United States Patent

[11] **3,619,609**

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[33] **Japan**
[31] **43/102602**

[54] **CORONA DISCHARGE DEVICE FOR ELECTROPHOTOGRAPHY EMPLOYING INTERLEAVED DISCHARGE ELECTRODE ELEMENTS AND COUNTER ELECTRODE ELEMENTS**
3 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** ..... **250/49.5 GC,** 250/49.5 ZC, 250/62, 317/262 A
[51] **Int. Cl.** **H01j 37/26**
[50] **Field of Search** ..... 250/49.5 GC, 49.5 ZC, 49.5 TC, 6 Z; 317/4, 262 A

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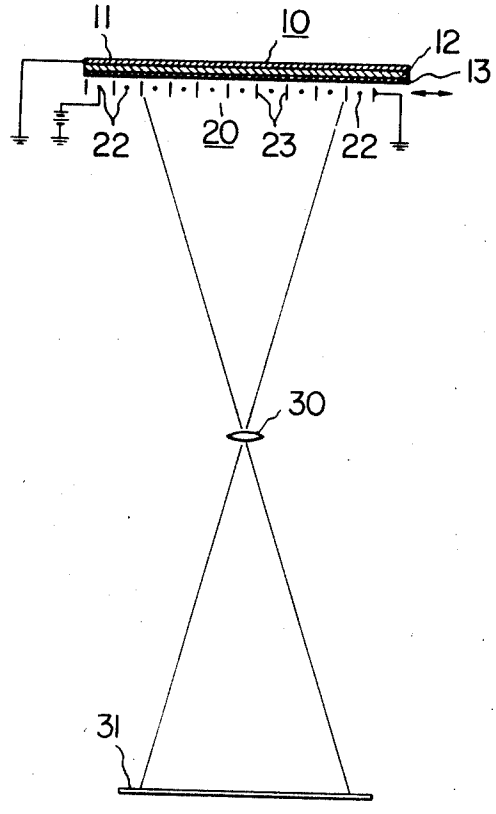
ABSTRACT: In a corona discharge device for electrophotography comprising a corona discharge electrode and a counter electrode for depositing electric charge on a photosensitive element upon which a light image is projected through the corona discharge device, both the corona discharge electrode and counter electrode are composed of parallel conductors which are moved at high speed while the light image is being projected upon the photosensitive element through the corona discharge device to eliminate the effect of the shadow thereof.



