United States Patent

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[73] Assignee **RCA Corporation**

[54] **ELECTROSTATIC CHARGING APPARATUS WITH MEANS TO BLOW ELECTROSTATIC CHARGE ONTO A PHOTOCONDUCTIVE SURFACE FROM A REMOTELY LOCATED CORONA GENERATOR**
5 Claims, 2 Drawing Figs.

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[50] **Field of Search** ..... 250/49.5(61); 49.561; 346/74 (ES)

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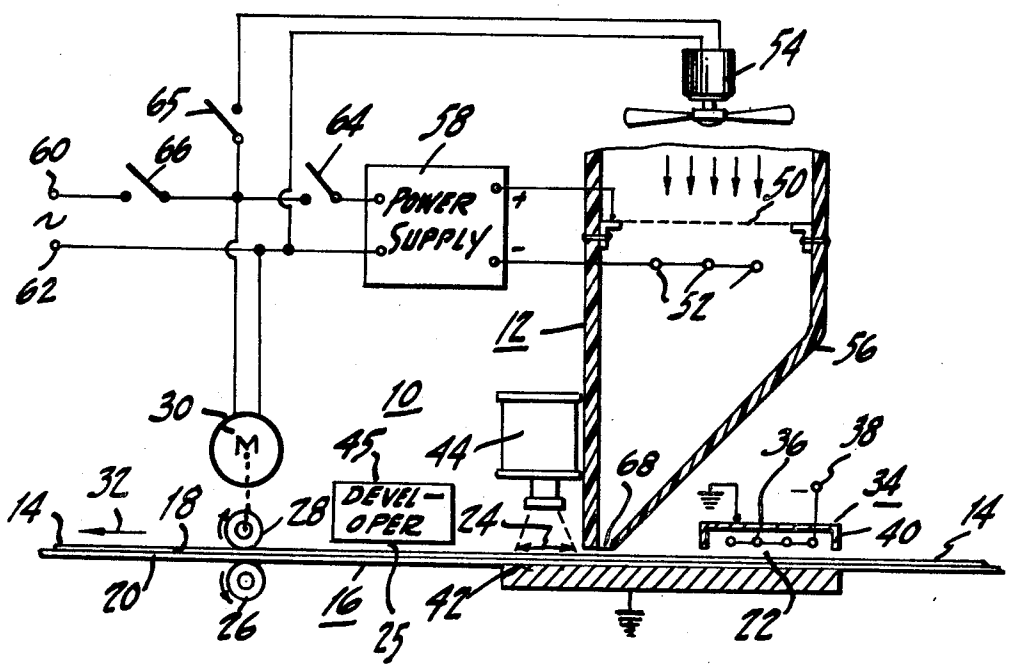
ABSTRACT: An insulating surface, such as the surface of a photoconductive layer of an electrophotographic recording element, is provided with an electrostatic charge by a method comprising (1) charging a gas (air) with a corona discharge device at a location relatively remote from the insulating surface, and (2) blowing the charged gas to the insulating surface at a desired location. Apparatus for charging the insulating surface comprises a conduit disposed between electrodes of a corona discharge device and the insulating surface at the desired location. Blower means blow the charged gas through the conduit to the insulating surface.



