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Takahashi

[11] **3,911,335**

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[54] **METHOD OF AND APPARATUS FOR FORMING ELECTROSTATIC LATENT IMAGES**

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[73] Assignee: **Fuji Photo Film Co., Ltd.,** Minami-ashigara, Japan

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[30] **Foreign Application Priority Data**

Sept. 7, 1973 Japan 48-100827

[52] **U.S. Cl.** ..... **317/262 A;** 250/324

[51] **Int. Cl.²** **H01T 19/00**

[58] **Field of Search** ..... 317/262 R, 262 A; 250/324, 250/325, 326; 96/1 C

[56] **References Cited**

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Primary Examiner—J. D. Miller
Assistant Examiner—Harry E. Moose, Jr.
Attorney, Agent, or Firm—Fleit & Jacobson

[57] **ABSTRACT**

An electrostatic latent image forming plate having a conductive layer on an insulating substrate is employed. The conductive layer is removed in the form of the image to be obtained to make on the insulating substrate recessed portions having an insulating bottom surface in the form of the image. The image forming plate having the insulating recessed portions is subjected to a corona discharge made by a corona charger. In the corona charging region in which the image forming plate is subjected to the corona discharge, the conductive layer is grounded by a grounding means provided in contact with the surface of the image forming plate. By the grounding means, the potential of the isolated conductive parts of the image forming plate is lowered to prevent the discharge between the isolated conductive parts. In the apparatus for forming an electrostatic latent image on the image forming plate having insulating recessed portions, grounding wires or grounding rollers which are grounded are provided in contact with a drum or an endless belt on which the image forming plate is carried so that the surface of the conductive layer of the image forming plate may be grounded thereby.

