

United States Patent

[11] 3,613,638

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[21] Appl. No: **869,673**
[22] Filed **Oct. 27, 1969**
[45] Patented **Oct. 19, 1971**
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[56]

References Cited

UNITED STATES PATENTS

3,251,706	5/1966	Walkup	117/17.5
3,262,806	7/1966	Gourge	117/17.5
3,375,806	4/1968	Nost	118/637

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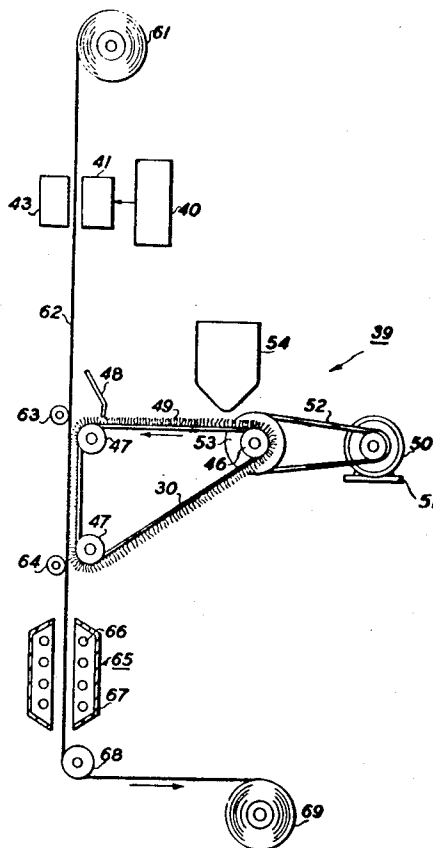
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[54] **MATERIALS FOR FIBROUS DEVELOPMENT MEMBER**
7 Claims, 1 Drawing Fig.

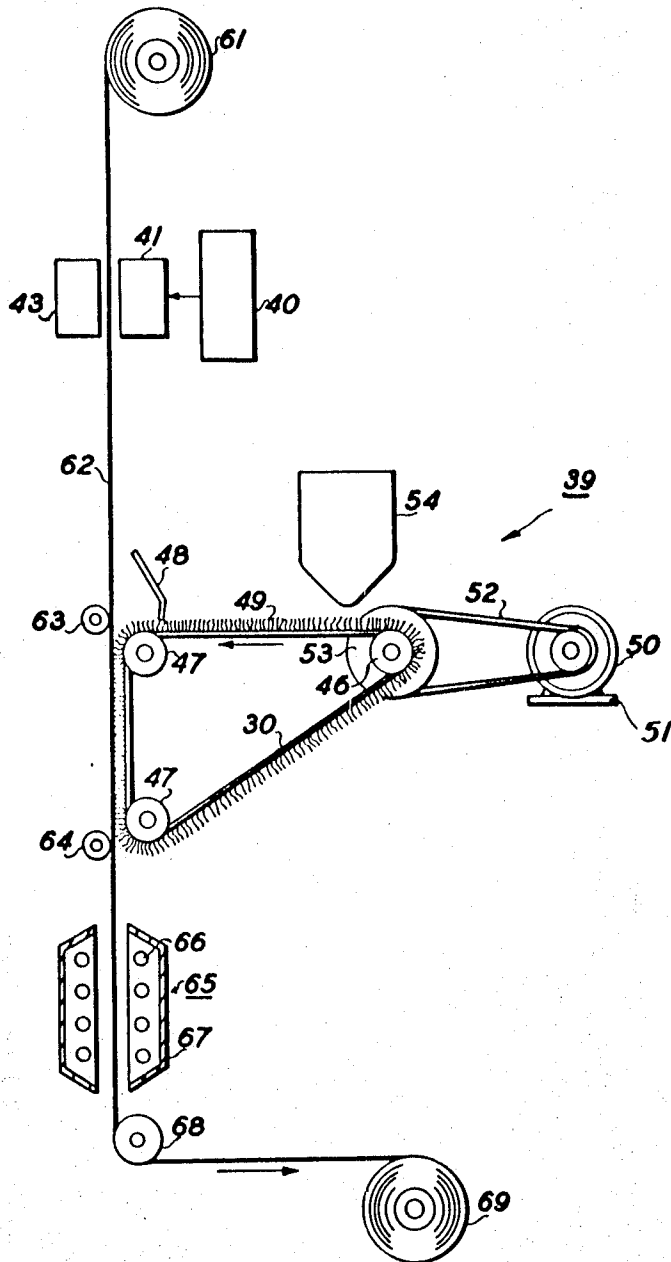
[52] U.S. Cl. **118/637,**
117/17.5
[51] Int. Cl. **G03g 13/00**
[50] Field of Search **118/637;**
117/17, 17.5

ABSTRACT: In a device for developing electrostatic latent charge patterns, a fibrous development member comprising woven pile material, the fiber elements of which comprise composite combinations of conductive and insulating materials, such as glass and steel.



