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CORONA CHARGING APPARATUS WITH MEANS TO URGE A FLOW OF
AERIFORM FLUID ACROSS THE CORONA WIRES
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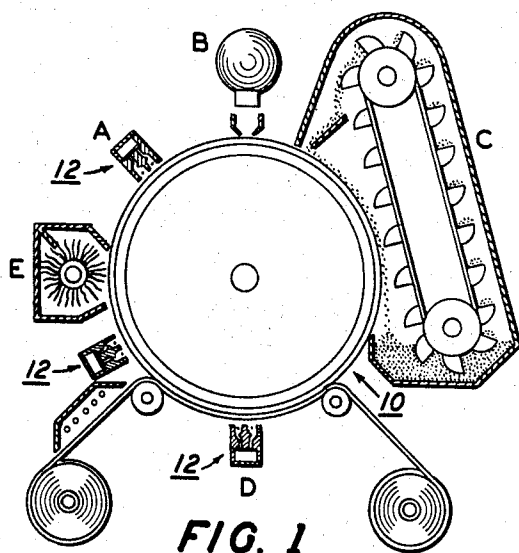


FIG. 1

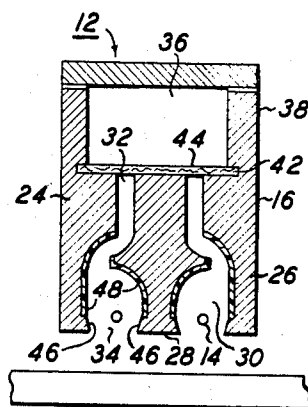


FIG. 3

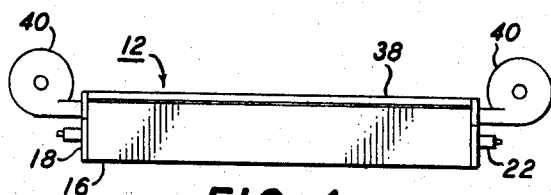


FIG. 4

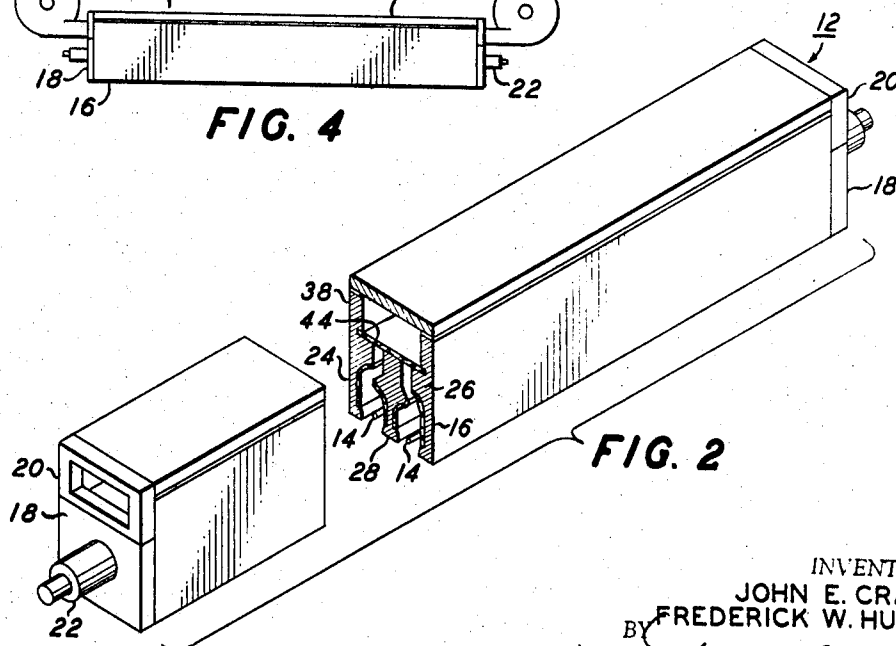


FIG. 2

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CORONA CHARGING APPARATUS WITH MEANS TO URGE A FLOW OF AERIFORM FLUID ACROSS THE CORONA WIRES

