United States Patent

Knechtel et al.

[15] **3,643,311**

[45] **Feb. 22, 1972**

[54] ROTATABLE POWDER DISPENSING CYLINDER FOR AN ELECTROSTATIC POWDER IMAGE FIXING APPARATUS

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[22] Filed: **July 27, 1970**

[21] Appl. No.: **58,514**

[30] **Foreign Application Priority Data**

Dec. 11, 1969 Germany ..... P 19 62 106.8

[52] **U.S. Cl.** **29/125**, 29/132

[51] **Int. Cl.** **B21b 31/08**

[58] **Field of Search** 29/125, 127, 116, 132; 118/637

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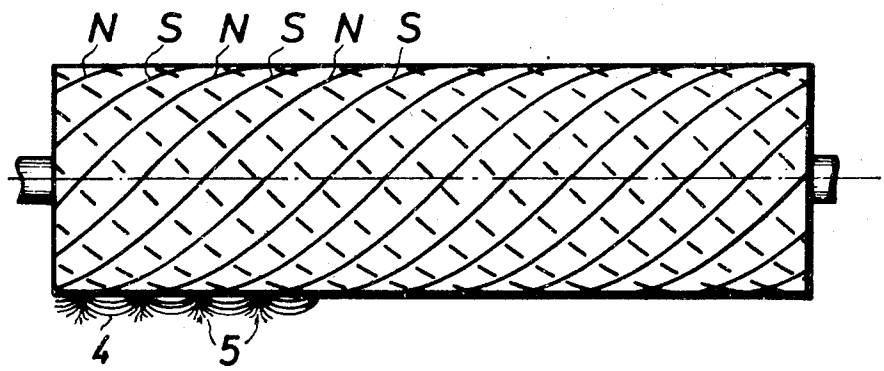
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[57] **ABSTRACT**

A rotatable cylindrical member has magnetic poles on its peripheral surface comprising parallel bands of alternating North and South poles with these bands being at an angle of about 45° to the generatrix of the cylinder. The cylindrical member may be solid or tubular and comprise a plurality of magnetic or nonmagnetic rings or disks adhered together and mounted upon a shaft which defines the rotary axis.

9 Claims, 5 Drawing Figures



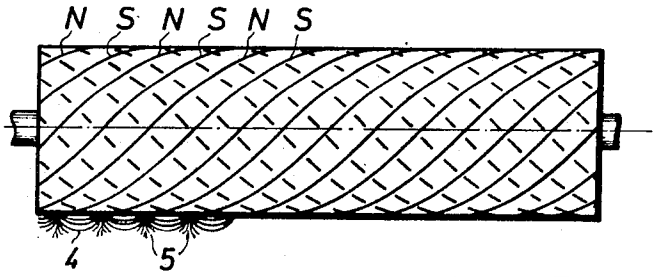


Fig. 1

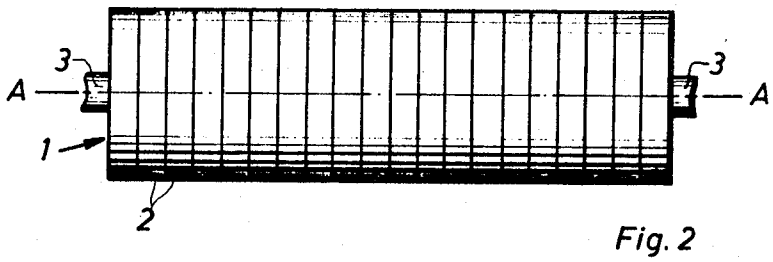


Fig. 2

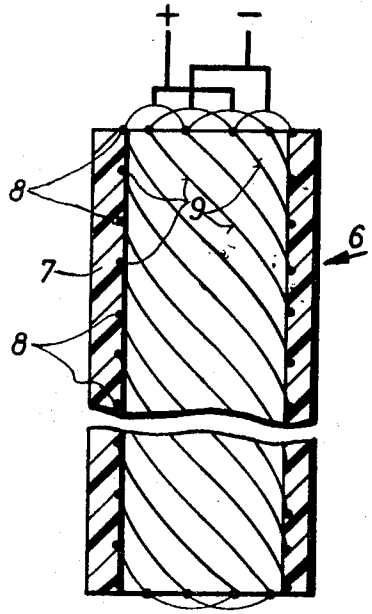


Fig. 3

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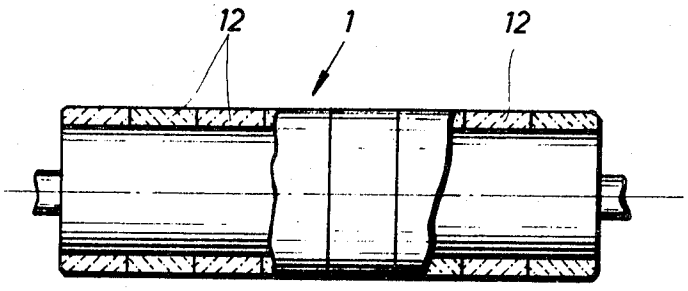


