Aug. 29, 1967 T. F. HAYNE ETAL 3,339,069
CORONA CHARGING DEVICE WITH MEANS TO PREVENT
TONER DUST CONTAMINATION
Filed Oct. 14, 1964 2 Sheets-Sheet 1

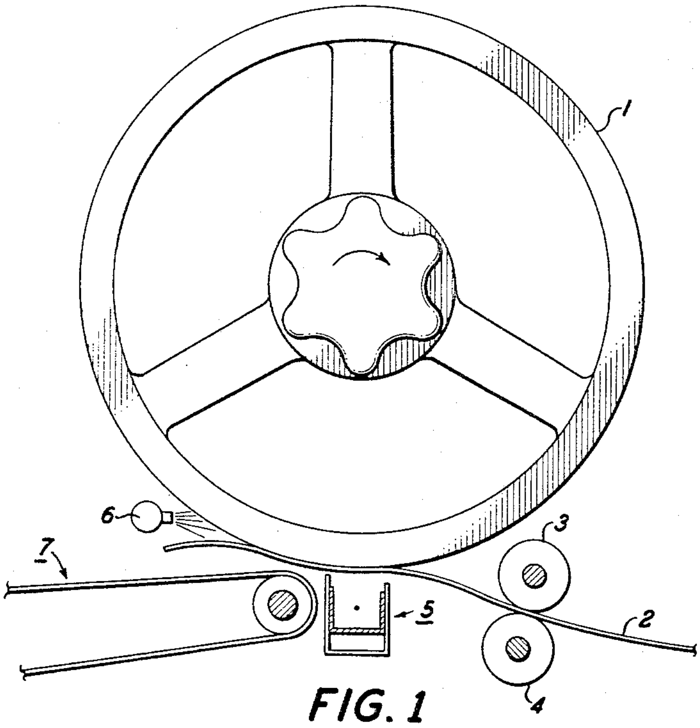

FIG. 1

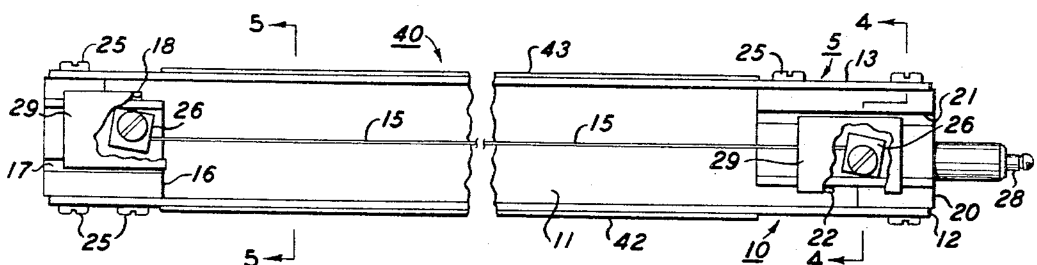

FIG. 2

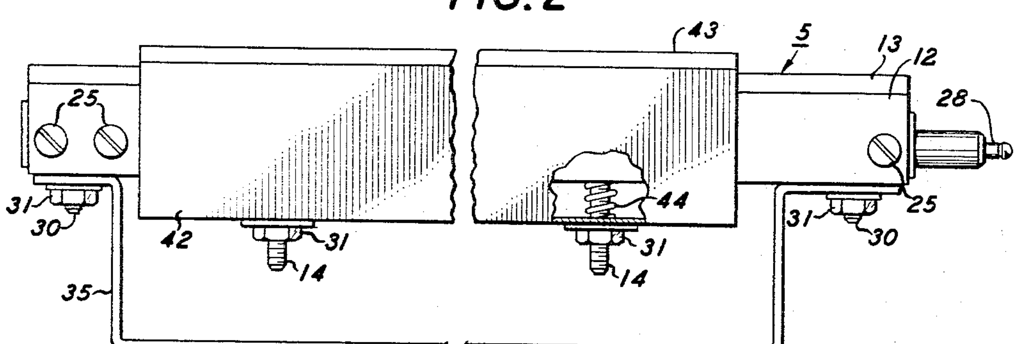

FIG. 3

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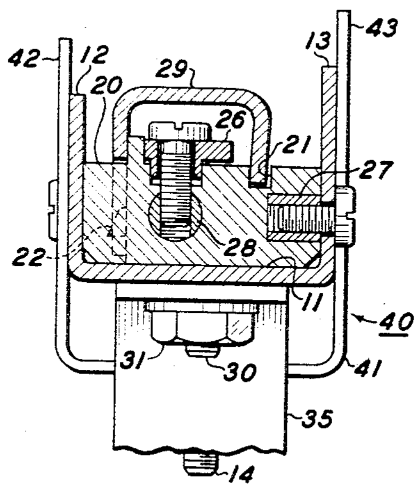