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6 Claims

ABSTRACT OF THE DISCLOSURE

A corotron having a corona emitting electrode wire supported within a shield. The shield has first and second elongated openings parallel to, and on opposite sides of, the electrode wire. Means are positioned adjacent the first opening to urge a flow of aeriform fluid across the wire and out of the second opening so as to maintain the electrode wire clean. A continuous insulating surface spanning the first opening is also provided within the shield to suppress the corona discharge which would otherwise be dissipated through the shield.

This case relates to improved corona generating devices for imposing electrostatic charge on a recipient member such as a xerographic surface.

In the practice of xerography as described for example in U.S. Patent No. 2,297,691 to Chester F. Carlson, a xerographic surface comprising a layer of photoconductive insulating material affixed to a conductive backing is used to support electrostatic images. In the usual method of carrying out the process, the xerographic surface is electrostatically charged uniformly over its surface and then exposed to a light pattern of the image being reproduced to thereby discharge the charge in the areas where light strikes the surface. The undischarged areas of the surface thus form an electrostatic charge pattern in conformity with the configuration of the original light pattern.

The latent electrostatic image can then be developed by contacting it with a finely divided electrostatically attractable material such as a resinous powder. The powder is held in image areas by the electrostatic charges on the layer. Where the electrostatic field is greatest, the greatest amount of powder is deposited; and where the electrostatic field is least, little or no powder is deposited. Thus, the powder image is produced in conformity with the light image of the copy being reproduced. The powder is subsequently transferred to a sheet of paper or other surface and suitably affixed to thereby form a permanent print.

In automatic machines employing the principle of xerography, it is common to employ a xerographic plate in the form of a cylindrical drum. When the plate is formed as a drum it can be continuously rotated past a plurality of stations capable of performing the various xerographic functions in an automatic cycle of operations.

It is usual to charge the xerographic surface with corona of a positive DC polarity by means of a corona generating device having an electrode insulatively supported by a conductive shield. The charge can also be negative for some systems. When the electrode is supplied with a potential at or above the corona threshold potential for the system, a quantity of ions in the form of a corona discharge are emitted from the electrode which can deposit uniformly onto the xerographic surface.

The most common form of xerographic charging apparatus in use today is that described in U.S. Patent No.

2,836,725 to Vyverberg. This type of device includes an electrode wire or wires supported relatively close to the surface to be charged. A grounded metallic shield generally surrounds the electrode except for an elongated opening through which the charge is emitted towards the recipient surface. The shield is conductive and held at electrical ground so that the electrode wire may be readily held at potentials in excess of threshold. Since the shield is maintained at ground, most of the corona current emitted goes directly to the shield and only a small portion thereof is effective to charge the plate by movement through the opening. Small deviations in output current of such an electrode wire have little effect in varying the corona current delivered to the xerographic surface since the proportionate change in the total current for a given wire is comparatively small when the corotron is operated above threshold.

Inherent in xerographic charging apparatus of the type described above is the continuous presence of dust generated by the operation of the various xerographic processing stations. With prolonged continuous operation, it has been found that dirt, dust and extraneous toner particles accumulate on and about the interior of the corona generating apparatus to such an extent that the charging efficiency thereof is substantially decreased. Foreign particles on the corona emitting wire also vary the output current of the device. This has necessitated frequent cleaning of corotrons in xerographic machinery.

In addition to the problem associated with cleanliness, it has long been known that the dissipation of the emitted corona through the grounded shield contributes to minimized efficiency of corona generating apparatus. While the use of a grounded conductive shield allows for minimized variations in the output current, the decreased efficiency caused by the grounded shields has long been a known and accepted by-product of this type of corona generating devices.

