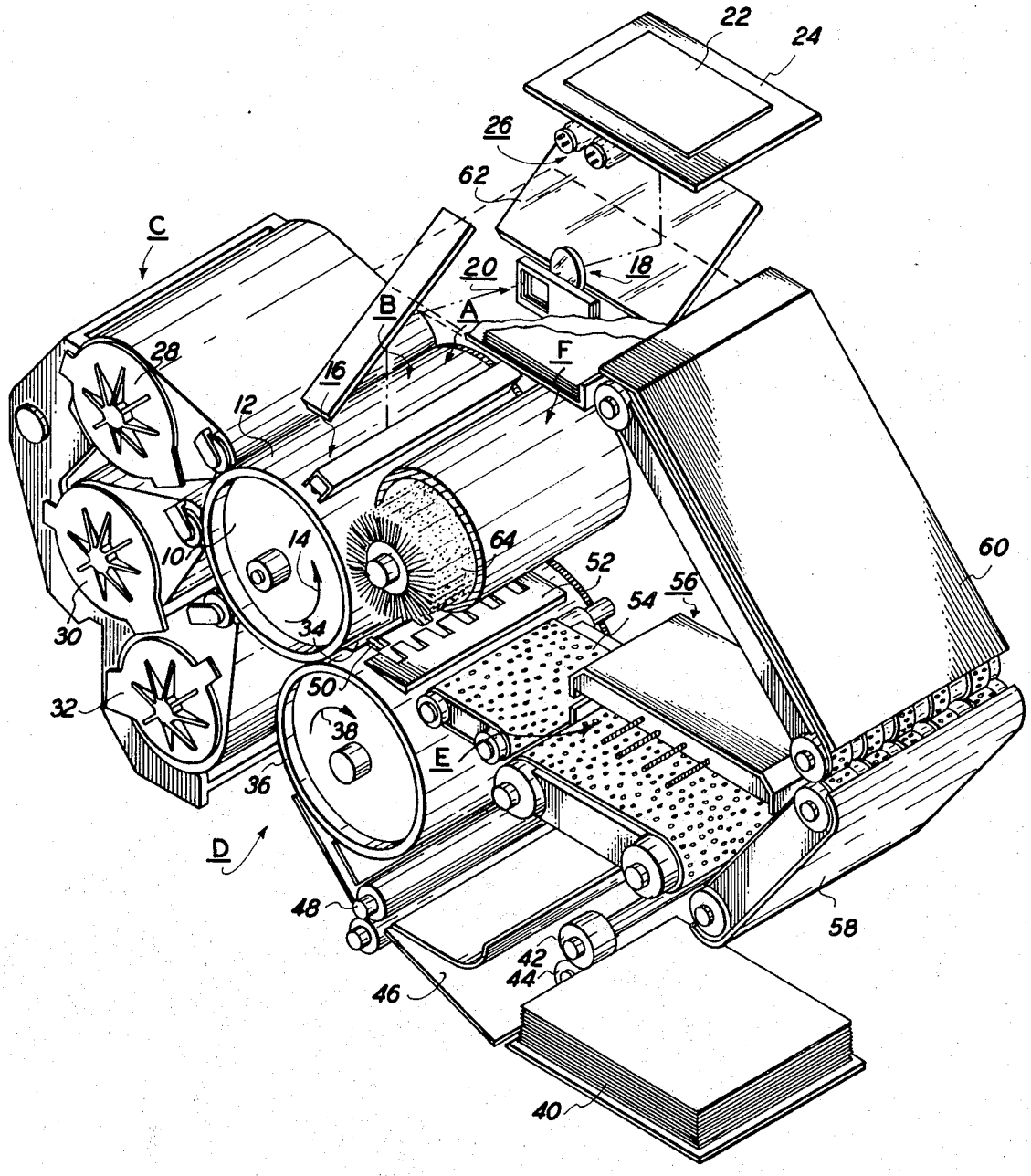

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FIG. 1

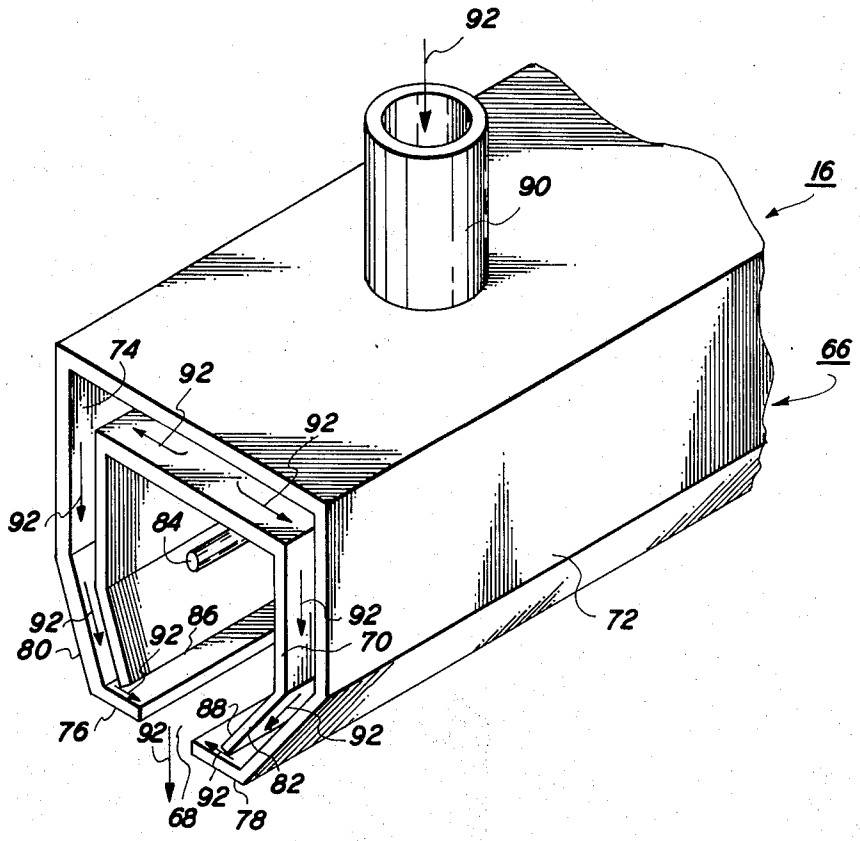


FIG. 2

CORONA GENERATING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates generally to an electrophotographic printing machine, and more particularly concerns a corona generating apparatus for charging a photoconductive surface to a substantially uniform potential.

In a typical electrophotographic printing machine, a photoconductive surface is electrostatically charged substantially uniformly thereover and then exposed to a light pattern of the image being reproduced. The light pattern discharges the electrostatic charge on the photoconductive surface in the irradiated areas. This results in the remaining charge on the photoconductive surface being in image configuration, i.e., it forms an electrostatic latent image. The electrostatic latent image may then be developed by placing in contact therewith a finely divided electrostatically attractable material, such as toner particles. The toner particles adhere electrostatically to the photoconductive surface in a pattern corresponding to the latent image recorded thereon. Thereafter, the developed image is transferred to a suitable sheet of support material, such as paper or a sheet of thermoplastic material, amongst others. The powder image transferred to the support material is subsequently affixed thereto to form a permanent print thereon.

As hereinbefore mentioned, it is necessary to deposit a substantially uniform potential on the photoconductive surface to insure that electrostatic charge may be selectively dissipated in accordance with the light pattern or image being reproduced. This may be achieved by such prior art devices as the corona generating apparatus described in U.S. Pat. No. 2,836,725 issued to Vyverberg in 1958. A corona generating apparatus generally includes a corona discharge electrode, such as a coronode wire, surrounded by a conductive shield. The corona discharge electrode is adapted to be supplied with a DC voltage of sufficient magnitude to create a corona current flow from the electrode to the photoconductive surface spaced therefrom.

Although a corona generating apparatus ia advantageously utilized to substantially uniformly charge a photoconductive surface, it is suitably adapted for various other applications. For example, a corona generating apparatus electrostatically transfers a powder image from a photoconductive surface to a sheet of support material, as well as, remove background toner particles therefrom, and neutralize the charge on toner particles adhering to the photoconductive surface after the transfer of the powder image to the support material. However, a disadvantage of a typical corona generating apparatus is its sensitivity to the accumulation of dust and toner particles.