FIG. 4

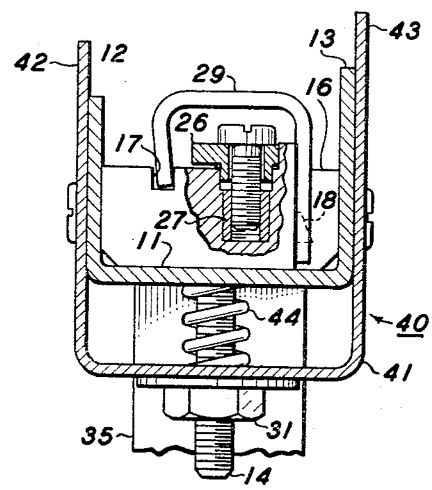

FIG. 5

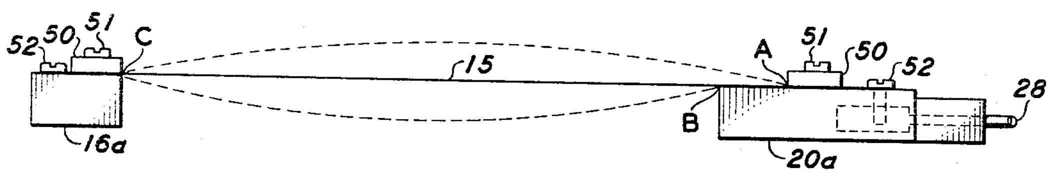

FIG. 6

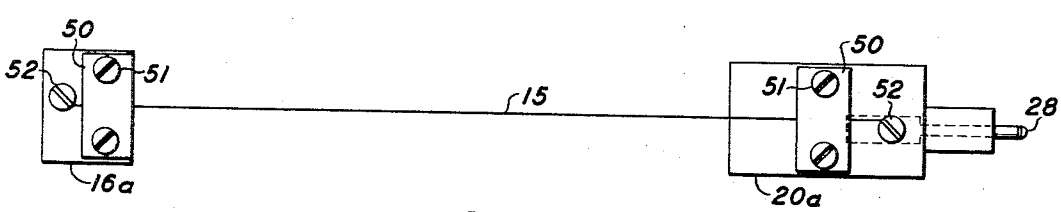

FIG. 7

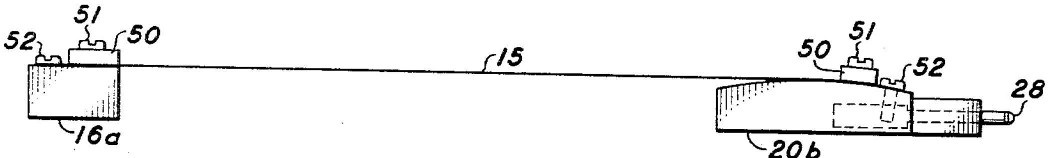

FIG. 8

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3,339,069

CORONA CHARGING DEVICE WITH MEANS TO PREVENT TONER DUST CONTAMINATION

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ABSTRACT OF THE DISCLOSURE

A corona emitting device including a corona wire supported within a shield adapted for xerographic functions. The shield has side walls of unequal height with the higher wall facing a source of toner dust contamination for wire cleanliness. The wire is mounted on insulating blocks with one wire end point mounted and the other wire end off-set mounted for damping vibrations of the wire.

This invention relates to the field of xerography and, particularly, to an improved corona generating device for imposing electrostatic charge on a support surface or on a xerographic plate.

In one mode of reproduction of copy by xerographic techniques, a uniform electrostatic charge is applied to a xerographic plate, comprising a photoconductive insulating material on a conductive backing. This charged xerographic plate is then exposed to the subject matter to be reproduced, usually by conventional projection techniques. This exposure of the xerographic plate, discharges the plate areas in accordance with the radiation intensity which reaches them and thereby creates an electrostatic latent image on or in the plate coating which may then be developed with an electroscopic material which clings to the plate electrostatically in a pattern corresponding to the latent electrostatic image. The thus formed powder image is usually transferred to a support surface by superposing the support surface thereon and applying an electrostatic charge to the exposed area of the support surface, whereby the xerographic powder image is electrostatically attracted and bonded to the support surface. The support surface is then separated from the xerographic plate and the xerographic powder image on the support surface may then be fixed thereto by any of a variety of techniques, such as heat fusing.

