Feb. 25, 1964 P. F. KING 3,122,634

CONTROLLED CHARGING IN XEROGRAPHIC COPYING APPARATUS

Filed April 4, 1962 3 Sheets-Sheet 1

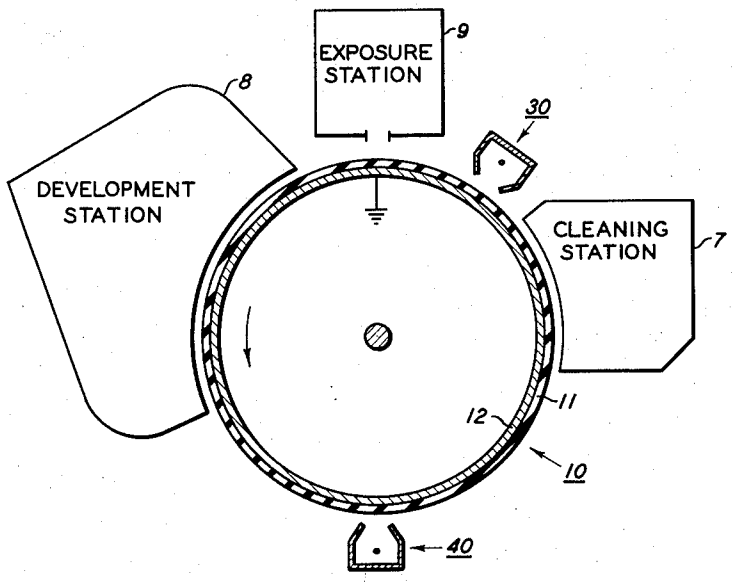


FIG. 1

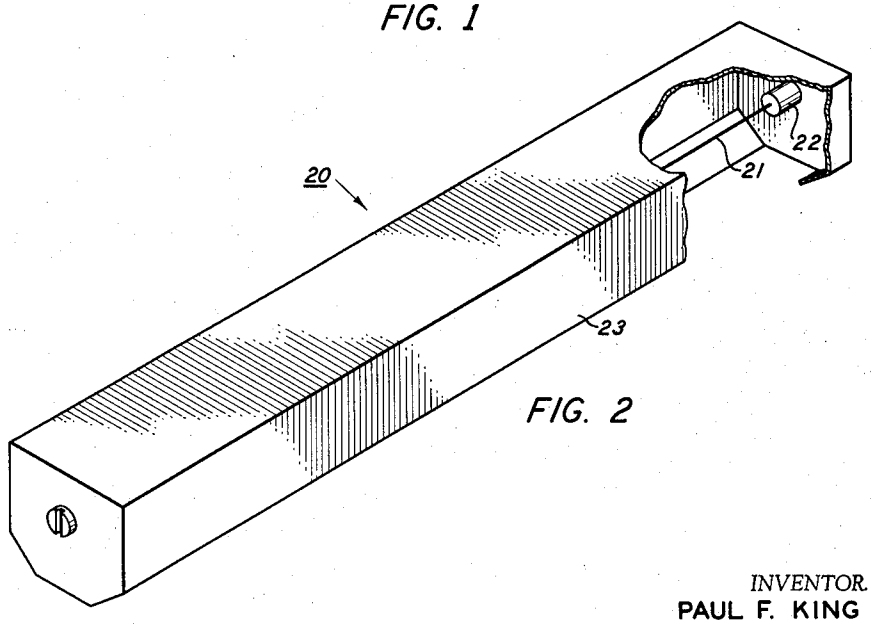


FIG. 2

INVENTOR.
PAUL F. KING

BY Stanley Z Polo

ATTORNEY

CONTROLLED CHARGING IN XEROGRAPHIC COPYING APPARATUS

Filed April 4, 1962 3 Sheets-Sheet 2

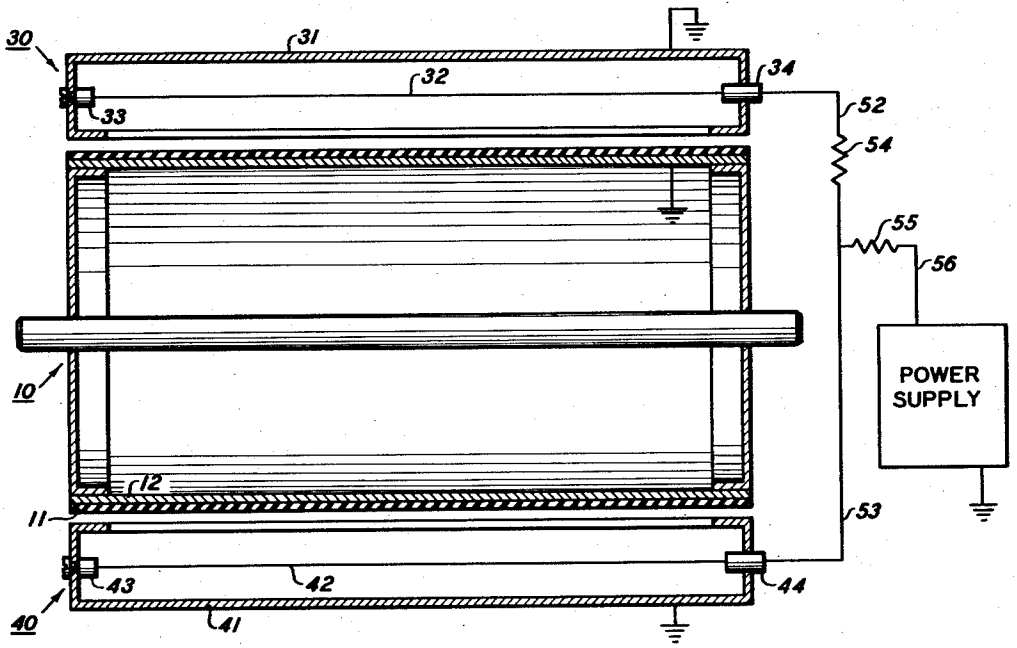


FIG. 3

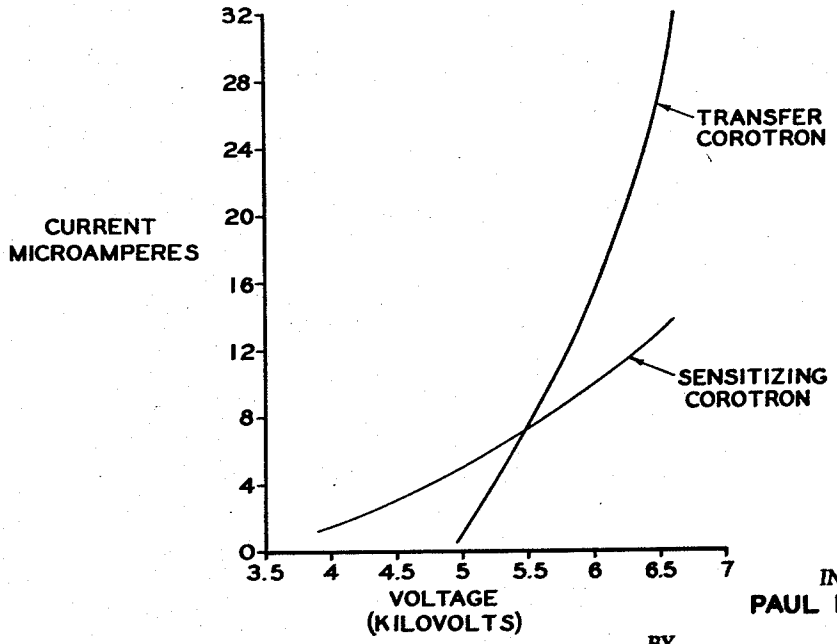


FIG. 4

INVENTOR
PAUL F. KING
BY Stanley Z Pole
ATTORNEY

Feb. 25, 1964 P. F. KING 3,122,634

CONTROLLED CHARGING IN XEROGRAPHIC COPYING APPARATUS

Filed April 4, 1962 3 Sheets-Sheet 3

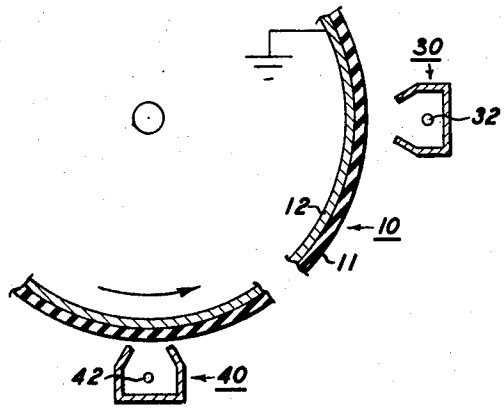


FIG. 5

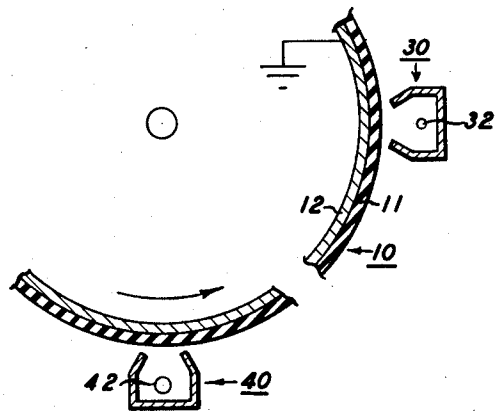


FIG. 6

INVENTOR.
PAUL F. KING

BY Stanley Z Cole
ATTORNEY

United States Patent Office

3,122,634

Patented Feb. 25, 1964

3,122,634
CONTROLLED CHARGING IN XEROGRAPHIC COPYING APPARATUS

Paul F. King, Webster, N.Y., assignor to Xerox Corporation, Rochester, N.Y., a corporation of New York

Filed Apr. 4, 1962, Ser. No. 185,050
4 Claims. (Cl. 250—49.5)

This invention relates to xerography in general and, more particularly, to the sensitization of xerographic plates.

In xerography a uniform electrostatic charge is deposited on the surface of a xerographic plate comprising a photoconductive insulating layer supported by a conductive backing layer. Exposure to an optical image selectively dissipates the charge in the light-struck areas, thus producing an electrostatic charge pattern in image configuration. An appropriate development process, such as dusting with an electroscopic powder which adheres to the charged areas, renders the latent