A recent advancement in corona generating apparatus is described in U.S. Patent No. 3,324,291, issued June 6, 1967 in the name of Frederick W. Hudson. This device employs the inherently generated corona winds as a means to self-clean the electrode wire. That application further describes the use of insulating side walls on the corona shield to suppress corona emitted from the electrode wire whereby an increased proportion of the generated corona may be employed for the intended charging function. In all, improved cleanliness and increased efficiency are achieved by employing the principle of the above-referred to corotron. The instant invention is an improvement over the above-referred to device, further improving efficiency and cleanliness.

It is therefore an object of the invention to improve corona generating devices.

It is a further object of the invention to increase the efficiency of corona generating devices.

It is a further object of the invention to increase the percentage of corona emissions directed to a recipient surface while maintaining minimal corona output variations of the corona emitting source.

It is a further object of the invention to suppress the majority of corona emissions from a corona emitting source so that a greater proportion of the emitted ions are directed to a recipient surface intended to be charged.

It is a further object of the instant invention to minimize the accumulation of undesirable particles in and around a corona generating apparatus.

It is a further object of the invention to supplement the air flow created by inherent corona winds adjacent a corona source.

It is a further object of the invention to force a flow of aeriform fluid across a corona generating element through a surface capable of suppressing the corona emis-

sions in substantially all areas except the area where emission will be directed toward the recipient surface.

These and other objects of the instant invention are obtained by a corotron having a corona emitting wire supported by a suitable shield. The shield is provided with a first opening on the side of the electrode wire opposite from the surface adapted to be charged. The shield has a second elongated opening on the side of the electrode wire opposite from the first elongated opening. A conductive strip is provided adjacent the second elongated opening to act as a reference potential means for effecting directional flow of the corona discharge generally towards the second opening and toward the recipient surface to be charged.

Suitable mechanisms are also provided adjacent the first elongated opening for urging a flow of air, gas or other aeriform fluid past the electrode wire and through the second opening. This maintains the area within the shield free from contaminating particles. The majority of the space within the shield is formed with walls of an insulating material. This presents a corona suppressing surface to the electrode wires in all areas remote from the second elongated opening and surface to be charged. A properly designed orifice adjacent the first elongated opening permits this insulating surface to suppress all corona which would otherwise be directed away from the recipient surface to be charged. By this construction, corona output is only directed toward the surface to be charged for increased efficiency of the corotron.

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

FIG. 1 illustrates schematically a xerographic reproducing machine capable of continuous and automatic operation and employing the corotrons of the instant invention;

FIG. 2 is a perspective view of a corotron constructed in accordance with the principles of the instant invention;

FIG. 3 is an end cross-sectional view of a portion of a corotron illustrated in FIG. 2; and

FIG. 4 is a side elevational view of the corotron of the instant invention.

Shown in FIG. 1 there is a xerographic machine employing the corotron of the instant invention. The elements of this machine, which is constructed for continuous and automatic operation, are all conventional in the xerographic arts, except for the novel corona charging elements which form the basis of the instant invention. For the purpose of the present disclosure, the several xerographic processing stations in the path of movement of the xerographic surface may be briefly described as follows:

A charging station A, at which a uniform electrostatic charge is deposited on the photoconductive layer of the xerographic drum;

An exposure station B, at which the light or radiation pattern of copy to be reproduced is projected onto the drum surface to dissipate the charge in the exposed areas thereof to thereby leave a latent electrostatic image of the copy to be reproduced;

A developing station C, at which a xerographic developing material, including toner particles having an electrostatic charge opposite from that of the latent electrostatic image, are moved into contact with the surface, whereby the toner particles adhere to the latent electrostatic image to form a xerographic powdered image in the configuration of the copy being reproduced;

A transfer station D, at which the xerographic powder image is electrostatically transferred from the drum surface to a transfer material or support surface, and

A drum cleaning and discharge station E, at which the drum surface is electrostatically charged to neutralize any electrostatic charges remaining thereon, then brushed to

remove residual toner particles remaining thereon after the image transfer, and at which time the drum surface is exposed to a relatively bright light source to effect substantially complete discharge of any residual electrostatic charge remaining thereon.