11 Claims, 8 Drawing Figures

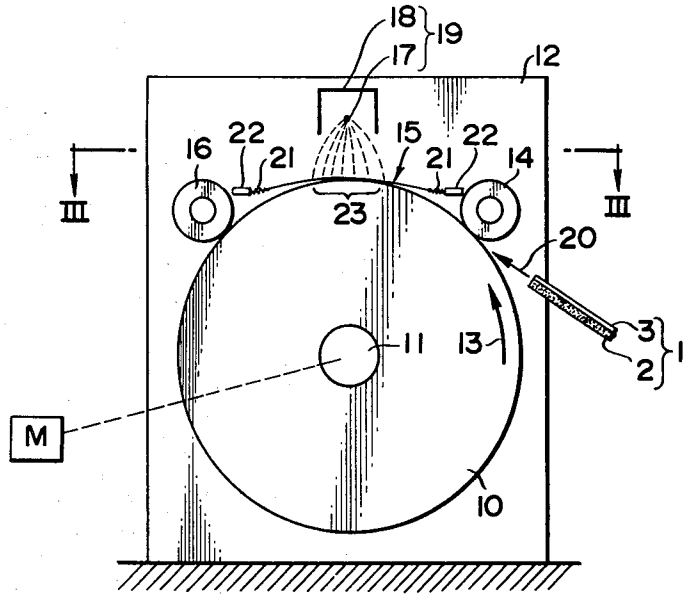


FIG. 1

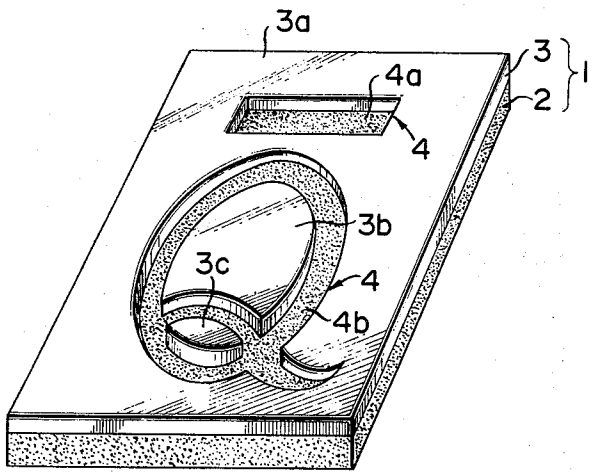


FIG. 8

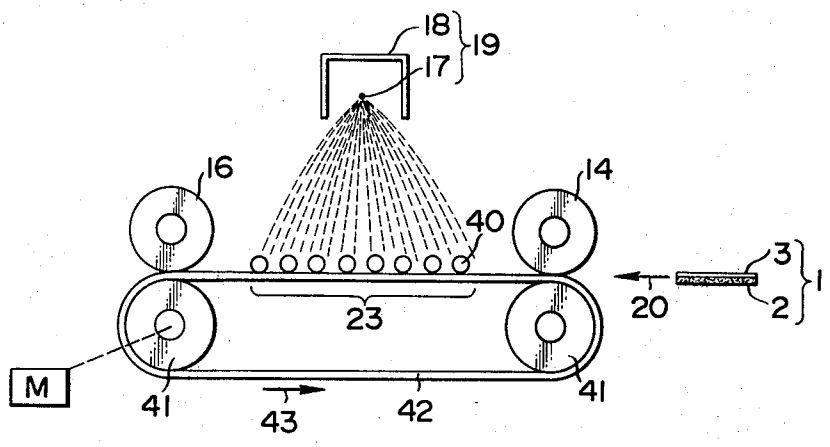
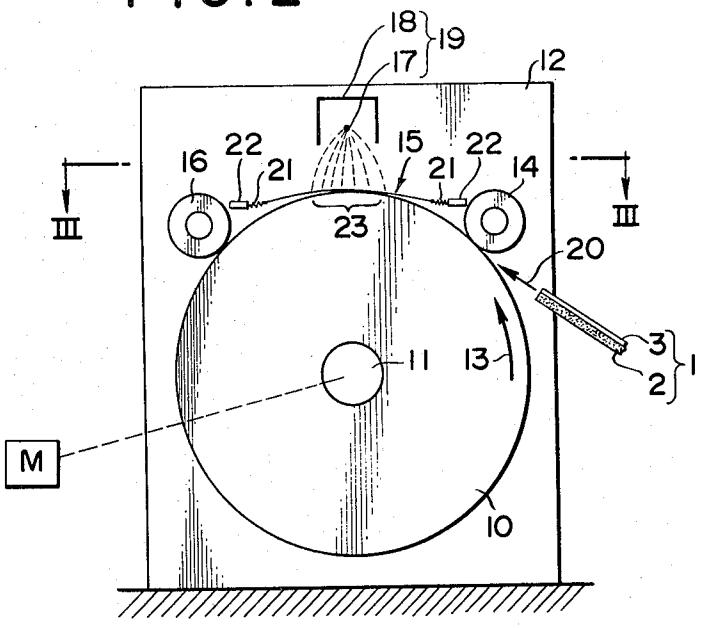


FIG. 2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15
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III
III
23
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2
1
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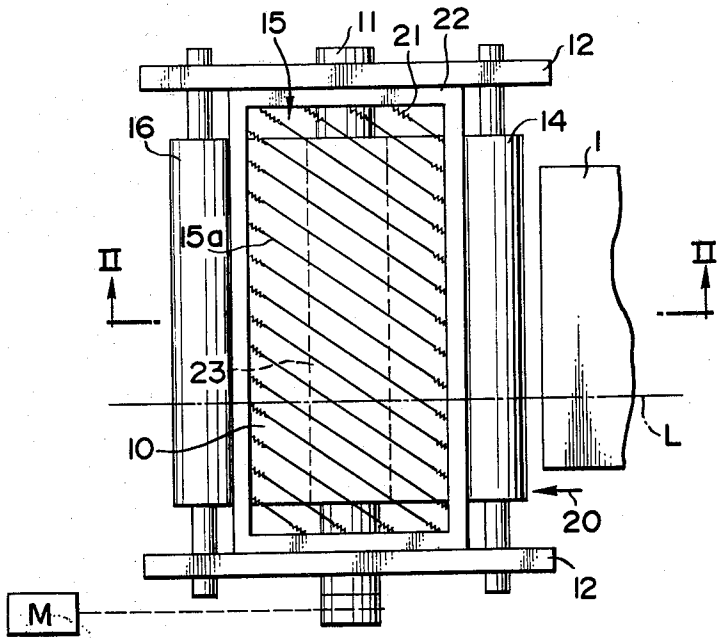
M
10

FIG. 3


15
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II
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10
20
12
M