PATENTED OCT 19 1971

3,613,638



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MATERIALS FOR FIBROUS DEVELOPMENT MEMBER

BACKGROUND OF THE INVENTION

In xerography and related arts, it is usual to deposit an image such as a powder image on an electrostatic charge pattern conforming to a pattern of light and shadow which is to be recorded or reproduced. For example, an electrostatic charge pattern known to the art as a xerographic electrostatic latent image, corresponding to a document, picture, or other image, is formed on an image-bearing insulating surface. In the prior art electrographic processes, an electrostatic charge pattern corresponding to alphanumeric characters or symbols is deposited on a suitable recording medium. One means of utilizing the electrostatic latent charge patterns is by development with a finely divided powder material, or toner, which is caused to adhere to the surface in a configuration corresponding to the electrostatic charge pattern. One method for development of such latent charge patterns utilized in the art has been cascading across a charge-bearing surface a two-component developer mixture such as is disclosed in U.S. Pat. No. 2,618,551. Another method for the deposition of powder corresponding to an electrostatic charge pattern comprises depositing finely divided powder on the charge pattern from an elongated flexible carrier body such as, for example, a fibrous member, such as disclosed in U.S. Pat. No. 3,251,706. It has been determined that natural fur materials when used as the fibrous development member described above provides satisfactory images. Natural furs, however, have proven to be expensive and, at times unavailable. In addition, natural furs are undesirable primarily from the standpoint of the difficulties of meeting quality control standards. This is so because there are no "standard animals" fur quality and the length of the fur fibers is a function of season, age and health of the animal, climate, etc. The synthetic brush materials developed in the prior art, to replace natural fur, such as nylon acryla and Dynel, have not performed as satisfactorily as natural fur to transfer toner to the electrostatic latent charge patterns.

SUMMARY OF THE INVENTION

The present invention provides new brush materials for use in brush development of electrostatic latent charge patterns. The brush comprises a composite combination of fiber materials selected from a group of insulating and conductive materials.

It is therefore an object of this invention to provide new brush materials for use in the development of electrostatic latent charge patterns.

It is a further object of this invention to provide new brush materials utilized in brush development of electrostatic latent charge patterns, the developed charge pattern being of a quality comparable to those developed with natural fur brushes.

It is still a further object of this invention to provide new brush materials for use in brush development of electrostatic latent charge patterns and including composite combinations of fibers of insulating and conductive materials.

It is a further object of the present invention to provide woven pile brush materials for use in brush development of electrostatic latent charge patterns, the brush comprising composite combinations of insulating and conductive materials, such as glass and steel.

DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention as well as other objects and features thereof, reference is made to the following description which is to be read in conjunction with the accompanying drawing which consists of a single figure of apparatus utilizing the materials of the present invention

DESCRIPTION OF THE PREFERRED EMBODIMENT

The brush development technique for developing electrostatic latent charge patterns deposited upon a medium is

described in the above-mentioned U.S. Pat. No. 3,251,706. The choice of the fibrous, brush or like material to be used in the development structure is based upon certain mechanical and electrical characteristics. Mechanical properties which direct the choice include, for example, material softness and flexibility so that while supported at one end it can be brushed against the charge pattern without undue abrasion of the medium. An electrical characteristic which is of vital significance is the correct triboelectrical relationship with the powder or toner. For this point it is noted that a very few select powder materials are suitable as developing powders and it is generally desired to charge these powders negatively by contact electrification with the brush for deposition on a positive polarity charge pattern. Other desirable properties of the brushlike member are absence of film-forming or scum-forming ingredients, suitable durability, chemical inertness and economical availability. It has been determined that solid area development is enhanced when the conductivity of the fiber, brush or like member is high (or resistivity is low). Conductivity may be controlled by treating the surface of the fibrous material with resins, dyes, or similar coatings.

When using materials other than natural fur as the fiber material, an additional characteristic which may effect the choice of material is the weave pattern in which the fibers are affixed to a backing member as the stiffness of the fibers is a function of the pile height and density thereof when woven to the backing member.

Previous attempts to use synthetics or materials other than natural animal fur for fur brush development have been relatively unsuccessful as the desired animal fur characteristics of proper toner triboelectrical relationship, high conductivity and soft and flexible fibers were not found in prior art materials. It has been discovered that the desired animal fur characteristics may be approximated by a fibrous composite material comprising, fibers of conductive and insulating materials. The conductive materials provide the high-conductivity characteristic of natural fur while the insulating portion of the composite provides the proper triboelectrical relationship and may provide for fiber softness. As set forth hereinabove, the configuration in which the fibrous materials are affixed to the backing member, i.e., pile height and pile density, controls the softness, or stiffness, of the fibrous composite material.