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SHEET 1 OF 2

FIG. 1

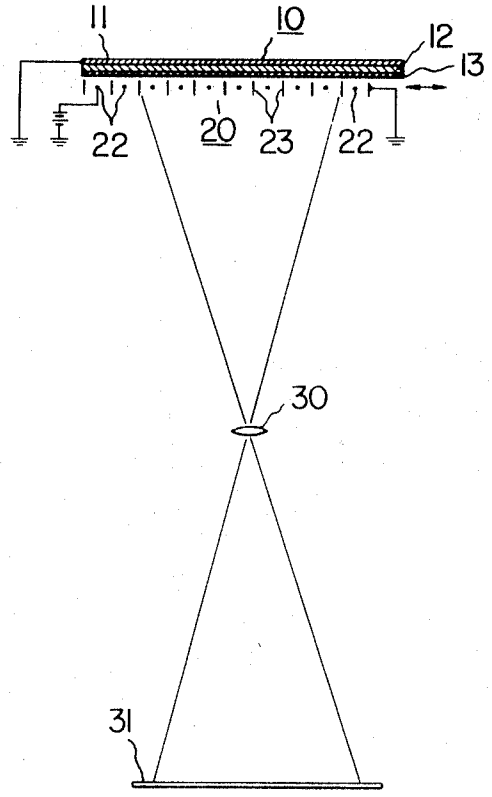

FIG. 2

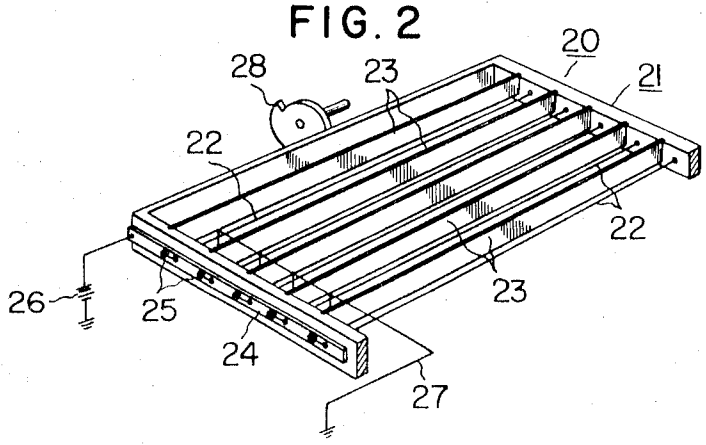

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FIG. 3

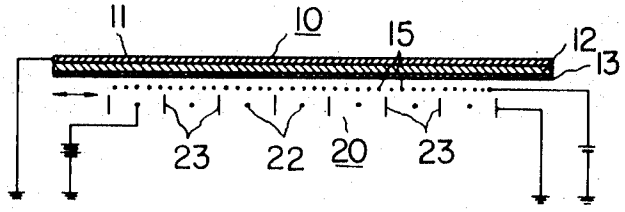


FIG. 4

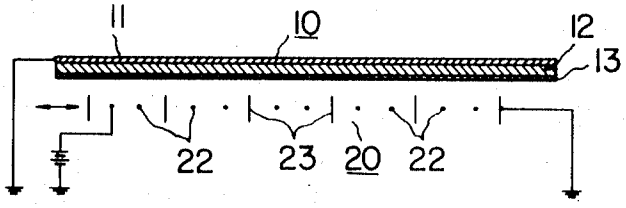


FIG. 5

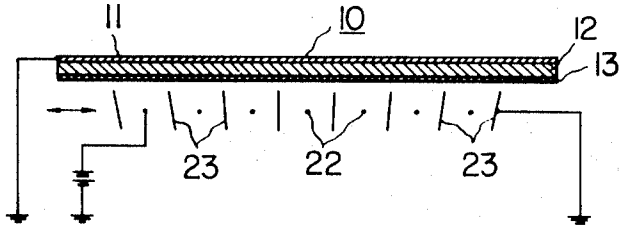
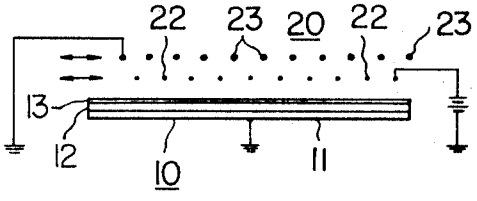


FIG. 6



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CORONA DISCHARGE DEVICE FOR ELECTROPHOTOGRAPHY EMPLOYING INTERLEAVED DISCHARGE ELECTRODE ELEMENTS AND COUNTER ELECTRODE ELEMENTS

BACKGROUND OF THE INVENTION

This invention relates to corona discharge devices for electrophotography.

As is well known in the art, various types of corona discharge devices are now widely used in the art of electrophotography to deposit electric charge, positive or negative, on the surface of photosensitive elements to form an electrostatic latent image thereon.

In one prior arrangement a photosensitive element comprising a backing electrode, a photosensitive or photoconductor layer and a transparent highly insulative layer which are integrally bonded to the backing electrode is used, and a corona discharge device is associated with the photosensitive element, comprising a plurality of parallel spaced apart fine metal wires which are arranged in a plane parallel to and spaced from the surface of the transparent highly insulative layer and a transparent counter electrode parallel to and spaced from the plane of the fine metal wires. In operation the transparent electrode is grounded, a suitable source of voltage is connected across the backing electrode and fine metal wires and across the fine metal wires and the grounded transparent electrode to create corona discharge between the fine metal wires and grounded transparent electrode so as to deposit a charge on the surface of the photosensitive element, and a light image is projected upon the photosensitive element and the corona discharge device are moved relative to each other to scan the entire surface of the photosensitive element. With this arrangement, however, the light transmissibility of the transparent counter electrode is not sufficiently high, and moreover, the surface thereof is often contaminated by the accumulation of dust. As a consequence, it is necessary always to keep clear the transparent electrode.