Heretofore, various approaches have been utilized to achieve a reduction in, or elimination of, particle accumulation on the critical surfaces of corona generating apparatus. For example, air movement has frequently been used to reduce particle accumulation. The air movement is developed by a corona wind effect or a suitable blower in conjunction with appropriate ducting. As is well known in the art, a corona generating apparatus may be formed in a three wire configuration. A pair of low voltage or grounded wires are disposed adjacent the photoconductive surface, and a third, high voltage, wire is disposed intermediate the pair of low

voltage wires. The high voltage wire is spaced further from the photoconductive surface than the low voltage wires. Corona current flows from the high voltage wire to the pair of low voltage wires, and, thereafter, to the photoconductive surface. Air flow may be directed over the low voltage wires to prevent the accumulation of particles on the surface thereof opposed from the high voltage wire. If the particles are not removed therefrom, dust or toner particles adhering to the high voltage wire will decrease the corona current generated therefrom as the intensity of particle accumulation increases. Contrawise, dust or toner particles adhering to the low voltage wire will increase the corona current generated therefrom as the density of particle accumulation increases. However, the increase in current produced by particle accumulation on the low voltage wires is not inversely proprotional to the decrease in current produced by particle accumulation on the high voltage wire.

Numerous prior art devices have been developed for cleaning corona generating apparatus. By way of example, U.S. Pat. No. 3,324,291 issued to Hudson in 1967 describes a housing having a frame with a filter unit connecting a pair of outer walls. An interior wall is spaced intermediate the outer walls with the upper end thereof spaced from the filter. A pair of electrodes extend in a longitudinal direction in the housing, one of the electrodes being disposed between one of the outer walls and the intermediate wall. The other electrode is located between the other of the outer walls and the intermediate wall. Air flows in a downwardly direction through the filter and passes over the electrodes to remove particles therefrom. Similarly, U.S. Pat. No. 3,471,695 issued to Hudson in 1969 discloses a corona generating apparatus having a shield constructed from a pair of longitudinally extending end blocks and a center block disposed therebetween defining a pair of open ended cavities. A pair of electrodes are located in the shield, one in each of the cavities. Above each of the electrode wires is an elongated opening arranged to permit a flow of air onto the electrodes for removing particles therefrom. However, none of the foregoing prior art patents disclose a corona generating apparatus wherein the shield is arranged to control the corona discharge, as well as directing air flow thereover for removing particles from the critical surfaces thereof.

Accordingly, it is a primary object of the present invention to improve corona discharge regulation and particle removal from a corona generating apparatus.

SUMMARY OF THE INVENTION

Briefly stated, and in accordance with the present invention, there is provided a corona generating apparatus having a portion of the shield arranged to control the corona discharge from the discharge electrode.

The preferred embodiment of the present invention includes an elongated shield defining an open ended chamber, and a corona discharge electrode mounted in the open end of the shield chamber. In the present instance, the shield comprises a substantially nonconductive inner member and a substantially conductive outer member secured thereto. The outer member has a control portion extending inwardly over the side marginal regions of the open end of the chamber. In this way, the control portion of the outer member of

the shield regulates the corona discharge from the discharge electrode.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will become apparent upon reading the following detailed description and upon reference to the drawings, in which:

FIG. 1 is a schematic perspective view illustrating an electrophoto graphic printing machine having the corona generating apparatus of the present invention incorporated therein; and

FIG. 2 is a perspective view of the corona generating apparatus used in the FIG. 1 printing machine.

While the present invention will be described in connection with a preferred embodiment thereof, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents that may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

With continued reference to the drawings wherein like reference numerals have been used throughout to designate like elements, FIG. 1 schematically illustrates an electrophotographic printing machine in which the present invention may be incorporated. The electrophoto graphic printing machine depicted schematically in FIG. 1 shows the various components utilized therein for producing multi-color copies from a colored original. Although the corona generating apparatus of the present invention is particularly well adapted for use in an electrophotographic printing machine, it should become evident from the following description that it is equally well suited for use in a wide variety of machines and is not necessarily limited in its application to the particular embodiment shown herein.