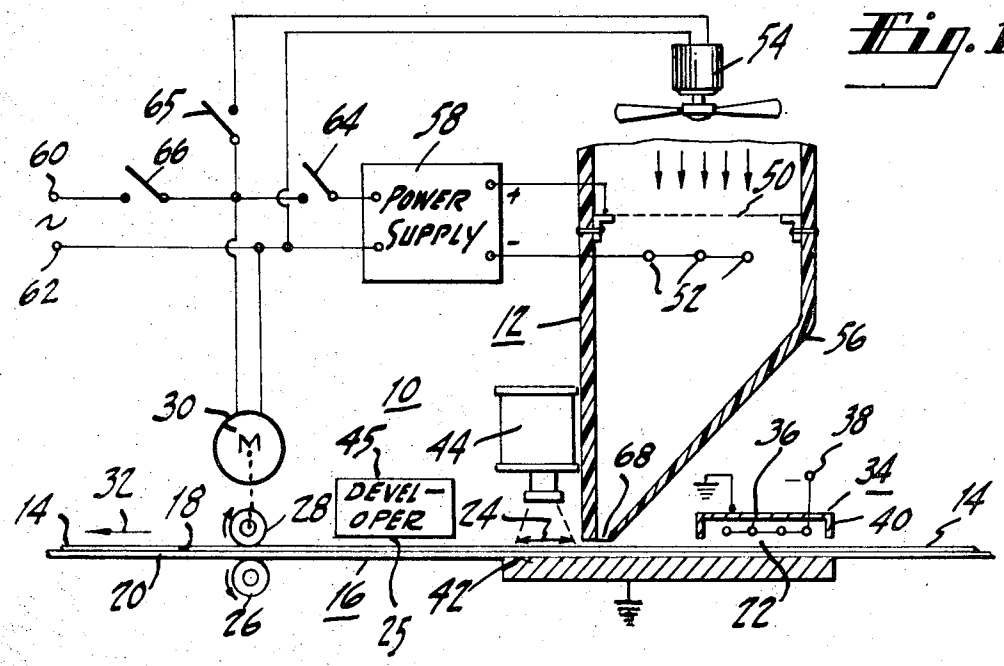


Fig. 1.

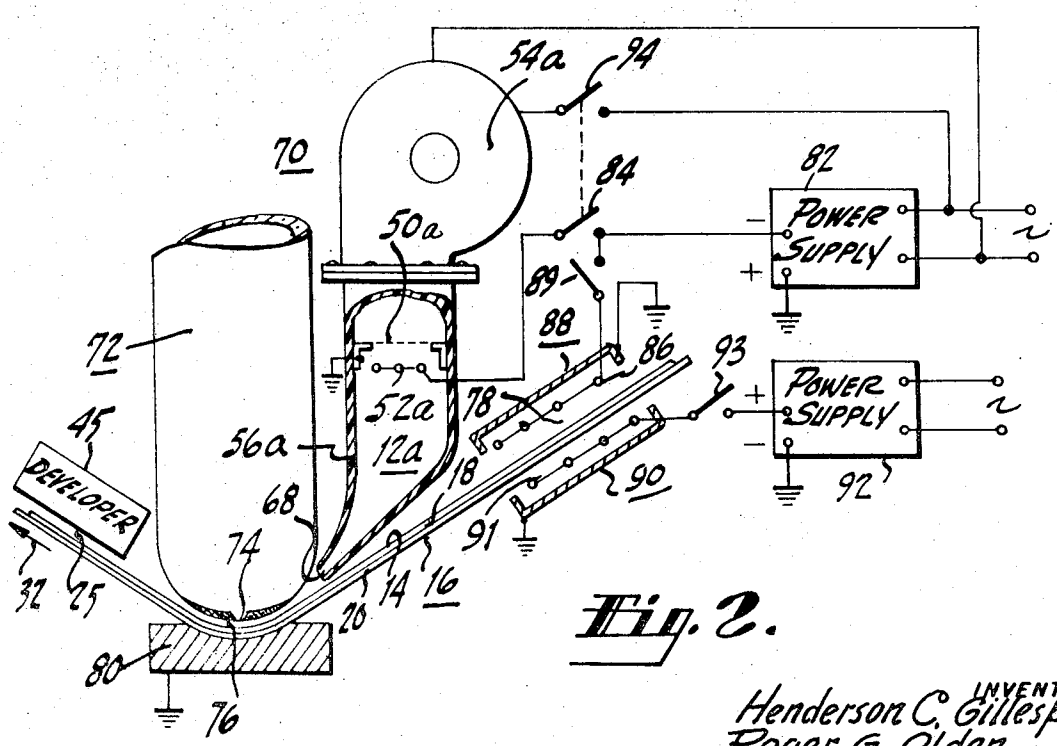


Fig. 2.

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ELECTROSTATIC CHARGING APPARATUS WITH MEANS TO BLOW ELECTROSTATIC CHARGE ONTO A PHOTOCONDUCTIVE SURFACE FROM A REMOTELY LOCATED CORONA GENERATOR

BACKGROUND OF THE INVENTION

This invention relates generally to electrostatic charging, and more particularly to improved apparatus for, and an improved method of, generating electrostatic charges and applying them to an insulating surface at a desired location relatively remote from the charge generating source.