As noted above, this machine is conventional in the xerographic arts except for the use of the improved corona charging devices which form the basis of the instant invention. Such corona charging devices may be employed, for example, at the charging, transfer, and cleaning stations. While it is disclosed that the novel charging device could be employed at all three of these stations, it should be realized that the invention of the instant application is in the charging device itself and as such could be used to any one or more of the xerographic stations without affecting the operation of the others.

As described above, the xerographic surface 10 is formed on the surface of the drum so that it can be continuously and sequentially moved past the various processing stations including the corotron 12 of the instant invention. The corotron, as more readily seen in FIGS. 2-4, includes a pair of corona emitting wires 14 mounted within a shield generally designated by numeral 16. The electrode wires are mounted within insulating supports 18 adjacent the ends 20 of the shield. Suitable connecting means 22 are provided adjacent the ends of the shield for connecting the electrode wires to a suitable source of activating potential, not shown.

According to the illustrated embodiment, the shield is constructed with a pair of end blocks 24, 26 and a center block 28 therebetween. The end blocks and center block are suitably contoured as shown in FIG. 3 to provide cavities 30 for the reception of the corona emitting electrode wires 14. Above each of the electrode wires is a first elongated opening 32 adapted for the introduction of a flow of air, a suitable gas or other suitable aeriform fluid, past the wires. Cooperating with the first elongated opening is a second elongated opening 34 adapted to permit the flow of fluid to be moved past the electrode wires towards the recipient surface to be charged. The openings are substantially parallel to the wires and preferably of the same length as the wires. When a potential is applied to an electrode wire, its associated second elongated opening 34 acts as an exit orifice for the flow of fluid and electrons emitted by the electrode wires.

As is known in the art, corona emissions have associated therewith corona winds comprised of ionized air molecules which acquire velocities such that their momentum carries the ions toward the xerographic surface to be charged. It has been determined that such a flow of air creates a vacuum on the side of the wires remote from the surface being charged. And, as described in the aforementioned Hudson patent, the air pumping action of the natural corona winds can be utilized to maintain the chamber, in which the electrode wires are located, free from contaminating particles.

It has been determined, however, that by supplementing the natural corona winds with a forced fluid flow, the cleaning action of the winds may be increased. Consequently, a wind generating chamber 36 is provided adjacent the first elongated opening 32 to effect this result.

While any suitable fan, compressor, or the like may be employed to effect this result, it has been determined that an elongated plenum chamber formed on the side of the shield remote from the recipient surface to be charged can effect a continuous and even flow of fluid along the length of the wire. According to the disclosed embodiment, this may take the form of a channel 38 having a cavity in communication with the first elongated opening. Adjacent each end of the channel, as schematically shown in FIG. 4, are compressors 40 adapted to maintain pressurized air within the cavity. In this manner, the desired supplemental flow of fluid may be continuously supplied to the corona generating elec-

trode wire. Variable capacity compressors may be employed to vary the flow rate for individual corotron units.

To insure that the fluid entering the unit is itself generally free from dust or dirt particles, there are provided grooves 42 within the shield for the reception of an air filter unit 44. A unit capable of adequately filtering fluids entering the corotron shield could include a central core of a filter media such as Aerosolde 85 or Aerosolde 95 marketed by the American Air Filter Company of Louisville, Ky. This type of an air filter offers minimum resistance to a flow of air while removing the smallest of contaminating particles from the air fed therethrough. While an air filter is disclosed as being beneficial when located in this region, the air filter could, in fact, be eliminated if a source of uncontaminated fluids could be provided by means of suitable compressors or fans.

As described in the aforementioned U.S. Patent No. 2,836,725 to Vyverberg and the aforementioned Hudson patent, it is desirable to have at least a portion of the shield formed of an electrically conductive material. By this arrangement it is possible to energize the corona wire to a potential substantially in excess of the corona threshold potential of the system for uniformity of output current.

