United States Patent [19]

Tamai et al.

[11] **3,799,340**

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[54] **REFINING PHOTOCONDUCTIVE PARTICLE**

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[73] Assignee: **Fuji Photo Film Co., Ltd.**, Kanagawa, Japan

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[30] **Foreign Application Priority Data**

Dec. 2, 1970 Japan 45-106638

[52] **U.S. Cl.** ..... **209/127 R**

[51] **Int. Cl.** **B03c 7/08**

[58] **Field of Search** ..... 209/127 R, 128, 129, 131; 15/1.5

[56] **References Cited**

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Assistant Examiner—Ralph J. Hill
Attorney, Agent, or Firm—Gerald J. Ferguson, Jr.

[57] **ABSTRACT**

Apparatus for refining composite photoconductive particles comprising transparent cores with photoconductive films disposed thereon, the apparatus comprising means for uniformly charging and dispersing the composite particles in a layer on an electroconductive member so that the composite particles are electrostatically attracted to the electroconductive member, means for uniformly exposing the layer of composite particles to radiation within the sensitive wavelength region thereof to reduce the electrostatic attraction of desired composite particles for the electroconductive member, and first removing means for removing the desired composite particles from the electroconductive member.

7 Claims, 5 Drawing Figures

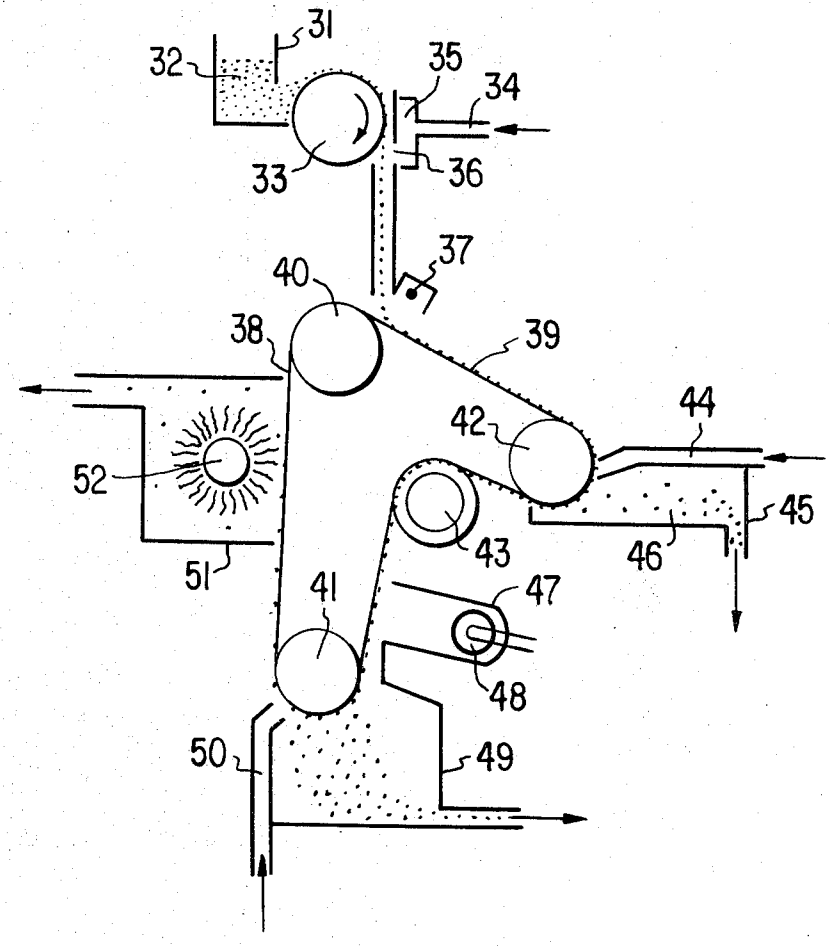


FIG. 1

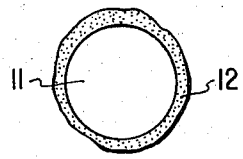


FIG. 2

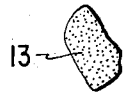


FIG. 3

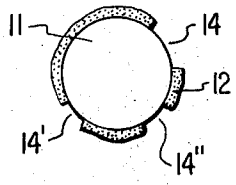


FIG. 4

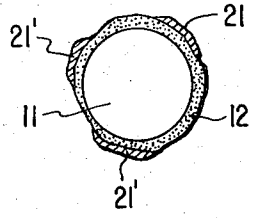
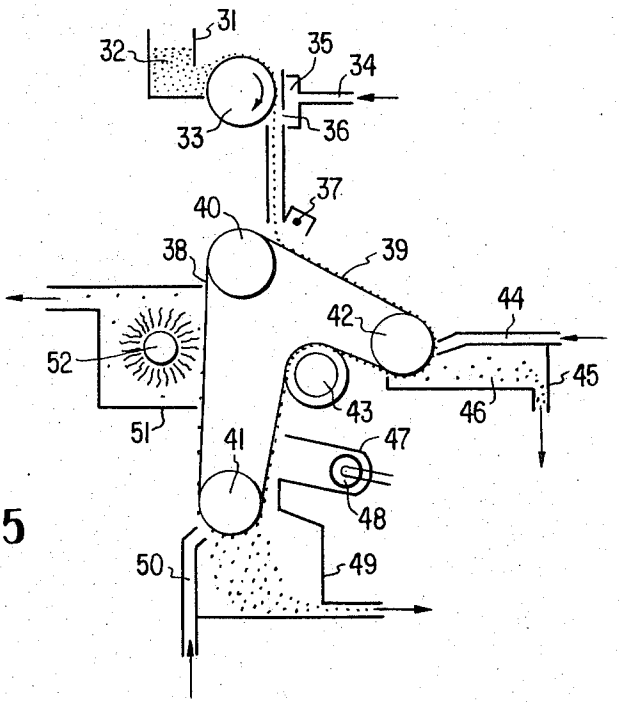


FIG. 5



REFINING PHOTOCONDUCTIVE PARTICLE

BRIEF DESCRIPTION OF THE DRAWING

FIGS. 1 to 4 are the cross-sectional views of photoconductive particles of different shapes.

FIG. 5 is a cross-sectional side view of a device embodying this invention.

DETAILED DESCRIPTION OF THE INVENTION

This invention relates to an improvement in electrophotographic process, and particularly to a process for refining photoconductive particles.

One of the electrophotographic process already known utilizes the combination of photoconductive particles and electroconductive plate as disclosed for example in Japanese Patent Publication No. 12385/69 and 8838/70. Said process consists of the steps of either scattering the photoconductive particles to form a layer thereof on an electroconductive material and then electrostatically charging thus formed layer or dispersing photoconductive particles previously charged on said material to form a layer of said particles, then subjecting said layer to imagewise exposure, removing the particles of which electrostatic charge is dissipated by said exposure and fixing the remaining particles thereon or after transferring to other suitable materials.