In many electrostatic printing systems of the type wherein a continuous web of an electrophotographic recording element is moved simultaneously past a charging station and exposure station, it is desirable that the distance between these stations be as short as possible. Unless this were so, the electrostatic charge on the portion of the web between the charging and exposure stations would either decay to a useless value or be entirely dissipated if the printing system were shut down for some time. Since nothing can be printed on the discharged portion of the web when the system is started again, the discharged portion represents a loss of the recording element. Also, in electrostatic printing systems of the demand type, wherein it is necessary for the recording element to be available substantially instantly on demand, the aforementioned portion of the web between the charging and exposure stations may have lost enough of its original electrostatic charge during a waiting (nondemand) period so that it is not available for substantially instant exposure, again representing a waste of material and a loss of both information and time. The length of the portion of the web of recording element between the charging and exposure stations, however, is greater than usually desired because of the bulkiness of the parts in conventional, prior art, electrophotographic printing systems.

The improved electrostatic charging method and apparatus described herein provide an electrostatic charge on demand on the insulating surface of the recording element at a location immediately adjacent the exposure station, thereby eliminating or substantially reducing the aforementioned disadvantages of prior art electrostatic printing systems.

SUMMARY OF THE INVENTION

Briefly stated, the improved method of charging a surface at a desired location comprises (1) charging a gas relatively remote from the desired location, and (2) blowing the charged gas to the desired location. The improved apparatus comprises a conduit disposed between a pair of electrodes and the desired location relatively remote from the electrodes. When the electrodes are suitably energized, they produce a corona discharge in the ambient gas, charging the latter. Blower means are disposed to blow the charged gas through the conduit to the surface to be charged at the desired location.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view of a portion of one type of electrostatic printing system, some parts being in cross section and some partly schematic, showing one embodiment of improved electrostatic charging means; and

FIG. 2 is a view of a portion of another type of electrostatic printing system, some parts being in cross section and some partly schematic, showing another embodiment of improved electrostatic charging means for charging the insulating surface of a web of a recording element at a location adjacent an exposure station provided by a cathode ray tube.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown an electrostatic printing system 10, employing one embodiment of improved electrostatic charging means 12. The electrostatic printing system 10 is of a type adapted to provide an electrostatic latent image on an insulating surface 14 of a recording element 16. The recording element 16 is a continuous web of sheet material which comprises a relatively insulating photoconductive layer 18, such as zinc oxide in a suitable binder, on a relatively conductive backing 20, such as paper.

The recording element 16 is pulled from a source of supply (not shown) past an electrostatic charging station 22, a charge-pattern forming station, hereinafter called an exposure station 24, and a developing station 25 by a pair of opposed pressure rollers 26 and 28. The roller 28 is mechanically coupled to an electric motor 30 for pulling the paper in a direction indicated by an arrow 32. The travel of the recording element 16 may be either continuous or intermittent.

A corona discharge device 34 is disposed over the recording element 16 at the charging station 22 so that a wire electrode 36 of the device 34 is disposed about one-half inch from the insulating surface 14 of the recording element 16. The corona discharge device 34 is energized by a suitable source of a unidirectional voltage whose negative terminal is connected to a negative terminal 38 of the device 34, and whose positive terminal is grounded, as is the shield 40 of the device 34. Thus, when the corona discharge device 34 is energized, a substantially uniform negative charge is deposited on the surface 14 at the charging station 22. The backing 20 of the recording element 16 rests on a grounded, electrically conductive plate 42 that extends between the charging station 22 and the exposure station 24.

Means are provided to form a charge pattern, such as a latent electrostatic image, on the previously uniformly charged insulating surface 14 at the exposure station 24. To this end, a light-image projector 44, such as a photographic enlarger, for example, is disposed over the recording element 16 at the exposure station 24 and adapted to project a series of light images successively onto the charged surface 14 as it moves past the exposure station. Thus, a series of latent electrostatic images are formed on the surface 14 as a result of discharging the previously imparted, uniform electrostatic charge selectively through the photoconductive layer 18 in proportion to the light intensities of the projected images. The latent electrostatic images may be developed at the developing station 25 by any toning and fixing means 45 known in the electrostatic printing art.