Fig. 4

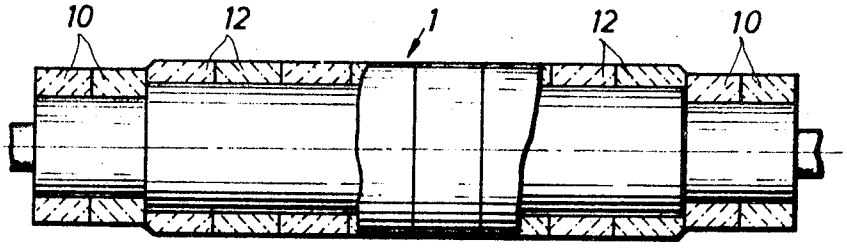


Fig. 5

ROTATABLE POWDER DISPENSING CYLINDER FOR AN ELECTROSTATIC POWDER IMAGE FIXING APPARATUS

The present invention relates to an electrostatic powder image fixing apparatus, more particularly, to a rotatable cylinder for uniformly applying toner powder to an electrostatically charged web moving past the cylinder.

In one form of an electrostatic printing system, a radiation image of the copy to be reproduced is projected onto the sensitized surface of a plate to form an electrostatic latent image. The latent image is then developed with an oppositely charged developing material to form an electrostatic powder image corresponding to the latent image on the plate surface. The powder image is next electrostatically transferred to a web of paper, foil or the like upon which the image is affixed by a fixing device. This results in permanently adhering the powder image to the web.

The fixing device utilizes a toner powder which is an electrostatically charged, finely divided material, such as an electroscopic powder. A cylinder rotating adjacent the moving web has been employed for dispensing the toner onto the web in order to fix the image thereon. It is desired that this cylinder distribute the powder as uniformly as possible onto the web. The application of the powder on the surface should be sufficiently deep so that the surfaces to be printed have an intensive black appearance.

In one form of such a magnetic cylinder or drum, the magnetic lines of flux extend radially from the peripheral surface of the cylinder to a corresponding pole of opposite polarity spaced from the cylinder. Such cylinders will uniformly apply the toner powder onto the paper web but this application is not sufficiently intensive since only that portion of the cylinder which is opposite the magnetic pole functions to apply the toner. The opposite pole cannot be built in different sizes because of the nature of its construction.

In another form of magnetic cylinder a plurality of unlike poles are positioned on the surface of the drum which may comprise a plurality of permanently magnetic disks magnetized in an axial direction and assembled to form a cylinder. In this construction the lines of force are unevenly distributed over the cylinder surface and toner powder is transferred in a nonuniform manner to the paper. As a result, streaks and lines are formed which are undesirable.

It was then proposed to construct a magnetic cylinder having a plurality of circumferentially undulating alternately spaced North and South poles on the peripheral surface of the cylindrical member. The cylinder was constructed of a plurality of correspondingly shaped preformed steel disks interposed between magnetic rubber disks stacked to form the cylinder. This cylinder construction gave good results with respect to uniformity of distribution and intensity of the toner powder. However, this structure was extremely expensive.

It is therefore the principal object of the present invention to provide a novel and improved magnetic powder dispensing cylinder for an electrostatic powder fixing apparatus.

It is another object of the present invention to provide such a magnetic cylinder which uniformly applies toner powder to the paper in such a manner that proper saturation is achieved while at the same time the cylinder is simple and inexpensive in construction.

According to one aspect of the present invention a powder dispensing cylinder for an electrostatic powder image fixing apparatus may comprise a cylindrical member mounted upon a shaft extending along its central longitudinal axis to define an axis of rotation. The peripheral surface of the cylinder is provided with means for defining magnetic poles in the form of bands extending around the surface at an angle of about 45° to the generatrix of the cylinder. These bands are parallel to each other and define alternately North and South magnetic poles. The cylindrical member may comprise a permanently magnetic material or a core of nonmagnetic material surrounded by a layer of permanent magnetic material. The cylinder may be solid or tubular and may comprise a plurality of magnetic or nonmagnetic disks or rings adhered together and mounted upon the shaft defining the rotary axis.

Other objects and advantages of the present invention will be apparent upon reference to the accompanying description when taken in conjunction with the following drawings, which are exemplary, wherein;

FIG. 1 is an elevational view of the magnetic cylinder showing the magnetic pole bands thereon in accordance with the present invention;

FIG. 2 is an elevational view of a modification of the cylinder wherein a plurality of disks are stacked together;

FIG. 3 is a sectional view of a magnetic head according to the present invention;

FIG. 4 is a sectional view through a cylinder similar to that of FIG. 2 but comprising a plurality of stacked rings; and

FIG. 5 is a view similar to that of FIG. 4 and showing a modified form of this cylinder.

Proceeding next to the drawings wherein like reference symbols indicate the same parts throughout the various views a specific embodiment and modifications of the present invention will be described in detail.

As may be seen in FIGS. 1 and 2, a magnetic cylinder according to the present invention is indicated generally at 1 and comprises a plurality of sintered disks 2 which are suitably fastened or adhered together. The disks are mounted upon a shaft 3 which defines a rotary axis along the line A—A.