The invention relates to the refining process of the photoconductive particles of the above mentioned type after the manufacture thereof and/or after the repetitive use thereof.

The photoconductive particles for use in electrophotographic process of the above-mentioned type contain core materials. In this invention, the core materials should be considerable transparent (absorption coefficient not exceeding $1.3 \times 10^2 mm^{-1}$) to the radiation of the major part of sensitive wavelength region of the photoconductive materials used in said process.

Said core material can be composed of glass, thermoplastic resin, solvent soluble resin, metal oxide, etc. Also said photoconductive material can be those oridinarily employed in the electrophotographic process of the above mentioned type, such as selenium, cadmium sulfide, zinc sulfide, anthracene, zinc oxide etc., or the mixture thereof with insulating resin.

FIG. 1 shows the enlarged cross-section of photoconductive particles preferred for use in the electrophotographic process of the above-mentioned type. In FIG. 1, a transparent core **11** is uniformly covered with an insulating photoconductive layer **12.** Such particles as shown in FIG. 1 stick to an electroconductive plate by electrostatic attractive force when electrostatically charged in a dark place, and efficiently lose the electrostatic charge thereon when exposed to light and becomes removable from said electroconductive plate.

FIG. 2 shows the enlarged cross-section of photoconductive particles formed in the course of manufacture of said particles and provided with unpreferable shape. Such particles do not contain transparent core material therein but consist exclusively of insulating photoconductive material **13.** Such particles as shown in FIG. 2 also stick to an electroconductive plate by electrostatic attractive force when electrostatically charged in a dark place, but do not easily lose the electrostatic charge even when exposed to light and thus remain unremovable on said plate. That is to say, such particles are provided with far lower sensitivity to light compared with the particles as shown in FIG. 1, and the presence of the unpreferred particles in those as shown in FIG. 1 gives rise to elevated fog level.