In general, the electrostatic charging of the xerographic plate in preparation for the exposure step and the electrostatic charging of the support surface to effect transfer are accomplished by means of corona generating devices whereby electrostatic charge on the order of 800 to 1100 volts is applied to the respective surfaces, in each instance. A form of corona generating device for this purpose is disclosed in Vyverberg Patent 2,836,725, issued May 27, 1958, wherein a single corona wire is connected to a high voltage source and is supported in a conductive shield that is arranged in closely spaced relation to the surface to be charged. Suitable means are usually provided to effect relative movement of the surface to be charged and the corona generating device whereby a uniform electrostatic charge is deposited.

As is well known, the corona threshold potential and the corona current from a charged wire are functions of the thickness of the wire such that the corona threshold increases with any increasing thickness of the wire and the corona current for any given potential decreases with any increasing thickness of the wire. In addition, the corona threshold potential and corona current are also

effected directly by the deposit of dust that may accumulate on the wire and by variations of movement and ionized condition of the air surrounding the wire.

In continuous automatic xerographic reproducing machines, using cut sheet material, such as paper, for the support surface onto which the xerographic powder image formed on the drum is transferred, a sheet stripping apparatus of the type disclosed in Rutkus et al. Patent 3,062,536 is used to separate the support surface from the xerographic drum after transfer. In this type of device, air under pressure is directed against the leading edge of the support surface on the drum to force it away from the drum, the support surface then peeling away from the drum due to its own weight. Although this high pressure air is directed against the drum surface and the leading edge of the support surface in pulses of short duration, this air blast will periodically dislodge small quantities of toner from the surface of the drum or from the leading edge of the support material. This loose powder will eventually settle on various components in the xerographic apparatus, and in particular, onto the corona wire and shield of the corona charging device used at the transfer station of the xerographic apparatus. This toner powder, which can now be considered dust, accumulating on the corona wire and shield drastically effects the corona generating capability of the wire and causes a nonuniform electrostatic charge to be deposited on the support surface during transfer.

Accordingly, the principal object of the present invention is to improve the construction of corona generating devices whereby a uniform electrostatic charge may be deposited on a xerographic plate or other surface.

Another object of the present invention is to provide a corona generating device of such construction that is particularly suitable for continuous operation in automatic machines.

These and other objects of the invention are attained by employing a single corona wire or electrode that is connected to a high voltage source and is insulated from but supported within a conductive shield of such a construction to limit the accumulation of dust on the corona wire. The corona wire is supported on insulated blocks within this conductive shield in such a manner as to prevent the corona wire from vibrating which would cause damage to the wire. By this arrangement, it is possible to energize the corona wire to a potential substantially in excess of the corona threshold potential of the wire and, since the shield is maintained at ground potential, most of the corona current emitted goes directly to the shield and only a small portion thereof is effective to charge the plate or support surface. In addition, a dust shield, similar in configuration to the conductive shield encloses this device to further prevent the accumulation of dust either on the corona wire or the conductive shield.

For a better understanding of the invention as well as other objects and features thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawings wherein:

FIG. 1 illustrates schematically the transfer station of an automatic xerographic reproducing apparatus incorporating a corona generating apparatus in accordance with the invention to apply an electrostatic charge to a support surface advanced into contact with the xerographic plate of the apparatus;

FIG. 2 is the top view of a corona charging device constructed in accordance with the invention;

FIG. 3 is a view in side elevation of the corona charging device of FIG. 2;

FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 2;

FIG. 5 is a sectional view taken along line **5—5** of FIG. 2;

FIG. 6 is a side view of another embodiment of a corona wire mounting arrangement;

FIG. 7 is a top view of the corona wire mounting arrangement shown in FIG. 6; and

FIG. 8 is a side view of still another corona wire mounting arrangement.

Referring now to FIG. 1, there is shown schematically, the image transfer station of an automatic xerographic reproducing apparatus, at which, the xerographic powder image previously formed on the xerographic plate is electrostatically transferred from the xerographic plate to a support surface, such as cut sheet paper.