The printing machine illustrated in FIG. 1 employs a photoconductive member having a drum **10** mounted rotatably within the machine frame (not shown). Photoconductive surface **12** is mounted on the exterior circumferential surface of drum **10.** One type of suitable photoconductive material is disclosed in U.S. Pat. No. 3,655,377 issued to Sechak in 1972. A series of processing stations are positioned such that as drum **10** rotates in the direction of arrow **14** it passes sequentially therethrough. Drum **10** is driven at a predetermined speed relative to the other machine operating mechanisms from a common drive motor (not shown). The various machine operations are coordinated with one another to produce the proper sequence of events at the appropriate processing stations.

Drum **10,** initially, moves photoconductive surface **12** through charging station A. Charging station A has positioned thereat an ion source or the corona generating apparatus of the present invention, indicated generally at **16.** Corona generating apparatus **16** extends in a generally transverse direction across photoconductive surface **12.** This readily enables corona generating device **16** to charge photoconductive surface **12** to a relatively high substantially uniform potential. Corona generating apparatus **16** will be described in detail hereinafter with reference to FIG. **2.** Continuing now with the description of the various processing stations in the electrophotographic printing machine of FIG. **1,** drum **10** is next rotated to exposure station B.

Exposure station B includes thereat a moving lens system, generally designated by the reference numeral **18,** and a color filter mechanism, shown generally at **20.** A suitable moving lens system is disclosed in U.S. Pat. No. 3,062,108 issued to Mayo in 1962, and a suitable color filter mechanism is described in copending application Ser. No. 830,282 filed in 1969. As shown in FIG. **1,** an original document **22,** such as a sheet of paper, book or the like, is placed face down upon transparent viewing platen **24.** Lamp assembly **26,** lens system **18,** and filter mechanism **20** are moved in a timed relation with drum **10** to scan successive incremental areas of original document **22** disposed upon platen **24.** In this way, a flowing light image of original document **22** is projected onto photoconductive surface **12.** Filter mechanism **20** is adapted to interpose selected color filters into the optical light path. The appropriate color filter operates on the light rays passing through lens **18** to record an electrostatic latent image on photoconductive surface **12** corresponding to a preselected spectral region of the electromagnetic wave spectrum, hereinafter referred to as a single color electrostatic latent image.

After exposure, drum **10** rotates the single color electrostatic latent image recorded on photoconductive surface **12** to development station C. Development station C includes thereat three individual developer units, generally indicated by the reference numerals **28, 30** and **32,** respectively. A suitable development station employing a plurality of developer units is disclosed in copending application Ser. No. 255,259, filed in 1972. Preferably, the developer units are all of the type referred generally to as magnetic brush developer units. A typical magnetic brush developer unit utilizes a magnetizable developer mix having carrier granules and toner particles. The developer mix is continually brought through a directional flux field to form a brush thereof. The electrostatic latent image recorded on photoconductive surface **12** is developed by bringing the brush of developer mix into contact therewith. Each of the respective developer units contain therein discrete toner particles of a color complementary to the spectral region of the wave length of light transmitted through filter **20,** e.g., a green filtered electrostatic latent image is rendered visible by depositing green absorbing magenta toner particles thereon. Blue and red latent images are developed with yellow and cyan toner particles, respectively.

Drum **10** is next rotated to transfer station D where the powder image adhering electrostatically to photoconductive surface **12** is transferred to a sheet of final support material **34.** Final support material **34** may be, amongst others, plain paper or a thermoplastic sheet. A bias transfer roll, shown generally at **36,** recirculates support material **34** and is biased electrically to a potential of sufficient magnitude and polarity to attract electrostatically toner particles from the latent image recorded on photoconductive surface **12** to support material **34.** A suitable electrically biased transfer roll is described in U.S. Pat. No. 3,612,677, issued to Langdon et al. in 1971. Transfer roll **36** rotates in the direction of arrow **38** in synchronism with drum **10** (in this case at the same angular velocity). Inasmuch as support material **34** is secured releasably thereon for movement in a recirculating path therewith, successive toner powder images may be transferred thereto in superimposed registration with one another.

Support material **34** is advanced from stack **40** thereof. Feed roll **42,** in operative communication with retard roll **44,** advances and separates successive uppermost sheets from stack **40.** The advancing sheet moves into chute **46** which directs the sheet into the nip between register rolls **48.** Thereafter, girpper fingers **50** mounted on transfer roll **36** secure releasably thereon support material **34** for movement therewith in a recirculating path. After a plurality of toner powder images have been transferred to support material **34,** gripper fingers **50** release support material **34** and stripper bar **52** separates support material **34** from transfer roll **36.** Support material **34** is, thereafter, advanced on endless belt conveyor **54** to fixing station E.