FIG. 4

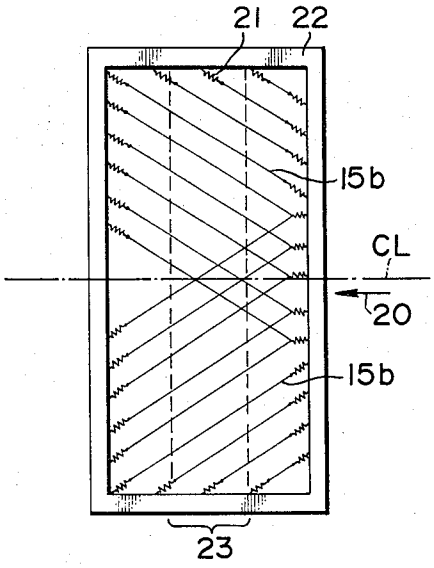

FIG. 5

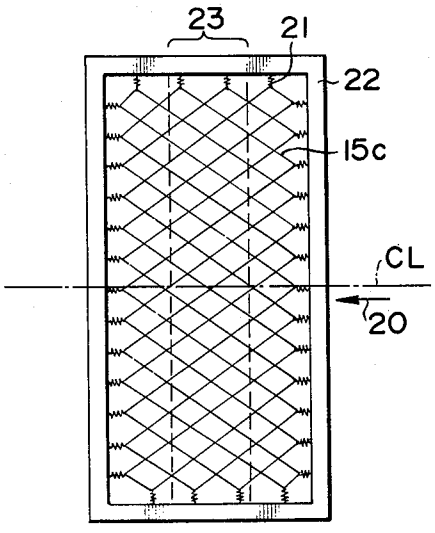

FIG. 6

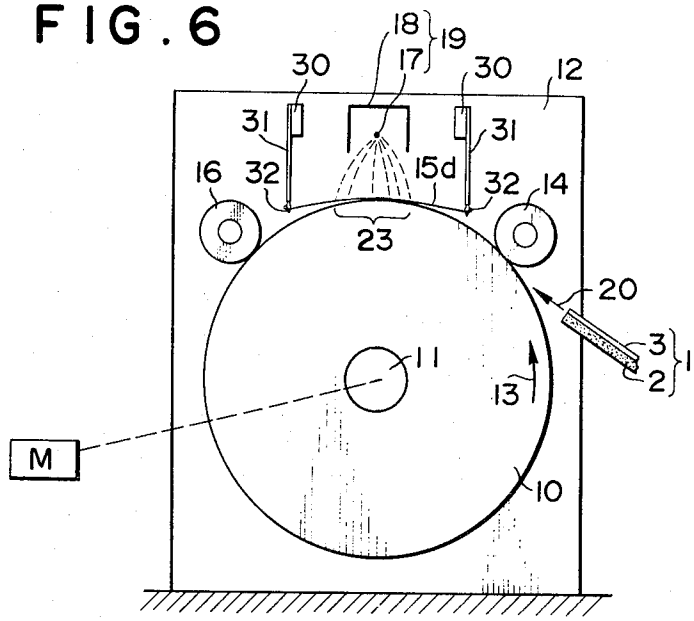
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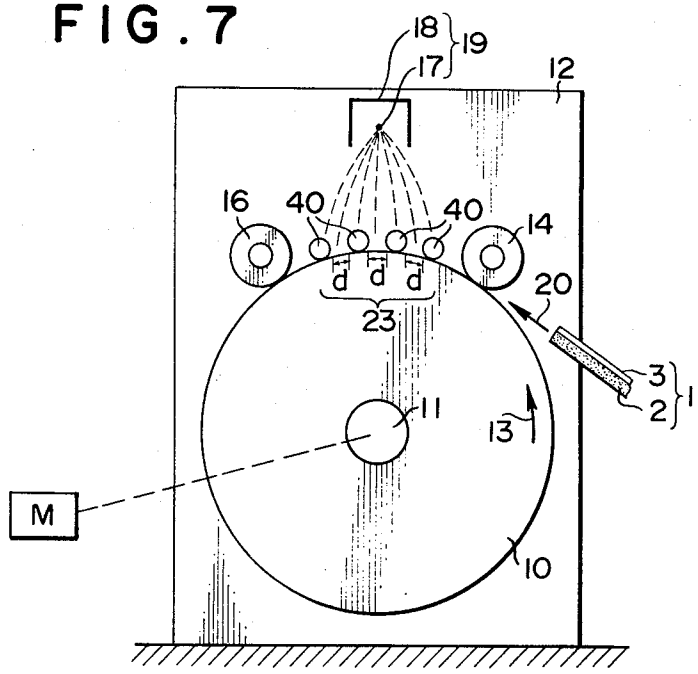
FIG. 7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METHOD OF AND APPARATUS FOR FORMING ELECTROSTATIC LATENT IMAGES

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a method of and apparatus for forming an electrostatic latent image, and more particularly to a method of forming an electrostatic latent image on an electrostatic latent image forming plate which has a conductive surface with insulating recessed portions formed in the shape of an image to be obtained thereon and to an apparatus for carrying out the method.