It has been observed that, in the absence of the improved charging means 12, hereinafter to be described, any electrostatic charge deposited on the insulating surface 14 between the charging station 22 and the exposure station 24 would decay rapidly and eventually disappear if the motion of the recording element 16 were stopped for even a few minutes. Hence, no satisfactory charge patterns would be formed on this discharged portion of the recording element 16 when this portion eventually passed through the exposure station 24. This portion of the recording element 16 would, therefore, be wasted every time the electrostatic printing system was stopped, in the absence of the improved charging means 12.

The improved charging means 12 is adapted to provide an electrostatic charge on the insulating surface 14 immediately adjacent the exposure station 24 so that substantially no portion of the recording element 16 would be wasted if the electrostatic printing system 10 were stopped. The improved charging means 12 comprise a pair of electrodes 50 and 52, a blower 54, and a conduit 56, such as a tubular member of insulating plastic material open at both ends. The electrode 50 comprises a piece of metallic screen material, such as a metal screen of about 40 to 60 mesh. The electrode 50 is supported within the conduit 56, by any suitable means, at a location relatively remote from the exposure station 24 and is connected to the positive output terminal of a power supply 58. The power supply 58 should provide a unidirectional output voltage of at least 6,000 volts. The electrode 52 comprises a relatively thin wire electrode connected to the negative output terminal of the power supply 58. The thin wire of the electrode 52 is adapted to produce electrical charges when employed in a corona discharge device. The polarity of the charges depend upon the polarity of the output terminal of the voltage source connected to the electrode 52.

The input terminals of the power supply **58** are connected to terminals **60** and **62** of a suitable power source through serially-connected switches **64** and **66**. The blower **54** is connected in parallel with the input terminals of the power supply **58** through switches **64** and **65**. The motor **30** is connected to the power source terminals **60** and **62** through the switch **66**.

The electrodes **50** and **52** comprise a corona discharge device which, when energized by the power supply **58**, produces a corona discharge in the gas (air) between the electrodes **50** and **52**, thereby charging the ambient gas. The polarity of the charge of the charged ambient gas is predominantly that of the polarity of the onput terminal of the power supply connected to the wire electrode **52**. The wire electrode **52** should be connected to the negative output terminal of the power supply **58**, as shown, to charge the surface **14** of the layer **18** negatively when the layer **18** is of zinc oxide. The corona discharge device **34** can be energized either from the power supply **58** or from a separate power supply, as desired.

The blower **54** communicates with the conduit **56** and is disposed, by any suitable means, adjacent an open end of the conduit **56** above the screen electrode **50**. When energized, the blower **54** is adapted to blow the air charged by the corona discharge between the energized electrodes **50** and **52**, through the conduit **56** and onto the insulating surface **14** at a location immediately adjacent the exposure station **24**. The conduit **56** has an elongated lower opening **68** adjacent to both the insulating surface **14** and the exposure station **24** so that the charged air can impinge upon the insulating surface **14** at this location for charging the surface **14**. The opening **68** extends perpendicularly to the direction of travel of the recording element **16**.

The improved charging means **12** operates in the electrostatic printing system **10** as follows: The electrostatic system **10** is started by closing the switches **64**, **65**, and **66**. This action (**1**) moves the web of the recording element **16** in the direction of the arrow **32**, (**2**) provides a corona discharge between the electrodes **50** and **52** to charge the ambient air therebetween, (**3**) causes the blower **54** to blow the charged air through the conduit **56** and through the opening **68** therein, (**4**) applies the charged air onto the insulating surface **14** at a location substantially adjacent the exposure station **24**, and (**5**) causes the blower to force the recording element **16** into good electrical contact with the grounded plate **42**. Thus, the insulating surface **14** of the recording element **16** is provided with a uniform electrostatic charge at a location where it can be exposed substantially immediately by images from the light-image projector **44**. The electrodes **50** and **52** of the charging means **12** may be about 5 inches, for example, from the surface **14** of the recording element **16** to be charged.

The conventional corona discharge device **34** may be energized from its own power supply (not shown) when the motor **30** is started, and the switches **64** and **65** may be opened to deenergize the power supply **58** and the blower **54** after the insulating surface **14** of the recording element **16** that has been charged by the corona discharge device **34** has reached the exposure station **24**, thereafter obviating the need for the improved charging means **12**.