image visible. This powder image may then be transferred to a material such as paper by placing the material in face-to-face contact with the powder image and applying electrical charge to attract the powder to the material surface. This copy may then be rendered permanent by fixing such as by heat fusing.

The general process described has been successfully adapted to a system of continuous xerographic copying comprising a number of sequential steps. Apparatus for this system includes a cylindrical drum, made up of a conductive backing having coated thereon a photoconductive insulating layer, which is rotated on its longitudinal axis so that a particular surface of the drum will pass, respectively, a charging station, an exposure station, a developing station, a transfer station, and finally a cleaning station. It has been found that an electrostatic charge can be applied at the sensitizing and transfer stations in a number of ways. However, the most successful technique is to apply the charge by means of corona discharge from a wire, or a wire array, maintained at a high potential relative to the backing member supporting the photoconductive layer.

One of the general types of corona discharge units, called the corotron, and disclosed in Vyverberg U.S. Patent No. 2,836,725, consists of a flat sided U-shaped channel, having inwardly bent lips, and a single corona wire strung between insulating blocks mounted on either end of the channel. Normally, the U-shaped channel, or shield, of this unit is maintained at ground potential. The wire is fed from a high voltage source and the xerographic plate is moved relative to the wire at a uniform rate of speed to place an electrostatic charge on the plate.

Since the deposition of developer powder is sensitive to small variations in the potential on the photoconductive insulating layer and undesired variations can be caused by a non-uniformity in the initial charging, it is essential that the electrostatic charge be uniform throughout when the plate is sensitized in order to provide good quality in the finished copy. Lack of uniformity in the initial potential results in a streaky copy or other undesirable variations when the photoconductive layer is dusted with developer powder. This defect is particularly noticeable in the reproduction of continuous tone subjects such as photographs.

Even though considerable effort may be made to prevent charge irregularities by, for instance, assuring a constant rate of travel of the plate relative to the charging device, eliminating variations in the photoconductive layer itself, or by eliminating the effect of non-uniformity

in the corotron wire by moving the corotron with respect to the xerographic plate in two or more directions, variations of the high voltage feeding the corotron may nevertheless cause charge irregularity. Accordingly, some means of voltage regulation is generally necessary to adequately minimize these power supply variations. This has generally been attempted through the use of additional circuit components which necessarily increase the overall cost and complexity of the xerographic copying apparatus.

On the other hand, the need for uniformity of the charge laid down by the corotron at the transfer station is not critical. A comparatively wide range of variation does not deleteriously affect the quality of the xerographic copy.