2. Description of the Prior Art

It has been proposed in the field of printing to use an electrostatic latent image forming plate which has a conductive surface with insulating recessed portions formed in the shape of the image to be printed. In this method, the insulating recessed portions are electrostatically charged and a developing material is supplied in the charged recessed portions and transferred to a recording paper or the like to form an image thereon. Generally, in the process for charging the insulating recessed portions, a corona charger is used to uniformly charge the image forming plate. During the charging process, the conductive surface of the recording plate is grounded.

In the above described method, electrically isolated island like conductive parts are formed surrounded by the insulating recessed portions formed in the shape of an image. For example, when a letter of O is to be printed, an electrostatic latent image in the form of O is formed on the image forming plate which has an O-shaped annular insulating recessed portion and a circular electrically isolated island like conductive part surrounded thereby. In such a case, charges on the isolated conductive part remain thereon without being neutralized even if the conductive background part of the image surrounding the annular insulating recessed portion is grounded. The charges remaining on the isolated conductive part deteriorate the performance of image formation.

In order to remove charges from the isolated conductive parts, all the isolated conductive parts of the image forming plate must be grounded. However, it is practically very difficult and troublesome to ground all the isolated parts particularly in cases where the number of the electrically isolated parts is great and the area thereof is small.

Even when all the isolated parts are grounded, it is very difficult to ground all the isolated parts simultaneously. Therefore, it is inevitable that there is made a potential difference between adjacent isolated conductive parts. When the difference in potential is large, there may occur gas discharges therebetween. If the discharges occur between the isolated conductive parts, the charges on the insulating areas are influenced thereby and disappear. Obviously, the electrostatic latent image is partly damaged by the discharges.

In order to overcome the above described drawback of the prior art, it has been proposed as disclosed in Japanese Pat. Publication No. 14846/**1968** to provide conductive meshes in contact with the isolated island like parts of the image forming material so that all the isolated parts may be electrically connected with each other and be grounded simultaneously all together.

The above described method employing conductive meshes provided in contact with the isolated conductive parts is, however, disadvantageous in the following points. First, the image obtained becomes illegible by the existence of the conductive meshes overlapped with the image, which meshes are finely divided to make electrical connection between small conductive parts. Second, the number of the processes is increased in order to provide the conductive meshes on the image forming plate.

SUMMARY OF THE INVENTION

In the light of the foregoing observations and description of the conventional method of forming an electrostatic latent image on an image forming plate having insulating recessed portions on a conductive surface in the shape of the image to be obtained, the primary object of the present invention is to provide a method of forming an electrostatic latent image on an image forming plate of the above described type in which no means for grounding the material is provided in the image forming plate itself.

Another object of the present invention is to provide a method of forming an electrostatic latent image on an image forming plate having insulating recessed portions on a conductive surface in which the gas discharge between the adjacent conductive parts of the plate is prevented.

Still another object of the present invention is to provide an apparatus for forming an electrostatic latent image on an image forming plate having on a conductive surface insulating recessed portions formed in the shape of an image to be obtained.

In the method of forming an electrostatic latent image in accordance with the present invention, the conductive surface having insulating recesses of an image forming plate is grounded in a charging process to prevent the discharge between isolated conductive parts thereof. Further, after the charging process, the conductive surface is grounded again to neutralize the charges thereon.

The image forming apparatus in accordance with the present invention employs a plurality of wires or rollers brought into contact with the conductive surface of the image forming plate for grounding the conductive surface during the charging process of the same. By grounding the conductive surface of the plate during the charging process, the potential difference between the isolated conductive parts is reduced and the discharge therebetween is prevented.