Thus, the electrostatic printing system **10** may be operated with the electrostatic charging provided by either the improved charging means **12** alone or the combination of the improved charging means **12** and the conventional, corona discharge device **34**. The operation of the improved charging means **12** is necessary, however, to prevent waste and to provide a charged surface for substantially instant exposure every time the electrostatic printing system **10** is started.

The blower **54** may be operated independently of the power supply **58** through the switch **65**. Such operation is desirable because the stream of air provided by the blower **54** also functions to force the recording element **16** into good electrical contact with the plate **42**. Such action is important for the formation of good electrostatic images at the exposure station **24**.

Referring now to FIG. **2**, there is shown another electrophotographic printing system **70** using another embodiment of improved charging means **12***a*. The electrophotographic printing system **70** (FIG. **2**) differs from the system **10** (FIG. **1**) primarily in the charge-pattern forming means. Analogous parts with substantially similar functions in the systems **10** and **70** are designated by similar reference numerals. Where analogous parts differ in form, one is distinguished from the other by a reference letter.

The light-image projector in the electrophotographic printing system **70** is a cathode ray tube **72** having an elongated phosphor screen or face **74**. The face **74** extends perpendicularly to the direction (arrow **32**) of travel of the recording element **16**. Light images are formed on the face **74** by an electron beam in response to signal receiving equipment (not shown) in a manner well known in the art. An exposure station **76** is adjacent the face **74** of the cathode ray tube **72**. The recording element **16** in the system **70** is pulled past a charging station **78** and the exposure station **76**, in the direction of the arrow **32**, by any suitable drive means, such as those described, for example, for driving the recording element **16** in the system **10** in FIG. **1**. The backing **20** of the recording element **16** is kept in contact with a grounded plate **80**, at the exposure station **76**, in a manner to be hereinafter described.

The charging means **12***a* in the system **70** (FIG. **2**) is substantially similar to the charging means **12** in the system **10** (FIG. **1**). The wire electrode **52***a* is connected to the negative terminal of a power supply **82** through a switch **84**. The negative terminal of the power supply **82** is also connected to a wire electrode **86** of a corona discharge device **88**, through a switch **89**. The positive terminal of a power supply **82** is grounded, as is the screen electrode **50***a* of the charging means **12***a*.

A corona discharge device **90** is arranged to form a double corona discharge arrangement with the corona discharge device **88**. A wire electrode **91** of the corona discharge device **90** is connected to the positive terminal of a power supply **92**, through a switch **93**. The negative terminal of the power supply **92** is grounded, as are the shields of the corona discharge devices **88** and **90**. Each of the power supplies **82** and **92** is energized from a suitable input voltage source and is adapted to provide a unidirectional voltage of at least 6000 volts.

The blower **54***a*, in FIG. **2**, is energized from the input voltage source to the power supply **82**, through a switch **94**. The switches **84** and **94** may be ganged for simultaneous operation of the blower **54***a* and energization of the electrodes **50***a* and **52***a*.

In operation, the recording element **16** is moved, either continuously or intermittently, in the direction of the arrow **32**. The corona discharge devices **88** and **90** are energized by the power supplies **82** and **92** through switches **89** and **93**, respectively, and the corona discharge device formed by the electrodes **50***a* and **52***a* in the charging means **12***a* is energized through the switch **84**. The blower **54***a* is started by closing the switch **94**. The ambient air between the electrodes **50***a* and **52***a* is charged negatively by the resulting corona discharge and is blown by the blower **54***a*, through the conduit **56***a* and onto the insulating surface **14** at a location substantially adjacent the exposure station **76**.

The charged air blown through the opening **68** at the bottom of the conduit **56***a*, in addition to charging the surface **14**, forces the recording element **16** against the grounded plate **80**. This action maintains the recording element **16** a very short distance away from the face **74** of the cathode ray tube **72**, thereby preventing frictional wear on the face **74** that may otherwise be caused by the movement of the recording element **16** thereover.

After the system **70** has been rendered operative and the portion of the recording element originally between the exposure station **76** and the charging station **78** has passed the exposure station **76**, the switch **84** may be opened, inactivating the electrodes **50***a* and **52***a*. Under these conditions, the surface **14** of the recording element **16** is charged by the corona discharge devices **88** and **90**.