Typical insulating materials utilized in the novel composite fibrous brush of the present invention includes: glass, nylon, acrylic and methacrylic polymers, polyethylene, rayon, dacron, orlon, arnel, wool, polyacrylonitriles, polyethylene terephthalate and other polyesters, polyamides, vinylacetates, styrenes, polyurethanes, modified rosin, polycarbonates, etc.

Typical conductive materials utilized in the novel composite fibrous brush include: graphite, steel, copper, brass, aluminum, nickel, platinum, chromium, silver, gold, etc.

The conductive and insulating fiber materials described above are interwoven together to form a composite fiber brush of a predetermined pile height and pile density. For example, steel and glass fibers, steel and rayon fibers, glass and rayon fibers, graphite and glass fibers and graphite and rayon fibers may be woven to a common backing member such as cloth, metal, plastic, etc. The steel and graphite fibers effectively act to increase the low conductivity of the rayon and glass thereby enabling the fibers to lose the net charge built up thereon to counterbalance the charge carried away by the development powder while the glass and rayon fibers provide softness and a proper triboelectrical relationship to the composite fibrous brush. The composite fibers provide improved solid area development of the latent electrostatic charge pattern and closely approximates the development characteristics of natural fur.

The fibers, after being affixed to the backing member by a resin epoxy or other suitable adhesive, may be mounted to a supporting member, or the backing member may itself be the support, to develop electrostatic latent charge patterns as will be described hereinafter.

As set forth hereinabove, fiber stiffness is related to pile height and pile density, as well as to the materials comprising the brush. Therefore, pile height may be controlled such that the surface on which the electrostatic charge pattern is deposited is not abraded by the brush during development. The pile height also may be controlled so that a predetermined distance is maintained between the charge-supporting surface and the member supporting the fibrous elements so, for example, one may observe the support surface as the charge patterns are being developed. The manner of weaving the materials to a backing member as described hereinabove is well known to those having skill in the fiber-weaving art.

The preferred brush comprises a composite combination of steel and glass fibers. The pile density of the composite may range from about 300,000 fibers per square inch to about 1,000,000 fibers per square inch, the pile height may range from about 0.3 inches to about 0.75 inches, the percentage of steel fibers in the composite may range from about 0.5 to about 4.2 percent and the percentage thereof of glass fibers in the composite may range from about 99.5 to about 95.8 percent. It should be noted that although the number of steel fibers in the composite is relatively small, the surface area of the steel fibers may range from about 5 to about 60 percent of the composite surface area since the steel fiber diameter is greater than the glass fiber diameter.

The general nature of the invention having been set forth, the following examples are given in further illustration thereof.

EXAMPLE I

Fibers of glass are affixed to a backing member in rows by an epoxy resin. Steel fibers are then affixed to the backing member in rows after every third row of glass fibers. The composite comprises 400,000 fibers per square inch, 99.3 percent of which are glass and 0.7 percent steel. The fiber pile height is 0.4 inches.

EXAMPLE II

Fibers of glass are affixed to a backing member in rows by an epoxy resin. Steel fibers are then affixed to the backing member in rows after every second row of glass fibers. The composite comprises 600,000 fibers per square inch, 97.9 percent of which are glass and 2.1 percent steel. The fiber pile height is 0.51 inches.

EXAMPLE III

Fibers of glass are affixed to a backing member in rows by an epoxy resin. Steel fibers are then affixed to the backing member in rows after every second row of glass fibers. The composite comprises 800,000 fibers per square inch, 96.4 percent of which are glass and 3.6 percent steel. The fiber pile height is 0.625 inches.

Referring now to the sole figure, an electrographic process employing the present invention is disclosed. It should be noted that the present invention may be utilized in other processes, such as xerography, and that the brushlike member described hereinabove may be utilized to clean toner deposited on the xerographic drum.

As shown diagrammatically in the figure, a recording medium 62, such as paper having a layer of thin insulating material coated on the working surface thereof, receives an electrostatic latent image at the recording station from the electrical discharge produced at recording head 41. The electrical discharge is initiated by a controlled voltage pulse derived from a control unit 40. Associated with the recording head 41 is a backing electrode 43. In general, the recording head 41 is provided with a plurality of styli, electrically insulated from each other. The styli are energized by the control unit 40 to produce latent electrostatic charge patterns on the recording medium 62 corresponding to alphanumeric characters or symbols. Although the recording medium 62 is illustrated as moving relative to the recording head 41, the converse is equally

applicable. The charge pattern may be formed by ionizing the air between the recording head 41 and the backing electrode or by bringing the styli in contact with the recording medium 62.

It is to be realized that the present invention is directed to the member for developing the electrostatic charge pattern. The deposition of charge on a recording medium in a pattern corresponding to alphanumeric characters or symbols may be provided in accordance with well-known conventional techniques, for example, such as disclosed in U.S. Pat. No. 3,289,209.