Other objects and features of the present invention will be made apparent from the following detailed description of the preferred embodiments thereof taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a perspective view showing an example of the electrostatic latent image forming plate used in this invention,

FIG. **2** is a schematic sectional elevational view showing an embodiment of the latent image forming apparatus in accordance with the present invention,

FIG. **3** is a schematic horizontal sectional view showing the embodiment of the apparatus as shown in FIG. **2** taken along the line III—III of FIG. **2**,

FIG. **4** is a plan view showing an example of a grounding wire device employed in this invention,

FIG. 5 is a plan view showing another example of a grounding wire device employed in this invention,

FIG. 6 is a schematic sectional elevational view showing another embodiment of the image forming apparatus in accordance with the present invention,

FIG. 7 is a schematic sectional elevational view showing still another embodiment of the image forming apparatus in accordance with the present invention, and

FIG. 8 is a schematic side view showing a further embodiment of the image forming apparatus in accordance with the present invention.

PREFERRED EMBODIMENTS OF THE INVENTION

An example of an electrostatic latent image forming plate used in this invention is illustrated in FIG. 1. The image forming plate 1 comprises a substrate 2 at least the surface of which is insulating and a conductive layer 3 deposited thereon. The substrate 2 is made of highly dielectric material such as polyvinyl chloride, polyethylene, polystyrene, polypropylene, polyester, polyvinylidene chloride, cellulose triacetate and the like. The substrate 2 may be made of material of comparatively low resistance such as metal foil or paper covered with dielectric material as the above mentioned resins. The conductive layer 3 is a thin film of metal such as cupper, tin, zinc, aluminium, silver, gold and so forth or may be a thin film comprising fine particles of said metal, alloy or carbon dispersed in a proper binder coated in a thin film layer on the substrate 2.

The image forming plate 1 as described above is provided with recessed portions 4 shaped in the form of the image desired to be obtained. The insulating surface of the substrate 2 is exposed at the bottom of the recessed portions 4. The recessed portions 4 can be made by chemically removing the conductive layer 3 by the art of etching or may be mechanically removed by use of a scraping means such as a steel pen. Depending on the material used in the conductive layer, various known means are used to remove the conductive layer from the surface of the substrate to form the recessed portions 4. In the example of the image forming plate 1 shown in FIG. 1, a character of $\bar{Q}$ which is a combination of a letter of "Q" and a sign of "—" is formed with recessed portions 4*a* and 4*b*. By the recessed portions 4*a* and 4*b* are formed three conductive parts 3*a*, 3*b* and 3*c*. One conductive part 3*a* is the background of the character $\bar{Q}$ and the other two conductive parts 3*b* and 3*c* are electrically isolated island like conductive parts.

The depth of the recessed portions 4 is preferably not less than 5μ and the surface resistance of the recessed portions 4 is preferably not less than $10^{12}\Omega$ so that the charges may remain thereon for a predetermined time. The surface resistance of the conductive layer 3 is preferably not more than $10^{10}\Omega$ so that the surface thereof may easily be grounded.

The structure of the image forming plate used in the present invention is not limited to that shown in FIG. 1. For instance, an intermediate layer made of insulating material which is easily peeled off may be interposed between the substrate 2 and the conductive layer 3 so that the conductive layer 3 may easily be removed from the surface of the substrate together with the intermediate layer or it may be assured that the bottom surface of the recessed portion become insulating even if the intermediate layer is left at the bottom of the recessed portions 4 on the surface of the substrate 2.

An embodiment of the apparatus for forming an electrostatic latent image on the above described image forming plate in accordance with the present invention will be described in detail with reference to FIGS. 2 and 3. A feed drum 10 mounted to a shaft 11 is rotatable about the shaft 11 and has a conductive surface which is grounded. The shaft 11 is supported at the opposite ends thereof by a pair of parallel side plates 12 and is rotated in the counterclockwise direction as indicated by an arrow 13 in FIG. 2 by means of a motor M, for instance. In contact with the surface of the drum 10 are arranged a feed-in roller 14, a grounding wire device 15 and a feed-out roller 16 in this order in the direction of rotation of the drum 10. Above the grounding wire device 15 is provided corona charger 19 comprising a corona electrode 17 impressed with a high D.C. voltage and a grounded shield 18. The drum 10 is made of metal such as iron, cupper, aluminium, duralumin, brass, stainless steel and so forth.