It has been found that a corotron can be designed so that it will display a very steep current-voltage characteristic. Thus, a small increase in voltage causes a disproportionately large increase in current flow. Basically, this invention utilizes the electrical characteristics of an appropriately designed corona discharge device as a means to maintain the voltage fed into the sensitizing corotron nearly constant. As herein described an appropriately designed transfer corotron is connected in parallel with the sensitizing corotron in such manner that variations in supply voltage will mainly affect the transfer corotron and have only a minimal effect on the sensitizing corotron. This invention, at the same time, obviates separate power supplies for the transfer station and the sensitizing station.

The principal object of this invention, therefore, is to provide a means to economically obtain better print quality by reducing the effect of variations in power supply voltage on the sensitizing corotron.

It is another object of this invention to provide for the elimination of one power supply in a system for continuous xerographic copying.

It is still another object of this invention to provide a means to reduce the likelihood of damage to a xerographic plate by overcharging.

Additional and further objects of this invention will be obvious to those skilled in the art and will be apparent from the following specification and the drawings in which:

FIGURE 1 illustrates schematically a preferred embodiment of a xerographic apparatus adapted for continuous operation;

FIGURE 2 is an isometric view of a corotron of the type comprising the sensitizing station and transfer station of FIGURE 1;

FIGURE 3 shows a side view of the xerographic drum and the corotrons comprising the sensitizing station and transfer station shown in FIGURE 1; and,

FIGURE 4 is a graph showing the difference in current voltage characteristics of two corotrons.

The present invention may be used in conjunction with a continuous xerographic copying apparatus shown in FIGURE 1. A xerographic plate including a photoconductive layer **11** is coated on a conductive backing **12** and formed in the shape of a drum, generally designated by numeral **10**. Drum **10** is mounted on a shaft (not shown) journaled in a frame (not shown) to rotate in the direction indicated by the arrow to cause the drum surface sequentially to pass a plurality of xerographic processing stations described functionally as follows:

A sensitizing station, generally designated by the numeral **30** and to be described in greater detail below, at which a uniform electrostatic charge is deposited on the photoconductive layer **11** of the xerographic drum **10**;

An exposure station **9**, at which a light or radiation pattern of copy to be reproduced is projected on the

photoconductive surface 11 to dissipate the charge in the exposed areas;

A development station 8, at which electroscopic powder is applied to the drum surface by means of a magnetic brush or, for instance, by cascading toner particles over the drum surface whereby the powder particles adhere to the photoconductive layer in image configuration;

A transfer station shown as a discharge electrode generally designated 40, at which the powder image is electrostatically transferred from the drum surface to a transfer material such as paper; and,

A cleaning station 7, at which residual toner particles are removed by brushing, for instance.

In commercial appartus designed to function according to this description, it is usual for the sensitizing station and transfer station to consist of corotrons identical in all respects which are activated by separate power supplies.

FIGURE 2 shows a corotron suitable for operation according to the present invention as part of the sensitizing station or the transfer station. This assembly comprises two insulating terminal blocks 22 positioned at either end of the assembly and joined together by a conductive ground shield 23. A fine conductive strand 21 is mounted on the insulating terminal blocks and runs lengthwise of the assembly from one block to the other under the ground shield 23. This wire strand forms the corona discharge electrode and is conductively connected to a high voltage power source.

The sensitizing-transfer network comprising this invention is shown in its relationship to the xerographic drum 10 in FIGURE 3. At the sensitizing corotron generally designated 30, a corona wire 32 is centered within a grounded corona shield 31 and is supported by insulating blocks 33 and 34. Similarly, the transfer corotron 40 is made up of a shield 41 surrounding corona wire 42 which is supported by insulating blocks 43 and 44. High positive charging voltages are fed to the charging corotron and transfer corotron by branches 52 and 53, respectively, of lead 56 which is connected to the plus terminal of the power supply. Resistive circuit components are indicated by numerals 54 and 55.