At fixing station E, a fuser, indicated generally at **56,** coalesces the transfer powder images to support material **34.** One type of suitable fuser is described in U.S. Pat. No. 3,498,592 issued to Moser et al. in 1970. After the fixing process, support material **34** is advanced by endless belt conveyors **58** and **60** to catch tray **52** for subsequent removal therefrom by the machine operator.

Although a preponderance of the toner particles are transferred to support material **34,** invariably some residual toner particles remain on photoconductive surface **12** after the transfer of the toner powder image to support material **34.** These residual toner particles are removed from photoconductive surface **12** as it moves through cleaning station F. Here the residual toner particles are first brought under the influence of a cleaning corona generating device (not shown) adapted to neutralize the electrostatic charge remaining on the toner particles. The neutralized toner particles are then mechanically cleaned from photoconductive surface **12** by a rotatably mounted fibrous brush **64.** A suitable brush cleaning device is described in U.S. Pat. No. 3,590,412 issued to Gerbasi in 1971. Rotatably mounted brush **64** is positioned at cleaning station F and maintained in contact with photoconductive surface **12.** Hence, residual toner particles remaining on photoconductive surface **12,** after each transfer operation, are readily removed therefrom.

It is believed that the foregoing description is sufficient for purposes of the present application to illustrate the general operation of an electrophotographic printing machine embodying the teachings of the present invention.

Referring now to the specific subject matter of the present invention, FIG. **2** depicts schematically corona generating apparatus **16.** Corona generating apparatus **16** includes an elongated shield, designated generally by the reference numeral **66,** defining an open ended chamber **68.** Shield **66** includes a non-conductive inner member **70** which may be formed from a suitable plastic or other non-conductive material. Preferably, inner member **70** is substantially U-shaped. Shield **66** also includes a conductive outer member **72** opposed from and closely spaced to inner member **70.** Outer member **72** is suitably secured to inner member **70** in an opposed spaced relationship defining a conduit **74** therebetween. By way of example, outer member **72** may be attached to inner member **70** by means of a plurality of spaced brackets located in conduit **74.** However, it is apparent that the brackets (not shown) must be disposed in conduit **74** so as not to obstruct the fluid-flow (in this case air). Preferably, outer member **72** is conductive and made from an aluminum extrusion. Moreover, outer member **72** is also formed in a U-shaped configuration. Outer member **72** includes a control portion or a pair of spaced bent lips **76** and **78,** respectively, extending inwardly over the side marginal regions of open ended chamber **68.** Lip **76** extends inwardly from side wall **70** over one side marginal region of open ended chamber **68.** Lip **78** extends inwardly from side wall **82** over the other side marginal region of open ended chamber **68.**

A corona discharge electrode **84** is mounted in open ended chamber **68** extending in a longitudinal direction from one end of shield **66** to the other end thereof. A pair of insulating plates (not shown) are affixed permanently at either end of shield **66** by suitable means, i.e., by suitable fasteners or by being adhesively secured thereto. Discharge electrode **84** is suitably attached to the insulating plates, e.g., by suitable fasteners. Discharge electrode **84** is, preferably, a coronode wire made from a conductive material such as tungsten with a tungsten oxide coating thereon. The insulating plates are, preferably, made from a dielectric material such as glass alkyd, Lucite, Plexiglass, Lexan or the like.

Referring once again to FIG. **2,** coronode wire **84** is positioned in open ended chamber **68** of shield **66.** Lips **76** and **78** extend over the side marginal regions of open ended chamber **68** beyond edge portions **86** and **88** of inner member **70.** In addition, lips **76** and **78** are made from a conductive material, i.e., aluminum, which may be grounded or biased to a suitable voltage level. The non-conductive inner member **70** provides mechanical protection for coronode wire **84** but has little influence on the corona current level, provided, however, that coronode wire **84** is disposed closer to lips **76** and **78** than to inner member **70.**