The feed-in roller 14 comprises, for instance, a metal shaft and a rubber coating made of rubber material having hardness of 10 to 100 such as natural rubber, neoprene, Buna rubber, butyl rubber, SBR, silicone rubber and the like. The rubber coating provided on the metal shaft of the feed-in roller 14 may contain conductive powder as of carbon, or may be made of the same material as that of the drum 10. The feed-out roller 16 which grounds the surface of the image forming plate 1 may be made of the same material as that of the feed-in roller 14 and should preferably be made of rigid conductive material so as not to damage the latent image formed in said recessed portions of the plate 1. The feed-out roller 16 is grounded by proper means. The feed-in roller 14 and the feed-out roller 16 are rotatably supported and spring urged to be in press contact with the surface of the feed drum 10 by means of a proper spring means such as a plate spring, a coil spring and the like.

The grounding wire device 15 comprises, as shown in FIG. 3, a rectangular frame 22 and a plurality of grounding wires 15*a* tensioned in parallel with each other and fixed to the frame 22 by means of springs 21 fixed at the opposite ends of the grounding wires 15*a*. The grounding wires 15*a* are urged to be in contact with the surface of the feed drum 10 by the force of the springs 21. The grounding wires 15*a* are made of conductive material such as tungsten, molybdenum, cupper, iron, brass, phosphor bronze, stainless steel and the like and has the diameter of 10 to 500μ. As shown in the drawing, the grounding wires 15*a* are tensioned obliquely with respect to the feeding direction of the feed drum 10. The pitch of the parallel arrangement of the grounding wires 15*a* is determined so that at least one wire 15*a* may exist in contact with the surface of the drum 10 in the charging region 23 where the surface of the drum 10 receives corona ions generated from the corona electrode 17 of the corona charger 19 on a line L extending in the feeding direction of the drum 10. In the example of the grounding wire device as shown in FIG. 3, two wires 15*a* are in contact with the surface of the drum 10 on the line L in said region 23. When the frame 22 is mounted to the side plates 12, and if the frame 22 and the springs 21 are conductive as well as the side plates 12, the grounding wires 15*a* can be grounded by grounding the side plates 12.

In operation, the image forming plate **1** comprising the substrate **2** and the conductive layer **3** having recessed portions **4** formed in the shape of the image desired to be obtained is inserted between the feed-in roller **14** and the feed drum **10** with the substrate **2** put in contact with the surface of the feed drum **10** as shown in FIGS. **2** and **3**, and accordingly, with the conductive layer **3** having the recessed portions **4** faced outside.

The image forming plate **1** inserted between the drum **10** and the feed-in roller **14** is carried by the feed drum **10** and fed in slide contact with the grounding wires **15***a* through the charging region **23.** While the image forming plate **1** advances through the charging region **23,** the surface of the conductive layer **3** slides on the grounding wires **15***a* in contact therewith. Since any part of the surface of the conductive layer **3** is brought into contact with the grounding wires **15***a* at least once, any part of the surface of the conductive layer **3** is grounded. Accordingly, any island like isolated part of the conductive layer **3** is grounded however small it may be.

While the image forming plate **1** advances through the charging region **23** carried by the feed drum **10,** the surface of the conductive layer **3** and the recessed portions **4** are charged with the corona ions coming from the corona electrode **17** of the corona charger **19.** Charges on the conductive surface **3** are, however, neutralized by the grounding wires **15***a* when the surface is brought into contact with the grounding wires **15***a.* Since the conductive layer **3** is grounded during the charging process while the image forming plate **1** passes through the charging region **23,** the potential of the conductive layer **3** including the electrically isolated island like parts **3***b* and **3***c* is lowered. Therefore, the potential difference between the adjacent isolated conductive parts is reduced, and consequently, the gas discharge therebetween is prevented.

For instance, when the image forming plate **1** as shown in FIG. **1** is fed through the charging region **23** in the apparatus shown in FIGS. **2** and **3,** the background portion **3***a* is always in contact with the grounding wires **15***a* and accordingly the potential thereof is always zero. The isolated parts **3***b* and **3***c* of small area are grounded for a short period during the charging process. By the short period grounding of the isolated parts, the potential of the isolated parts is lowered to such a level that no discharge may occur between isolated parts or between the isolated parts and the surrounding conductive part.

The image forming plate **1** is then brought into contact with the grounded feed-out roller **16** and the conductive layer **3** is completely grounded. When the material coated on the feed-out roller **16** is rigid, the surface of the feed-out roller **16** does not contact the surface of the bottom of the recessed portions **4,** but contacts only the surface of the conductive layer **3.** Therefore, the electrostatic latent image formed on the image forming plate **1** is not damaged by the feed-out roller **16.** When the depth of the recessed portions **4** is made not less than 5μ, the discharge between the feed-out roller **16** and the recessed portions **4** is also prevented, and accordingly, the electrostatic latent image is completely protected.