In accordance with this invention a corotron possessing a very steep current-voltage or low dynamic resistance characteristic is employed as a transfer corotron. Such a corotron in the circuit of FIGURE 2 operates as a voltage regulator with respect to the sensitizing corotron in the sensitizing transfer network. Specifically, when such a corotron is used, if the power supply voltage rises, a disproportionate rise in the current flow to the transfer corotron will also occur and thereby cause a greater voltage drop across resistive circuit component 55. This greater voltage drop across resistive circuit component 55 keeps the sensitizing corotron voltage more nearly constant thus maintaining uniformity in the potential applied to the sensitizing corotron. This results in a uniform output of corona discharge from the sensitizing discharge electrode and, in turn, uniform charging or sensitizing of photoconductive layer 11 coated on conductive and grounded backing member 12 of xerographic drum 10.

Steep current-voltage characteristics may be imparted to the transfer corotron in a variety of ways. One way is to operate the transfer corotron with the corona wire 42 positioned very close to conductive backing member 12 as compared with the space between corona wire 32 and conductive backing member 12, as shown in FIG. 5. However, a more practical method and the preferred method herein of achieving this desired current-voltage characteristic is through the use of a larger diameter wire 42 in the transfer corotron unit, as illustrated in FIG. 6. Sensitizing corotrons having corona wires .0035 inch in diameter are typically used in commercial systems. In such systems, a transfer corotron having a corona wire 42 of diameter in the range of about .0065 to .0090 and preferably .0075 inch will achieve the desired result.

A comparison of the difference in current-voltage characteristics or dynamic resistance between the two corotrons so constructed is illustrated graphically in FIGURE 4. The appreciably steeper current-voltage curve relating to the transfer corotron clearly indicates its suitability for utilization in the network shown in FIGURE 3. As illustrated by this curve, the voltage drop across the transfer corotron would remain nearly constant even though appreciable variations in current flow were to occur. Effective voltage regulation is thus afforded the sensitizing corotron branch which is connected in parallel with the transfer corotron and fed from the same power supply.

As described above, resistive component 55 serves to convert the changes in current drawn by transfer corotron 40 into changes in potential to maintain the sensitizing corotron potential uniform. Substantial changes in transfer corotron current are to be expected with this invention, but transfer current, unlike sensitizing current, is not critical. Although the transfer corotron has a lower dynamic impedance than the sensitizing corotron, it is generally operated at a potential higher than that desirably applied to the sensitizing corotron. Resistive circuit component 54 may optionally be included as shown to lower the potential applied to the sensitizing corotron from that applied to the transfer corotron. As is known, this resistive component will also make the sensitizing corotron current less dependent upon the transfer corotron potential which is inherently quite uniform in view of this invention. Resistive circuit components 54 and 55 may be selected in accordance with the characteristics of the particular power supply and corotrons which are to be used, and element 54 may be omitted in some cases. Typical values for use with the illustrated corotrons are 70 megohms for element 55 and 150 megohms for element 54. Sensitizing plate potentials obtained with these components as compared with the conventional arrangement whereby a plate is sensitized by a corotron directly connected to its individual power supply shown in the table.

Input to Power Supply	Unregulated		Regulated	
	Plate Voltage	Change, percent	Plate Voltage	Change, percent
Normal input voltage	600		600	
90% of normal input voltage	440	−27	550	−8.3
110% of normal input voltage	740	+23	650	+8.3

It can be seen that with prior arrangements the xerographic plate potential varied much more rapidly than the input voltage to the power supply. In accordance with this invention, however, it can be seen that the plate potential varies even less rapidly than the input voltage to the power supply.

Limitation by the specific embodiments of the invention described herein is not intended. Rather, it is intended that the invention be covered broadly within the spirit and scope of the appended claims.

What is claimed is:

1. In a continuous xerographic copying apparatus including a xerographic plate the combination comprising a first sensitizing corona device in operative relation with said plate for depositing sensitizing charge thereon, a second corona device in operative relation with said plate, said second device having a lower dynamic impedance than said first device, said second device being connected electrically in parallel with said first device, a high voltage D.C. power supply, and resistance means connected between said power supply and said first and second devices.

2. The combination according to claim 1 in which said first and second devices incorporate corona wires and in which the wire of said second device is of larger diameter than of said first device.

3. The combination of claim 1 in which said second corona device is positioned closer to the xerographic plate than said first device.

4. The combination of claim 1 further including an additional resistance means in series with said first device.

References Cited in the file of this patent

UNITED STATES PATENTS

2,944,147	Bolton	July 5, 1960
2,982,647	Carlson	May 2, 1961