As shown, the image transfer station includes a sheet feeding arrangement adapted to feed sheets of support material successively to the xerographic plate in coordination with the presentation of the developed image on the plate surface at the transfer station.

A xerographic plate **1**, including a photoconductive layer or light-receiving surface on a conductive backing and formed in the shape of a drum, is mounted to rotate in the direction indicated by the arrow to cause the drum surface sequentially to pass a plurality of xerographic processing stations, only the transfer station being shown.

Sheets of support material **2** are advanced seriatim by feed rolls **3** and **4** into contact with the xerographic drum in registration with a previously formed xerographic powder image on the drum.

The transfer of the xerographic powder image from the drum surface to the sheets of support material is effected by means of a corona charging device **5**, constructed in accordance with the invention, that is located at/or immediately after the line of contact between the support material and the rotating drum. In operation, the electrostatic field created by the corona charging device is effective to tack the support material electrostatically to the drum surface, whereby the support material moves synchronously with the drum while in contact therewith. Simultaneously with the tacking action, the electrostatic field is effective to attract the toner particles comprising the xerographic powder image from the drum surface and cause them to adhere electrostatically to the surface of the support material.

Immediately subsequent to the image transfer station, there is positioned a stripping apparatus to paper pick-off mechanism **6** for removing the sheets of support material from the drum surface. This device, which is of the type disclosed in Rutkus et al., United States Patent 3,062,536, includes a plurality of small diameter orifices supplied with pressurized aeriform fluid by a suitable pulsator or other device. The pulsator is adapted to force jets of pressurized aeriform fluid through the outlet orifices into contact with the surface of the xerographic drum slightly in advance of the sheet of support material to strip the leading edge of the sheet from the drum surface and to direct it onto an endless conveyor **7**.

In this arrangement, toner particles can and are dislodged from either the surface of the drum or from the surface of the support material. These loose toner particles, still carrying an electrostatic charge are attracted to various internal elements of the apparatus, including the wire and shield of the corona generating device.

Referring now to the subject matter of the invention and, in particular to FIGS. 2, 3, 4 and 5 illustrating a preferred embodiment of the invention, the corona charging device **5** includes a grounded conducting shield preferably of aluminum or stainless steel. The shield, generally designated **10**, is of generally J-shaped cross-section and includes a bottom wall **11** and side walls **12** and **13** in perpendicular relation to the bottom wall **11**. In the form of the invention illustrated in FIG. 1, the side wall **13**, the wall nearest to the stripping apparatus **6**, and therefore the wall nearest to the source of dust, is of greater height than wall **12** for a purpose to be described.

A high voltage wire, or corona wire **15**, of any suitable non-corrosive material, such as stainless steel, having a uniform exterior and a diameter of appropriate size is located within the shield, the corona wire being spaced considerably closer to the bottom wall **11** than to either of the side walls **12** and **13**. For example, the corona wire **15** may be spaced three-eights of an inch from the bottom wall **11** and at least seven-sixteenths from each of the side walls.

The corona wire **15** is stretched between and attached to blocks **16** and **20** of suitable insulating material which are arranged between the side walls **12** and **13** at opposite ends thereof, and attached thereto as by screws **25** extending through these walls into the blocks **16** and **20**. One end of the corona wire is wound around or clamped against the turned depending portion under the square shoulder of a metal washer **26**, this assembly being held in position by a screw **25** extending through the metal washer into engagement with a threaded insert **27** preferably moulded into block **16**.

At its other end, the corona wire **15** is secured in a similar manner. As shown in FIGS. 2 and 4, this end of the wire is wound around or clamped against a second metal washer **26** and held in position by a screw **25** extending through the metal washer into engagement with a threaded aperture in a terminal plug **28**, the reduced portion of which extends into a suitable bored hole in the outboard end of block **20**. The exposed portions of the terminal plug is disposed for engagement with a suitable conducting bar or source carrying the high voltage supply. In the above-described structure, it is preferred to clamp the wire between the washer and the related block to prevent bending of the wire.

As shown in FIGS. 2 and 4, the axis of the turned metal washers **26** and screws **25** cooperating therewith are offset from the center line of blocks **16** and **20** to permit the wire to be stretched substantially equal distance from side walls **12** and **13**.

Each of the blocks **16** and **20** is provided with longitudinal slots **17** and **21**, respectively, and cut-back side portions having pins **18** and **22** respectively, formed integral therewith whereby an arc shield **29**, formed of suitable dielectric material, can be secured over the terminal ends of the corona wire **15**.