The arrangement of the grounding wires **15***a* is not limited to that shown in FIG. **3** and may be such that shown in FIGS. **4** and **5.** The second example of the grounding wire device is shown in FIG. **4** in which the grounding wires **15***b* obliquely tensioned in the frame **22** are provided symmetrically with respect to the center line CL along the direction of feed of the feed drum **10** to expand obliquely in the opposite directions from the center line CL. By providing the grounding wires **15***b* symmetrically with the center line CL, the image forming plate **1** can be fed smoothly without being biased laterally. The third example of the grounding wire device shown in FIG. **5** employs grounding wires **15***c* which are obliquely tensioned in the frame **22** in an obliquely crossed lattice pattern. The wires **15***c* obliquely extending in a lattice pattern in the frame **22** are also symmetrical with respect to the center line CL. Therefore, the image forming plate **1** fed in slide contact with the wires **15***c* is also smoothly fed without being biased laterally. Although the wires **15***b* or **15***c* in the second and third examples of the grounding wire device intersect in the frame **22,** the intersections do not bring any problem in the image formation if the wires are made sufficiently thin. In FIGS. **3, 4** and **5,** like elements are designated with like numerals and the description thereof is omitted with reference to FIGS. **4** and **5.**

Another embodiment of the apparatus for forming an electrostatic latent image is illustrated in FIG. **6,** in which the same elements as those shown in FIG. **2** are indicated with the same numerals and the description thereof is omitted here. The grounding wires **15***d* employed in this embodiment are tensioned between nails **32** arranged in aline at the lower end of a pair of spring plates **31** supported by a pair of parallel support bars **30,** respectively. The support bars **30** are fixed to the side plates **12** by proper fixing means. The wires **15***d* are tensioned obliquely and in parallel with each other similarly to those shown in FIGS. **4** and **5.** Since the wires **15***d* can easily be tensioned between the pair of spring plates **31** by simply tensioning the wire around the nails **32,** the grounding wire device employed in this apparatus is easily manufactured. The spring plates **31** are made of elastic material such as phosphor bronze, spring steel and the like having the thickness of 0.1 to 0.5mm.

Although the grounding wires **15***a*, 15*b*, 15*c* and **15***d* are tensioned obliquely with respect to the feeding direction of the feed drum **10** in the above described embodiments, it should be understood that the wires may be tensioned in the direction orthogonal to the feeding direction.

Still another embodiment of the apparatus for forming an electrostatic latent image in accordance with the present invention is shown in FIG. **7** in which the same elements as those shown in the above described embodiments are indicated with the same numerals. In the embodiment shown in FIG. **7,** grounding rollers **40** of small diameter are employed for grounding the surface of the conductive layer **3** of the image forming plate **1** instead of said grounding wires **15***a*, 15*b*, 15*c* and **15***d.* The grounding rollers **40** are grounded and arranged in parallel with each other in contact with the surface of the drum **10** in the charging region **23.** Further, the grounding rollers **40** are arranged at intervals with the space of *d* made therebetween. Preferably, the grounding rollers **40** are rotatably supported by the side plates **12.** Further, it is desirable that the grounding rollers **40** be movable up and down and downwardly urged onto the surface of the drum **10** by spring means such as spring plates or coil springs. The grounding rollers **40**

are made of rigid metal having a smooth surface such as stainless steel, cupper, aluminium, duralumin, brass and the like. The diameter of the rollers **40**, which is determined with reference to the width of the charging region **23** measured in the feeding direction and the amount of corona ions generated from the corona electrode **17** of the corona charger **19**, should preferably be 2 to 30mm. The interval *d* between the adjacent grounding rollers **40** which is determined with reference to the width of the charging region **23**, the amount of the corona ions and the diameter of the grounding rollers **40** should preferably be 1 to 20mm.

In this embodiment also, the surface of the conductive layer **3** of the image forming plate **1** is grounded by the grounding rollers **40** while the plate **1** passes through the charging region **23** being carried by the feed drum **10** in contact with the grounding rollers **40**. Since the isolated parts of the conductive layer **3** are grounded, the potential of the isolated parts is lowered and the gas discharge between the isolated conductive parts is prevented. Therefore, the electrostatic latent image is not damaged through the charging process.