Another problem involved in the corona discharge electrode wherein the light image is projected upon the photosensitive element lies in the undesirable effect of shadows of fine metal wires upon the quality of the latent image or a picture developed therefrom. Although such effect can be alleviated by moving the corona discharge electrode relative to the photosensitive element, to move the corona discharge electrode across the entire surface of the photosensitive element, it is necessary to use a driving mechanism having a long stroke, which requires longer exposure time and is not suitable for high speed operation.

SUMMARY OF THE INVENTION

It is an object of this invention to eliminate the transparent electrode for the corona discharge device thus increasing the overall photosensitivity of the photosensitive element.

Another object of this invention is to provide a novel corona discharge device for electrophotography wherein the effect of the shadows of metal wires can be eliminated.

Still another object of this invention is to provide a novel corona discharge device for electrophotography wherein the effect of the shadows of the metal wires can be eliminated by a relatively small relative movement between the corona discharge electrode and the photosensitive element.

In accordance with this invention, in a corona discharge device for electrophotography comprising a corona discharge electrode and a counter electrode cooperating with the corona discharge electrode for depositing electric charge on the surface of a photosensitive element through the corona discharge, the corona discharge electrode is comprised by a plurality of spaced apart parallel fine metal wires which are supported in a common plane uniformly spaced apart form the surface of the photosensitive element, the fine metal wires are shifted or reciprocated rapidly relative to the photosensitive element in a direction perpendicular to the axes of he metal wires while the light image is being projected upon the photosensitive element through the corona discharge device.

In accordance with another feature of this invention the counter electrode is also comprised by a plurality of spaced apart conductors which are arranged in a common plane. The conductors of the counter electrode may be interleaved with the fine metal wires comprising the corona discharge electrode or may be disposed in a plane spaced apart from the plane containing the fine metal wires. In any case, the corona discharge electrode and counter electrode are moved in unison relative to the photosensitive element while the light image is being projected upon the photosensitive element through them.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a schematic sectional view of a corona discharge device embodying this invention and a manner of forming an electrostatic latent image on a photosensitive element by utilizing the corona discharge device;

FIG. 2 is a perspective view of the corona discharge device shown in FIG. l; and

FIG. 3 to 6 are schematic sectional views of modified embodiments of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The electrophotographic apparatus shown in FIG. 1 comprises a photosensitive element **10**, a corona discharge device **20** and an optical system merely shown as a lens **30** to project the light image reflected by an object **31** upon the photosensitive element through the corona discharge device.

The photosensitive element **10** comprises a thin metal layer or backing electrode **11**, a photosensitive layer **12** and a transparent highly insulative layer **13**. Layers **12** and **13** are integrally bonded to the backing electrode layer. Where the latent image is to be formed by utilizing persisting internal polarization effect provision of the highly insulative layer is essential, and the photosensitive layer **12** preferably contains a plurality of charge trap levels. On the other hand, where the latent image is to be formed by the conventional xerographic method, the highly insulative layer is not essential and the photosensitive layer **12** may be formed of a suitable photoconductor. Since any particular construction of the photosensitive element and the method of forming a latent image thereon are immaterial to this invention it is believed unnecessary to describe them in detail.

The corona discharge device **20** comprises a rectangular insulator frame **21**, a plurality of spaced apart parallel discharge electrodes in the form of fine metal wires **22** disposed in a common plane parallel to and spaced from the surface of the highly insulative layer **13** and a plurality of spaced apart grounded counter electrodes in the form of thin metal strips **23**. Wires **22** and metal strips **23** are disposed alternately and parallel with each other. Opposite ends of these wires and strips are secured to opposite sides of the frame **21**. The front ends of metal wires **22** are secured, as by screws **25**, to a conductive strip **24** mounted on the front side of the frame **21**, as viewed in FIG. **2**. The strip **24** is connected to one pole of a voltage source **26** which may be a source of DC or AC depending upon the type of the method of forming the latent image. As diagrammatically shown in FIG. **2**, strips **23** are connected to a common grounded conductor **27**.