The blower **54a** alone may, however, remain activated to provide a stream of air between the face **74** of the cathode ray tube **72** and the recording element **16**. Thus, the stream of air provides two functions, keeping the recording element **16** in good electrical contact with the plate **80**, and separating the recording element from the face **74** of the cathode ray tube **72**. The first of these functions provides good electrostatic image formation at the exposure station **76**, and the second of these functions prevents undue wear on the face **74** of the tube **72**. The latent electrostatic images formed on the recording element **16** can be toned at the developing station **25** by any suitable developing means **45** known in the electrostatic printing art.

We claim:

1. Apparatus for imparting an electric charge to an electrophotographic recording element disposable at a charging station in an electrophotographic printing machine, said apparatus comprising:

gas charging means disposed at a location remote from said charging station for charging gas thereat;

conduit means communicating between said location and said charging station, said conduit means comprising a first portion of relatively large cross-sectional area at said location for housing said gas charging means and a second tapered portion of relatively much smaller cross-sectional area formed with an elongated narrow opening adjacent said charging station; and

blower means for blowing charged gas from said location through said conduit means to said charging station and upon said recording element.

2. In an electrostatic system for producing a charge-pattern on an insulating surface of a recording element, the combination of:

means including an electrically conductive plate to support said recording element at a charge-pattern forming station;

a corona discharge device having a pair of electrodes disposed at a location remote from said station and adapted to charge ambient air between said electrodes with an electrostatic charge of substantially one polarity when energized by a voltage of sufficient amplitude to produce a corona discharge,

a conduit communicating between said electrodes and said insulating surface at a desired location substantially adjacent said station, said conduit comprising a tubular member having a first portion of relatively large cross-sectional area for housing said pair of electrodes and a second portion tapered to an elongated narrow opening adjacent said station;

said plate also supporting said recording element at said location; and

means to blow said charged air through said conduit to said desired location, whereby to charge said insulating surface at said desired location, and to blow said recording element into good contact with said plate.

3. In an electrostatic printing system wherein a web of a recording element, having a relatively insulating photoconductive layer on a relatively conductive backing, is moved adjacent to the face of a cathode ray tube at a charge-pattern forming station, the improvement comprising:

an electrically conductive plate adjacent to said face and adapted to contact said backing of said recording element, said photoconductive layer facing said face;

a corona discharge device having a pair of electrodes remote from said station and adapted to produce a corona discharge in a gas between said electrodes to charge said gas when said device is electrically energized;

a conduit communicating between said electrodes and the surface of said photoconductive layer at a location substantially adjacent said station, said conduit having a first portion for housing said pair of electrodes therein and a second tapered portion having an elongated narrow opening adjacent said location and extending transversely across said layer;

said plate also supporting said recording element at said location; and

a blower to blow said charged gas through said conduit to said location, whereby to charge said surface of said photoconductive layer at said location, to blow said conductive backing into good electrical contact with said plate and to provide a slight separation between said photoconductive layer and said face of said cathode ray tube.

4. In an electrostatic printing method of the type wherein a surface of a photoconductive layer of a recording element is first electrostatically charged and then exposed to a light image to produce an electrostatic latent image the improvement of applying an electrostatic charge to said surface at a desired location, comprising:

charging a gas in a space of relatively large volume and cross-sectional area remote from said desired location with an electrostatic charge of a desired polarity; and

blowing said charged gas while concentrating it into a narrow stream of relatively smaller cross-sectional area to said surface at said desired location.

5. Electrophotographic printing apparatus comprising:

means for supporting an electrophotographic recording element at an exposure station;

gas conduit means having a relatively large cross section at one end, and a relatively smaller cross section at the other end;

a relatively large gas charging means which is larger than said relatively small cross section disposed in the lager end of said conduit means; and

blower means for blowing gas charged by said charging means through said conduit means and out the smaller cross section end thereof;

said conduit means being disposed with the larger end thereof together with said gas charging means remote from said exposure station and with the smaller end thereof adjacent to said exposure station, said smaller end by virtue of its relatively small size being spaced closer to said exposure station than could said relatively large charging means because of its relatively large size be spaced from said exposure station in the absence of said conduit means, whereby gas can be charged remote from said exposure station and blown through said conduit means to within close proximity of said exposure station.