Next, subsequent to the recording station, is the development station 39. A developing belt is passed around drive roller 46 and one or more guide rollers 47. Belt 49 is provided with elongated flexible carrier members supported at one end on a backing member 30 and free at the other end and positioned to brush against the charge-bearing surface on recording medium 62, such carrier members, for example, being fibers of the brush or other fibrous material or similar elongated members such as the composite fibrous brush set forth hereinabove, adapted and disposed to hold on their surface by electrostatic action suitably charged powder particles, such as the powders disclosed in U.S. Pat. No. 2,659,670, which are appropriate for the deposition on and development of an electrostatic latent image. It should be noted that the developing member is not limited to the belt structure but may be, for example, a cylindrical member having the elongated carriers affixed to the outer surface thereof, as disclosed in the aforesaid mentioned U.S. Pat. No. 3,251,706, a semicylindrical member having the elongated carriers affixed to the cylindrical portion thereof, a segmented brush, and various other geometrical configurations.

It is presently understood and believed that the mechanism of the development as shown is as follows. A powder-impregnated brushlike member is prepared by brushing the member into a supply of the appropriate powder whereupon the powder adheres to the elongated carrier body, apparently by electrical attraction from frictionally generated electricity. When the powder-impregnated brush is touched to the charge pattern on the recording medium, the charge preferentially attracts the charged powder from the brush fibers causing deposition of the powder on the pattern areas. A striking plate 48 is mounted to strike the brush fibers prior to their meeting the surface of the recording medium. The striking plate is generally metallic and is electrically grounded. It is thought that the powder-bearing brush striking against the metal plate causes uniform charging of the powder. The outer surface of the developing belt is brushlike in characteristics and is a multitude of elongated carrier members composed of the fiber materials described hereinabove extending outwardly from the surface of the belt. At least one of the rollers, such as for example roller 46, is desirably power driven as illustrated by member 50 mounted on support base 51 and adapted to drive roller 46 through belt 52 operating pulley 53. Positioned adjacent to the path of motion of developing belt 49 is a powder-dispensing hopper 54 containing a supply of developer powder and adapted to dispense this developer powder gradually to the developing member 49.

A recording medium supply roll 61 is adapted to feed the recording medium 62 past guide roller 63 and the development web 49. After passing between these members, the recording medium 62 may pass around guide roller 64, desirably through a fixing station 65, and around a guide roller 68 to a takeup roller 69. The fixing station 65 may be a suitable means to apply heat, solvent vapor or the like to the surface of the recording medium and as illustrated, may consist of a plurality of heating units 66 mounted within a casing 67 thereby adapted to heat the transfer web to melt onto its surface the plastic powder deposited thereon. The operation of the apparatus described hereinabove is as follows. The surface of the recording medium 62 is charged by passing it under recording head 41 and energizing control unit 40 to produce latent electrostatic charge patterns corresponding to alphanu-

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meric characters or symbols thereon. The recording medium 62 then passes to the development station 39. At this point development web 49, with its brushlike surface coming into contact with the recording medium 62, deposits a finely divided powder material on the surface thereof.

Leaving the development station is the recording medium 62 now bearing the powder pattern thereon which pattern corresponds to the electrostatic charge pattern on the recording medium 62. The recording medium 62 passes to a suitable fixing device 65 and then to takeup roll or to some other means for utilizing the resulting print.

While the invention has been described with reference to its preferred embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the true spirit and scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teaching of the invention without departing from its essential teaching.

What is claimed is:

1. Apparatus for developing a latent electrostatic charge pattern formed on a support surface comprising:
 - a brush element having a fibrous surface, said brush fibers being a composite of fibers of conductive and insulating materials,
 - means for supporting said brush element adjacent said support surface,

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means for impregnating the brush element with a powder developing material, said fibrous surface adapted to hold thereon by electrostatic attraction powdered material during impregnation and adapted to release said powder material for development of an electrostatic latent image, and

means for bringing the brush element in surface contact with the support surface, thereby depositing the developing material on said latent charge pattern.

2. The apparatus as defined in claim 1 wherein said insulating fiber materials are selected from the group consisting of glass, rayon, nylon, orlon, wool and arnel.

3. Apparatus as defined in claim 2 wherein said insulating fibers comprise glass.

4. The apparatus as defined in claim 1 wherein said conductive fiber materials are selected from the group consisting of graphite, steel, copper, chromium, silver and aluminum.

5. The device as defined in claim 4 wherein said conductive fibers comprise steel.

6. The apparatus as defined in claim 1 wherein said insulating fibers comprise glass and said conductive fibers comprise steel.

7. The apparatus as defined in claim 6 wherein the percentage of steel fibers in the composite brush is in the range from about 0.5 to about 4.2.

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