In operation, during projection of the light image and application of a suitable potential to metal wire electrodes **22**, the insulating frame **21** and hence metal wires **22** and strips **23** are moved rapidly in the direction at right angles to the axes of metal wires **22** and strips **23** over a distance sufficient to eliminate the effect of shadows of the wires and strips. This distance is preferably equal to at least the spacing between adjacent metal wires **22** or its integral multiple. As the photosensitivity of modern photosensitive elements has improved to a point requiring an exposure time of only 0.001 sec., such high speed movement of the corona discharge electrode device with respect to

the photosensitive element can be performed by any suitable means such as a rotating cam 28 shown in FIG. 2 or an electromagnet, not shown. Moreover, as wires 22 and strips 23 are provided with relatively small spacings over the entire surface of the photosensitive element, the distance over which they must be moved at high speed is relatively short. Thus, this invention makes possible the forming of latent images at high sensitivities without being affected by the shadow of the corona discharge electrode and by the low light transmissibility of the transparent counter electrode. According to this invention, as the counter electrodes 23 are interleaved in parallel with corona discharge electrodes 22, it is not necessary to make the counter electrodes from transparent material and to frequently clean them.

In the embodiment of the invention shown in FIG. 3, a control electrode 15 consisting of a plurality of fine metal wires is disposed between the corona discharge device 20 and the photosensitive element 10. A relatively low potential is applied to the control electrode to control the deposition of electric charge on the photosensitive element. Metal wires of the control electrode are arranged in parallel with fine wires 22 and metal strips 23 of the corona discharge device 20 and are moved together therewith.

In another modification shown in FIG. 4 grounded counter electrodes 23 are interposed between every two fine metal wires 22.

While in the foregoing embodiments, all grounded counter electrodes 23 are parallel and perpendicular to the surface of the photosensitive element, in the modified arrangement shown in FIG. 5, the counter electrode at the center is perpendicular to the photosensitive element, while other counter electrodes are gradually inclined from the center toward the opposite sides of the photosensitive element so as to minimize interference to light rays projected by the optical system such as lens 30 shown in FIG. 1. Grounded counter electrodes shown in other figures may also be inclined, if desired.

Further, instead of arranging corona discharge electrodes 22 and the grounded counter electrodes 23 in the same plane, they may be disposed in different planes at different distances from the photosensitive element 10 as diagrammatically shown in FIG. 6.

We claim:

1. In a corona discharge device for electrophotography comprising a corona discharge electrode and a counter electrode cooperating with said corona discharge electrode for depositing electric charge on a photosensitive element upon which a light image is projected through said corona discharge device; the improvement which comprises a corona discharge electrode including a plurality of spaced apart parallel fine metal wires, means to support said parallel fine metal wires in a common plane uniformly means to shift said parallel fine metal wires relative to said photosensitive element in a direction perpendicular to the axes of said metal wires while said light image is being projected upon said photosensitive element through said corona discharge device, and a counter electrode comprising a plurality of substantially parallel metal strips, said strips at the center of said photosensitive element being substantially perpendicular to the surface of said photosensitive element whereas the remaining strips are inclined, the inclination gradually increasing toward the opposite sides of said photosensitive element.

2. In a corona discharge device comprising a discharge electrode and a counter electrode and used for electrophotography in which a light image is projected upon a photosensitive element through said corona discharge device concurrently with the deposition of charge on the surface of said photosensitive element, the improvement wherein said corona discharge device comprises a plurality of spaced apart parallel fine metal wires which are supported by a frame in a common plane uniformly spaced apart and parallel to he surface of said photosensitive element, a plurality of spaced apart parallel strip shaped counter electrodes supported by said frame, said counter electrodes interleaving with said metal wires and being substantially perpendicular to the surface of said photosensitive element, and means for rapidly reciprocating said corona discharge device relative to said photosensitive element in a direction substantially parallel to the surface thereof while said light image is being projected upon said photosensitive element through said corona discharge device.

3. The corona discharge device as defined in claim 2 wherein said parallel fine metal wires are spaced apart from each other by a definite spacing and said parallel fine metal wires are shifted a distance equal to at least said spacing.

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