The arc shields **29**, formed of a dielectric material and J-shaped cross-section, have one wall provided with a suitable aperture to engage a pin, on blocks **16** and **20**, the opposite wall being engaged in the slot of the block as shown in FIGS. 4 and 5.

The corona charging device is supported in spaced relation to the drum as by a bracket **35** suitably grounded (not shown) to other elements of the xerographic apparatus, the bottom wall **11** of the shield being provided with studs **30**, secured thereto, which extend through suitable apertures in bracket **35** to receive nuts **31**.

Although the above-described corona charging device, will still accumulate dust, if operated in an area where dust is present, its operating characteristics, unlike previously known corona charging devices, will not be significantly changed by moderate dust accumulation. This is true because of the shape of shield **10** and the position of corona wire **15** in the shield. With this arrangement, the surfaces which accumulate most of the dirt are relatively non-critical. That is, the criticalness of the part of the shield surface is inversely proportional to the distance from wire **15**, or stated differently, the shield configuration which has its closest surface to the wire in such a location as to accumulate little dust will be relatively insensitive to dirt accumulation. This makes the bottom wall **11** of shield **10** the most critical surface and allows dust to accumulate on the side wall and inside corners of the shield without changing the operating characteristics of the device. It is to be realized that dust entering an electrostatic field will first be charged and then attracted to the nearest grounded surface. The height of the side wall of the shield which faces the sheet stripping device **6**, that is, side wall **13** has been increased over side wall **12** in order to block off dust or toner-laden air while providing additional non-critical surface areas for collecting dust.

With the above-described arrangement of shield construction and wire placement there is provided a corona charging device of simplicity and high efficiency to obtain reduced sensitivity to dust accumulation by making the shield of such configuration to collect dust in specific areas in order to make one surface, the bottom wall remain relatively clean and using this relatively clean surface the controlling factor in relation to the corona wire **15**.

Although the above-described structure is effective for continued operation in a dust-laden atmosphere without substantial changes in its operating characteristics, an additional shield may be provided to partially enclose the conductive shield and to provide additional surface area onto which dust may accumulate thereby extending the operating time of the corona generating device before its operating characteristics are affected.

This is accomplished by means of a second shield, generally designated **40**, which fits around shield **10** and is shaped in a similar manner to conform to shield **10**. Shield 40 includes a bottom wall **41** and side wall **42** and **43** formed perpendicular to bottom wall **41**. The walls of the shield formed of a suitable conductive material are coated with a thin layer of a dielectric material such as Teflon FEP, a Du Pont Corporation product composed of fluorinated ethylene/propylene. Satisfactory results have been obtained with a coating thickness of .0005 to .0010 inch of this material. This insulated shield when placed around conductive shield **10** is charged by corona wire **15** and then its exposed and charged surface areas will also attract dust particles to its dielectric surface before it can be attracted to the surface of shield **10**. Thus, this insulated shield cannot be considered as an extension of the side walls and bottom walls of the conductive shield.

Shield **40** is movably supported from shield **10** by studs **14** suitably secured and depending from bottom wall **11**. The studs **14** extend through suitable apertures formed in bottom wall **41** to receive nuts **31** whereby the shield **40** may be raised or lowered with respect to the walls of shield **10**. Coil springs **44** encircle the studs **14** between bottom wall **11** of shield **10** and bottom wall **41** of shield **40** to bias the shield **40** against the nuts **31** used to adjust the height of this shield.

Although arc preventing shields are used in the corona charging device to prevent arcing between the terminals of the corona wire **15** and the xerographic plate or support material, it has now been found that arcing has also occurred in prior art devices because of vibration of the corona wire, that is, a traveling vibration wave is induced in this wire by the voltage applied to the wire.

This arcing is believed to be a function of wire tension, which controls the amplitude and frequency of wire vibration. In addition, the electrostatic field generated by the corona wire itself is suspected to be a cause of the self-excited vibration. This view is supported by the vibration occurring at the natural frequency of the wire and in the fundamental mode at all times. One can only speculate as to the exact nature of the forces that are involved to cause this vibration of the wire. Because of this, if the excursions of the corona wire from its rest can be minimized, the arcing voltage level could be increased or conversely for a given operating voltage level, arcing could be eliminated.