A further embodiment of the apparatus for forming an electrostatic latent image on an image forming plate having insulating recessed portions on a conductive layer is illustrated in FIG. **8** in which elements similar to those shown in FIGS. **2** to **7** are indicated with similar reference numerals. In this embodiment, an endless belt **42** at least the surface of which is conductive is tensioned between a pair of feed rollers **41** and runs in the direction as shown with an arrow **43**. The image forming plate **1** is carried on the endless belt **42**. A number of grounding rollers **40** are rotatably provided in contact with the endless belt **42**. The endless belt **42** is made of metal thin film as of stainless steel, cupper, brass and the like and has the thickness of 0.05 to 0.2mm. The endless belt **42** may be composed of a film of synthetic resin such as polyester, polyvinyl chloride, polyethylene, polypropylene, cellulose acetate and the like and a coating layer of metal such as aluminium, cupper, tin, zinc and the like vacuum evaporated or plated thereon. In this embodiment also, the electrostatic latent image formed on the image forming plate **1** is not damaged through the charging process.

I claim:

1. Method of forming an electrostatic latent image on an image forming member composed of a substrate at least the surface of which is insulating and a conductive layer deposited thereon, said conductive layer being removed to form recessed portions having an insulating bottom surface in the shape of the image desired to be obtained and form a plurality of electrically isolated conductive parts on the substrate, comprising the steps of;

uniformly charging the surface of said image forming member,

grounding the surface of the conductive layer in at least a part of said uniformly charging step to lower the potential of the conductive parts to such a level that no gas discharge will occur between the conductive parts, and

further grounding the surface of the conductive layer after said uniformly charging step.

2. Method of forming an electrostatic latent image on an image forming member as defined in claim **1** wherein said step of uniformly charging the surface of the image forming plate is conducted by feeding the image forming plate on a grounded feeding means through a corona charging region in which corona ions are applied on the image forming plate, and said step of grounding the conductive layer in the uniformly charging step is conducted by feeding the image forming plate in slide contact with a grounding means stationarily provided in said charging region.

3. Apparatus for forming an electrostatic latent image on an image forming member composed of a substrate at least the surface of which is insulating and a conductive layer deposited thereon, said conductive layer being removed to form recessed portions having an insulating bottom surface in the shape of the image desired to be obtained and form a plurality of electrically isolated conductive parts on the substrate, comprising in combination;

a feeding means for feeding the image forming member through a predetermined passage,

a corona charging means provided on the way of said passage for uniformly charging the surface of the image forming member with corona ions when the member passes thereby,

a conductive backing member provided opposite to said corona charging means for supporting the back of said substrate of the image forming member when the image forming member passes by the corona charging means,

a first grounding means provided between said charging means and said backing member to be brought into contact with the surface of said conductive layer of the image forming member when the image forming member passes by the corona charging means for grounding the surface of the conductive layer, and

a second grounding means provided downstream said charging means to be brought into contact with the surface of the conductive layer of the image forming member for further grounding the surface of the conductive layer.

4. Apparatus for forming an electrostatic latent image as defined in claim **3** wherein said feeding means is provided with said conductive backing member.

5. Apparatus for forming an electrostatic latent image as defined in claim **4** wherein said feeding means is a rotatable drum having a conductive surface.

6. Apparatus for forming an electrostatic latent image as defined in claim **4** wherein said feeding means is an endless belt having a conductive surface.

7. Apparatus for forming an electrostatic latent image as defined in claim **3** wherein said first grounding means comprises grounded meshed grounding wires spring urged to be in contact with the surface of the conductive backing member.

8. Apparatus for forming an electrostatic latent image as defined in claim **3** wherein said first grounding means comprises a plurality of rollers having a grounded conductive surface spring urged to be in contact with the surface of the conductive backing member.

9. Apparatus for forming an electrostatic latent image as defined in claim **3** wherein said second grounding means is a roller having a conductive surface provided at the end of said passage to be rotated in contact with the surface of the image forming member.

10. Apparatus for forming an electrostatic latent image as defined in claim **3** wherein said feeding means comprises a drum having a conductive surface, a feed-in roller rotatable in contact with the drum and a feed-out roller rotatable in contact with the drum.

11. Apparatus for forming an electrostatic latent image as defined in claim **10** wherein said feed-out roller has a grounded conductive surface and serves as said second grounding means.

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