FIG. 3 shows the enlarged cross-section of particles of also unpreferable shape. In this case the core material **11** is not sufficiently covered with insulating photoconductive material **12.** Such particles are formed either in the manufacturing process thereof or in the repeated use thereof in the electrophotographic process of the above-mentioned type. When the core material **11** is composed of a substance provided with electric insulating materials such as plastics or glass, such particles do not easily lose the electrostatic charge thereon even under light exposure because said core material **11** is exposed on the surface as shown by **14, 14'** and **14''**, and therefore become difficultly removable. Consequently, such particles also lead to fogging.

FIG. 4 shows the enlarged cross-section of photoconductive particles of also unsatisfactory performance. In this case the core material **11** is completely covered with the insulating photoconductive layer **12,** but the surface thereof is contaminated with material of low electric resistance **21, 21'** and **21''**. Such particles show significantly lowered charge retaining ability, and therefore cannot be deposited on an electroconductive plate by means of charging operation in a dark place. Consequently, an electrophotographic process of the above-mentioned type carried out with photoconductive particles containing such particles will only provide defective reproductions.

The object of this invention is to provide a process for eliminating the particles of unsatisfactory or unpreferred property as shown in FIGS. 2 to 4 from the photoconductive particles to obtain particles of desirable performance.

This invention enables not only to remove the particles of undesirable properties as shown in FIGS. 2 to 4 formed in the course of manufacturing photoconductive particle, but also to remove the particles of undesirable properties formed by the repetitive use of said photoconductive particles. Besides the process of this invention enables to remove insulating or electroconductive alien particles dust during the repetitive use of photoconductive particles.

More specificially this invention is to provide a process for refining the photoconductive particles containing core material being considerably transparent (absorption coefficient not exceeding $1.3 \times 10^2 mm^{-1}$) to the radiation of major portion of sensitive wavelength range of the photoconductive material employed thereon, which comprises either dusting said particles on a electroconductive plate and electrostatically charging the layer thus formed of said particles or dusting said particles electrostatically charged in advance on said plate, then mechanically removing the particles provided withweaker electrostatic attractive force, exposing said layer of particles uniformly to a radiation within the sensitive wavelength range thereby dissipating the sticking force of photoconductive particles to said electroconductive plate and finally collecting the remaining particles on said plate, thereby to fractionate the particles according to the change of sticking force thereof before and after the exposure to radiation.

More practically the change of sticking force of the photoconductive particles to the electroconductive plate is utilized as follows:

I. The particles contained in the particle layer but not chargeable are removed by utilizing the reduced sticking force thereof to the electroconductive plate. It is therefore made possible to eliminate the particles of significantly low charge retaining ability as shown in FIG. 4 or electroconductive or low-resistance dust mixed in the particles during the course of repetitive use thereof. Practically this operation is realized by inclining the plate holding charged particle layer thereon thereby removing the undesirable particles and dust by gravity and/or blowing air stream to said particle layer to remove such undesirable particles and dust.

II. The satisfactory photoconductive particles as shown in FIG. 1 are collected by exposing said particles to radiation thereby dissipating the sticking force thereof to the electroconductive plate. It is thus made possible to collect the particles adapted for use in the electrophotographic process utilizing the photoconductive particles of the above-mentioned type. The particles sticking on the electroconductive plate lose the electrostatic attractive force thereof by uniform exposure to light and then are collected by gravity, air stream or suitable vibration.

The defective particles as shown in FIGS. 2 and 3 which do not lose the electrostatic charge thereof by the radiation still stick on said electroconductive plate. Thus, the photoconductive particles of lower sensitivity or having exposed core material and insulating dust mixed in the course of repetitive use remain on the electroconductive plate. Such remaining particles are removed from said electroconductive plate by mechanical removing such as with brush and/or blowing of strong air stream. Such operation can be combined with the steps of dissipating the charge on such particles such as corona discharged, blowing of ionized gas stream, radiation, etc.

From practical point of view, the electroconductive plate is preferably used repeatedly, and thereby conveniently formed into an endless belt. Such electroconductive plate can be composed of metal plate, electroconductive rubber, metal plate lined with flexible material, etc.

The device for embodying this invention will be explained in reference to attached FIG. 5.

The container **31** contains photoconductive particles **32** freshly manufactured or containing undesirable particles as the result of repetitive use thereof. Said photoconductive particles **32** are scooped up by the roller **33** from the bottom of said container **31** and are made to fall.

Uniform distribution is realized by the air stream from the dust **34**, which is blown from a slit **36** provided on a cushioning box **35** to the falling particles. Said falling particles are electrostatically charged by the corona discharge generated by a corona electrode **37**, thereby to form a charged particle layer **39** on an electroconductive belt **38**, which is driven by the driving rollers **40, 41** and **42**. Also provided are the rollers **43** which are in contact with the both side portions of said belt. Contaminated particles as shown in FIG. **4** and electronconductive or low resistance dust contained in the particle layer are removed therefrom by the air stream supplied from a duct **44** and collected in a container **45** of reduced pressure. The electroconductive particles thus collected are shown by **46**.