Referring now in particular to FIGS. 2, 6, 7 and 8, there is shown three different embodiments of wire mounting arrangements to reduce wire vibration and therefore arcing. Wire vibration can be reduced by offsetting the wire mounting point on the surface of the insulating support block on one end and by point mounting at the other end of the wire. As shown in FIG. 2, this can be accomplished by anchoring the right-hand end of wire **15** at a substantial distance from the inboard-end or left-hand of block **20**. At its opposite end, the wire is anchored near the inboard-end or right-hand end of block **16**, as previously described.

In the embodiment shown in FIGS. 6 and 7, the wire **15** is secured to blocks **16*a*** and **20*a***, serving the same function as blocks **16** and **20**, by clamps **50** secured to these blocks by screws **51**. To effect full point mounting of the wire at one end, the wire is clamped between a clamp **50** and the upper surface of block **16*a*** with the end of the wire encircling terminal screw **52**. The inboard or right-hand end of this clamp is aligned with the inboard or right-end end of block **16*a***. At its opposite end the wire is clamped between a clamp **50** and block **20*a*** substantially back from the inboard edge of this block. For simplicity, the vibration wave of the wire has been shown as a full wave as indicated by the dotted lines showing the wire **15** moving from its rest position as shown by the solid line illustration of the wire. Serious vibration of the wire **15** is eliminated by mechanical damping.

This is accomplished by an instantaneous change in the point of wire contact with the surface of block **20*a*** producing a phase and frequency change on alternate half cycles of vibration. For example, as the wire vibrates upward the points of contact of the wire are at points A and C while as the wire vibrates downward its points of contact have been changed to points B and C.

Success in reducing the amplitude of wire vibration is also achieved using an offset curved surface block **20*b*** and a point mounting at the other end, as shown in FIG. 8. The left-hand end of wire **15** is mounted in the same manner as the embodiment shown in FIGS. 6 and 7. The right-hand block **20*b*** has a curved upper surface, the wire being clamped thereon as by clamp **50** and screws **51**, the wire terminating at terminal screw **52**. The mechanism of operation of this embodiment is similar to that described in reference to the embodiment illustrated in FIGS. 6 and 7, if this latter embodiment is to be considered as the limiting case as the radius of the curved surface of block **20*b*** approaches infinity. In the case of the curved surface of block **20*b***, rate of change in position of the point of wire contact at this end is finite. This means that the rate of change of frequency and phase of vibration is also finite accounting for partial but adequate elimination of the self-excited vibration of the wire **15** and changes little even if the wire becomes contaminated with dust.

While the invention has been described with reference to the structure disclosed herein, it is not to be confined to the details set forth or the specific environment set forth. In addition, although the structure has been defined in terms such as bottom wall and side wall, and a particular mounting arrangement has been shown, it is realized that the corona charging device can be mounted in any position around the peripheral surface of the xerographic drum. Thus, for example, if the corona charging device were mounted at the 12 o'clock position instead of the 6 o'clock position, as shown, the bottom wall of the conductive shield could then be described as the top wall of the conductive shield. Therefore, this application is intended to cover such modifications or changes as may come within the purposes of the improvements or the scope of the following claims.

What is claimed is:

1. A corona emitting device for the emission of a corona discharge at a xerographic station at which a xerographic toner image is transferred from a photoconductive surface to a backing sheet and after which the backing sheet is separated from the photoconductive surface by a puffer capable of directing a flow of aeriform fluid between the photoconductive surface and the backing sheet, the corona device including

an electrically grounded conductive shield having a bottom wall and side walls perpendicular to said bottom walls, one of said side walls being substantially higher than said other side wall,

insulating support blocks connected to opposite ends of said shield between said side walls,

a corona wire,

means to secure said wire at its opposite ends to said support blocks in insulating relation to said conductive shield with said corona wire being positioned substantially closer to said bottom wall than said side walls and with said wire secured to said insulating blocks with an off-set mounting point on one of said insulating blocks and point mounting on said other insulating block,

means connected to one end of said corona wire and adapted to be connected to a source of high voltage potential and

means to support said corona device within the xerographic station with the higher of said side walls being closer to the puffer than said other side wall so as to permit the higher wall to electrostatically attract charged contaminating particles as caused by the puffer for increased cleanliness of the corona device.

2. The apparatus of claim 1 including a second shield having a surface coating of a dielectric material thereon positioned to enclose said conductive shield with the side walls of said second shield extending beyond the side walls of said conductive shield.

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