When operating at high potentials, small differences in corona diameter or minute accumulations of dust on the wire, or changes in ambient air condition will have relatively little effect on the corona current delivered to the plate. This is because proportionate change in the total current for a given wire diameter change is comparatively negligible when the corona potential is maintained at relatively high levels.

The conductive reference potential portion of the instant embodiment is formed as an integral part of the shield designated as lips 46. It may alternatively be merely electrically conductive strips on an electrically insulating shield. Furthermore, the electrically conductive reference strips may be grounded or biased to vary the potential at which the electrode wire may be operated. The grounded shield has been illustrated here in combination with the frame. It should be understood that where sparking is not a problem, it is possible that the recipient surface itself, such as a photoconductive layer can comprise the ground field toward which the ions are attracted.

If a corona emitting wire is exposed to either a recipient surface or an electrically conductive surface on all sides thereof, the corona emissions seeking a lower potential surface will be emitted in all directions. If, however, a corona emitting wire is partially surrounded by a corona suppressing surface, such as an insulator, adjacent one portion, that portion will suppress the emissions after a period, the period being determined by the properties of the system. When suppression occurs, a greater percent of the emitted corona will be directed towards the areas away from the insulating surface.

According to the instant invention, a majority of the side walls of the blocks are covered with an imperforate layer of an insulating material 48, as for example, of polytetrafluoroethylene or the like. When a source of potential is applied to the corona emitting wire, it will emit corona discharge in the form of ions in all directions. The ions which move upwardly as shown in FIG. 3 will be accepted by the insulating surface up to the point that it has been charged to the threshold difference of the system. Upon receiving such a full charge, the insulating surface will tend to repel further emissions from the wire and thus cut off the upwardly directed flow of ions. This charge is quickly attained under normal charging conditions. Inasmuch as the wire is then emitting a flow of corona only towards the conductive lips of the block and recipient xerographic surface, an increased percent of the ion emission is being utilized for the desired charging function. It should be noted that the cross-sectional configuration of the end blocks and center blocks of the

shield are constructed so that the entire area above the corona emitting wire presents a continuous and uninterrupted corona suppressing surface. This type of a configuration minimizes the corona discharge in a direction away from the corona receiving surface to be charged for maximum use of generated ions. Similar cross-sectional configurations might be employed and still within the scope of the invention so long as the area above the corona wire acts as a corona suppressing surface.

It has been disclosed in FIGURE 3 that the corona emitting wire be positioned on a line between the interface, between the corona suppressing insulator and the lips of the conductive shield. It should be understood, however, that the insulating surfaces could be extended slightly above or slightly below such a line. The suppressing of a majority of the corona emissions in the direction away from the recipient surface still occurs.

In operation the corona generating device is set into operation by connecting the electrode wires 14 to a suitable source of potential so that a corona discharge is provided. The compressors 40 are then set into operation to cause a flow of fluid through the first elongated opening 32, past the electrode wires 14, and out of the second elongated opening 34 to supplement the natural air flow of the corona winds. A recipient xerographic surface 10 to be electrostatically charged is then moved relative to the second elongated opening for the charging thereof. Corona emissions from the electrode wire will be directed in all directions. Corona emissions moving upwardly toward the insulating surface will be received by the insulating surface 48 to bring that area up to an equilibrium potential with the electrode wire. After that point the charged insulating surface will suppress the upwardly directed emissions and cut off further electrode emissions from the wire in this direction. If the emissions were not suppressed in this area, a continuous flow of electrons away from the recipient surface 10 would occur and the efficiency of the corotron would be minimized. Corona emissions toward the conductive lips 46 and recipient xerographic surface 10 continue for a predetermined period or until the surface is charged to an equilibrium potential with the potential source. The flow of fluid across the electrode wire maintains the cleanliness of the electrode wire for minimized variations in the output rate of the electrode wire.