Then the particle layer on the endless belt is exposed to light uniformly by a light source **48** located in the lamphouse **47**. The photoconductive particle lose the sticking force and fall apart from the belt **38** by the gravity or by the air stream from the duct **50**, then brought into a container **49** of reduced pressure and finally collected by a cyclon etc.

The particles retaining electrostatic charge still after said exposure and insulating dust, which are still remaining on the electroconductive plate **38**, are wiped off and removed by a brush **52** provided in a casing **51** of reduced pressure. Thus it is made possible to remove the undesirable particles and dust contained in the photoconductive particles.

The refining process according to this invention is applicable both for refining the photoconductive particles after the manufacture thereof and for restoring the performance of the photoconductive particles after repetitive use thereof.

This invention, therefore, enables not only to dispense with the special classification process thus far required after the manufacture of photoconductive particles but also to prolongate the lifetime of the photoconductive particles, and thus have an elevated industrial value.

What is claimed is:

1. A process for refining photoconductive particles for use in electrophotographic process and containing core material having an absorption coefficient not exceeding $1.3 \times 10^2 mm^{-1}$ to the radiation of the major part of the sensitivity wavelength range of the photoconductive material employed thereon, which comprises either dusting said particles on an electroconductive plate and electrostatically charging thus formed particle layer or dusting said particles electrostatically charged in advance on said plate to form a layer thereon, mechanically removing particles scarcely charged by utilizing the reduced sticking force thereof to said electroconductive plate, then exposing said particles layer uniformly to light covering whole sensitive wavelength range or a part thereof thereby dissipating the sticking force of said particles to said plate, and finally collecting said photoconductive particles.

2. Apparatus for refining composite photoconductive particles comprising transparent cores with photoconductive films disposed thereon, said apparatus comprising:

means for uniformly charging and dispersing said composite particles in a layer on an electroconductive member so that said composite particles are electrostatically attracted to said electroconductive member;

means for uniformly illuminating all of said layer of composite particles to radiation within the sensitive wavelength region thereof to reduce the electrostatic attraction of desired composite particles for said electroconductive member with respect to that of undesired composite particles so that said desired particles are differentiated from said undesired particles in accordance with their respective electrostatic attractions for said electroconductive member after they have both been subjected to said uniform illumination step; and

first removing means for selectively removing said desired composite particles from said electroconductive member.

3. Apparatus for refining composite photoconductive particles comprising transparent cores with photocon-

ductive films disposed thereon, said apparatus comprising:

means for uniformly charging and dispersing said composite particles in a layer on an electroconductive endless belt so that said composite particles are electrostatically attracted to said electroconductive endless belt;

means for uniformly exposing said layer of composite particles to radiation within the sensitive wavelength region thereof to reduce the electrostatic attraction of desired composite particles for said electroconductive endless belt; and

first removing means for removing said desired composite particles from said electroconductive endless belt;

second removing means for removing the undesired composite particles remaining on said electroconductive endless belt after said desired composite particles have been removed therefrom and before the composite particles are dispersed thereon, said undesired particles exhibiting substantially more electrostatic attraction for said electroconductive endless belt than said desired particles.

4. Apparatus as in claim **3** where said second removing means comprises a brush disposed within a chamber maintained at reduced pressure.

5. Apparatus as in claim **3** where said first removing means comprises a container so disposed with respect to said endless belt that said desired composite particles fall because of gravity into said container.

6. Apparatus for refining composite photoconductive particles comprising transparent cores with photoconductive films disposed thereon, said apparatus comprising:

means fo uniformly charging and dispersing said composite particles in a layer on an electroconductive member so that said composite particles are electrostatically attracted to said electroconductive member;

means for uniformly exposing said layer of composite particles to radiation within the sensitive wavelength region thereof to reduce the electrostatic attraction of desired composite particles for said electroconductive member; and

first removing means for removing said desird composite particles from said electroconductive member;

third removing means for removing further undesired composite particles before said first removing means removes said desired composite particles, said further undesired particles exhibiting substantially less electrostatic attraction for said electronconductive member than said desired particles.

7. Apparatus as in claim **6** where said third removing means comprises means for blowing a jet of air onto said layer of composite particles to loosen said further undesired particles from said electroconductive member.

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