A fluid-flow generating means, such as a suitable blower (not shown) is connected to duct **90** and arranged to direct the flow of fluid (in this case air) in the direction of arrow **92** in conduit **74.** Thus, the fluid-flow over the surfaces of lips **76** and **78** opposed from coronode wire **84** effects the removal of the particles therefrom insuring that lips **76** and **78** regulate the corona discharge from coronode wire **84.**

By way of example, corona generator means or a suitable high voltage source (not shown) excites coronode wire **84** to a voltage preferably ranging from about 6,000 volts to about 8,000 volts. The coronode wire current ranges from about 200 to about 500 micro amperes. Similarly, field applying means or a low voltage source (not shown) may be utilized to excite lips **76** and **78** to, preferably, 800 volts. Lips **76** and **78** have the bias voltage thereof set at about the desired final voltage level of photoconductive surface **12.** While the present invention has been described in connection with biasing lips **76** and **78** to a suitable voltage level, one skilled in the art will appreciate that the invention is not necessarily so limited and that lips **76** and **78** may be grounded.

As photoconductive surface **12** moves under lips **76** and **78** it acquires a charge sufficient to increase its voltage to about that of lips **76** and **78,** however, further charging thereof is suppressed by lips **76** and **78.** That is, when photoconductive surface **12** is charged to a voltage substantially the same as that of lips **76** and **78,** most of the corona current is conducted to lips **76** and **78** rather than to photoconductive surface **12.**

In recapitulation, it is evident that there has been provided a corona generating apparatus adapted to

have toner particles and dust cleaned therefrom in order to maintain the charging voltage produced on the photoconductive surface substantially constant. Moreover, the shield thereof includes a control portion adapted to regulate the corona discharge from the discharge electrode. This is achieved in the present invention by a shield having a non-conductive inner member spaced from a conductive outer member defining a conduit therebetween. In this way, a flow of fluid is directed through the conduit over the inwardly extending conductive lips secured to the outer member. The conductive lips may be suitably biased to an appropriate voltage level such that the photoconductive surface is charged to approximately the level thereof by a coronode wire disposed in the open end of the elonagted shield. Moreover, fluid-flow is directed to effect the removal of toner particles and dust from the surface of the lips opposed from the coronode wire insuring the maintenance of a substantially constant corona charge on the surface of the photoconductor moving thereunder.

Thus, it is apparent that there has been provided in accordance with the present invention, a corona generating apparatus that fully satisfies the objects, aims and advantages set forth above. While this invention has been described in connection with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, it is intended to embrace all such alternatives, modifications and variations as fall within the spirit and scope of the appended claims.

What is claimed is:

1. A corona generating apparatus, including:

an elongated shield defining an open ended chamber, said shield comprising a substantially non-conductive inner member, and a substantially conductive outer member secured thereto and having a control portion extending inwardly therefrom over the side marginal regions of the open end of the chamber, the inner member of said shield being secured to the outer member thereof in an opposed, spaced relationship defining a conduit therebetween for directing fluid-flow substantially over the control portion of the outer member to effect the removal of particles therefrom; and

a corona discharge electrode mounted in the chamber of said shield and arranged therein so that the control portion of said shield regulates the corona discharge from said discharge electrode.

2. An apparatus as recited in claim 1, further including means for generating a corona discharge from said discharge electrode.

3. An apparatus as recited in claim 2, further including means for applying a field regulating potential to the control portion of the outer member of said shield.

4. An apparatus as recited in claim 1, further including means for producing fluid flow through the conduit defined by the inner member of said shield and the outer member thereof.

5. An apparatus as recited in claim 4, wherein the outer member of said shield includes a substantially U-shaped member.

6. An apparatus as recited in claim 5, wherein the control portion of the outer member of said shield includes a pair of inwardly bent lips adapted to regulate the corona discharge from said discharge electrode, one of said lips extending inwardly over one side marginal region of the open ended chamber from one side wall of said U-shaped member, and the other of said lips extending inwardly over the other side marginal region of the open ended chamber from the other side wall of said U-shaped member.

7. An apparatus as recited in claim 6, wherein said discharge electrode includes an elongated conductive wire mounted in the chamber of said shield and extending substantially in a longitudinal direction along the length of said shield.

8. An apparatus as recited in claim 7, wherein the inner member of said shield includes a substantially U-shaped member.

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