The rate of flow of the aeriform fluid across the wire should be higher than the inherent speed of the toner laden dust in the vicinity. When used in a commercial-type xerographic machine, a flow of air between 100 and 500 feet per minute across the electrode wires 14 was found suitable.

It has been disclosed that the instant corotron is particularly adaptable for xerographic functions. It should be understood, that it is not intended to be limited to such use. It is further envisioned that the principles of the instant invention are equally applicable to single or multiple wire corotrons. The device could also be used with a self-contained illumination source, as for example when employed at a cleaning and discharge station. In such application the air flow would help keep the illumination source clean. Furthermore, its use need not be in conjunction with a continuous and automatic machine wherein the recipient surface is moved relative to the corotron but is equally applicable to flat xerographic type plates wherein the corotron is moved relative to the recipient surface or even where there is no relative motion between the corotron and recipient surface.

While the present invention as to its object and advantages has been described herein as carried out in a specific embodiment thereof, it is not desired to be limited thereby; but it is intended to cover the invention broadly within the scope of the appended claims.

What is claimed is:

1. In a corona emitting device of the type having an elongated electrode wire, means for connecting said elec-

trode wire to a source of corona generating potential, an electrode shield formed of side walls partially surrounding said electrode wire, a first elongated opening in said side walls, a second elongated opening in said side walls generally opposite said electrode wire from said first elongated opening and electrically conductive reference means adjacent said second opening for effecting directional flow of corona emitted from said electrode wire generally toward said second elongated opening and to exterior of the device, the improvement comprising,

means communicating with said first elongated opening to cause a flow of aeriform fluid past said electrode wire and past said second elongated opening to supplement the natural corona winds and

imperforate insulating means adjacent said side walls facing the electrode wire, said insulating means having a cross sectional configuration including elongated openings corresponding to said first and second elongated openings with the insulating means adjacent said first elongated opening being effectively overlapped when viewed from the electrode wire so as to present a continuous corona suppressing insulating surface across said first opening.

2. The apparatus as set forth in claim 1 wherein the means communicating with said first elongated opening includes an elongated channel associated with said electrode shield adjacent said first elongated opening on the side thereof remote from said electrode wire and further including means associated with said channel to increase the pressure within the channel to a pressure above the ambient air pressure.

3. The apparatus as set forth in claim 1 wherein the insulating means include a pair of insulating sheets, one on each side wall, the sheets being physically separated by said first elongated opening but arranged to appear overlapped when viewed from the electrode wire so as to present a unitary corona suppressing surface across said first opening.

4. The apparatus as set forth in claim 3 wherein said insulating sheets extend towards said second elongated opening to termination points wherein said termination points and the electrode wire are substantially within a common plane.

5. The apparatus as set forth in claim 4 wherein the portion of the side walls between said termination points

and the second elongated opening constitutes said electrically conductive reference means for maintaining a directional flow of emitted corona.

6. In a corona emitting device of the type having a pair of elongated electrode wires, means for connecting said electrode wires to a source of corona generating potential, electrical shields partially surrounding each of said electrode wires, said shields being formed of elongated side blocks and an elongated center block therebetween, first elongated openings between said side blocks and said center block, second elongated openings formed between said side blocks and said center block generally opposite said electrode wires from said first elongated openings and electrically conductive reference means adjacent said second openings for effecting directional flow of corona emitted from said electrode wires generally towards said second elongated openings and to exterior of the device, the improvement comprising,

means communicating with said first elongated openings to cause flows of aeriform fluid past said electrode wires and past said second elongated openings to supplement the natural corona winds, and

imperforate insulating members adjacent said side blocks and center block facing the electrode wires, said insulating means having cross sectional configurations including elongated opening corresponding to said first and second elongated openings with the insulating means adjacent said first elongated openings being effectively overlapped when viewed from the electrode wires so as to present continuous corona suppressing insulating surfaces across said first openings.

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