On the peripheral surface of the cylinder 1 there are provided a plurality of spaced parallel bands or strips NS which wind helically about the cylinder. The bands extend at an angle of about 45° with the direction of the generatrix of the cylinder and each band is about 4 mm wide measured along the surface of the cylinder. The bands thus form alternating North and South magnetic poles. A magnetic field 4 is thus formed between adjacent NS strips as may be seen in FIG. 1. Also, magnetic lines of flux 5 are directed away from and toward the peripheral surface of the cylinder and define a brush-shape as may also be seen in FIG. 1.

The developer powder or toner mixture which comprises iron particles and toner powder thus accumulates between the North and South magnetic pole strips in a relatively thick coat and is transferred to a paper web guided past the cylinder in a manner as described above.

It is known that the iron particles which are a component of the developer powder adhere longitudinally to the magnetic lines of flux. When these lines of flux are positioned transversely to the direction of movement of the paper past the cylinder, the iron particles rotate about the lines of flux as axes during this movement of the paper. As the iron particles rotate around the lines of flux most of the toner powder is transferred to the paper moving past the cylinder. At the same time, the iron particles pick up new toner from the so-called deeper deposits and transfer this toner again onto the moving paper web. The rotary movement of the iron particles thus guarantees the intensive application of the toner powder onto the cylinder.

If the lines of flux are positioned parallel to the direction of movement of this paper past the cylinder, the above described rotation of the iron particles around the magnetic flux lines will not occur. The iron particles will then transfer only that toner powder which adheres on the face of the cylinder directed toward the paper. As a result, the degree of intensity of the transferred powder on the paper is relatively weak. The same weak intensity will occur when the magnetic lines of flux extend vertically from the peripheral surface of the cylinder as described above with respect to the prior art.

As may be seen in the present invention, the magnetic lines of flux are positioned at approximately 45° to the direction of movement of the paper past the cylinder. Thus the iron particles rotate about axes which are at 45° to the direction of movement of the paper and an intensive application or transfer of the toner powder occurs as described above. At the same time, this inclined arrangement of the magnetic flux lines has the same advantages as the above described prior art

cylinder having the undulating alternating arrangement of North and South magnetic poles on the peripheral surface of the cylinder. The toner powder is thus transferred uniformly to the moving paper web because the magnetic pole bands or strips on the rotating cylinder execute a movement with respect to the moving paper, particularly when the cylinder is rotated at a higher speed as the paper is moved past it.

The cylinder according to the present invention can be easily fabricated particularly if a magnetic head is used such as illustrated in FIG. 3. The magnetic head is indicated at 6 and comprises a tubular member 7 of electrically nonconductive material. Inserted in the inner face of the tubular member 7 are helically positioned wires 8 and 9 which are parallel and spaced from each other with the wires 8 being electrically connected to each other and the wires 9 being electrically connected to each other. The wires 8 are then connected to a positive polarity and the wires 9 to a negative polarity of a direct current source. A nonmagnetic core which may be formed in the manner of the cylinder illustrated in FIG. 2 can then be inserted into the magnetic head as described above and shown in FIG. 3. When an electric current is sent through the wires 8 and 9, the magnetic poles will be formed on the peripheral surface of the resulting cylinder in the manner of the poles as shown in FIG. 1.

In FIG. 4 there is shown a cylinder similar to that of the cylinder shown in FIG. 2 but formed of a plurality of sintered rings 12 which are suitably adhered together.

In FIG. 5, there is shown a modified cylinder wherein a cylinder according to either FIG. 2 or 4 is provided at its outer ends with permanently magnetic rings 10 whose outer diameter is smaller than the outer diameter of the cylinder. The ends of the cylinder are preferably tapered downwardly toward the smaller diameter rings. The smaller diameter rings 10 function to accumulate superfluous developer powder at the ends of the cylinder with this powder attaching itself to these magnetic rings.

It is therefore apparent that the magnetic cylinder according to the present invention may be formed in either solid or tubular shape from a plurality of magnetic or nonmagnetic disks or rings which are suitably adhered together and mounted upon a shaft which forms the rotary axis. The disks or rings may be of a material which is magnetizeable, permanently magnetic, highly corrosive, and a hard ferritic preferably a ceramic material. The disks or rings may be sintered and interconnected in cylindrical shape by means of a suitable adhesive or bonding agent.

The permanent magnetic material for the drum may comprise an isotropic barium ferrite, such as a hard ferritic material having the chemical composition $BaO_6Fe_2O_3$. Instead of barium ferrite, the hard ferritic materials lead ferrite and strontium ferrite may also be used, but only in isotropic form since the magnetization does not permit the use of anisotropic hard ferritic material. The permanent magnet material is basically characterized as having a high coercive force with sufficient induction. In this respect, isotropic titaniferous Alnico material could also be used. While the latter mentioned isotropic titaniferous Alnico material is satisfactory, the isotropic barium ferrite mentioned above is preferred.

It is understood that this invention is susceptible to modification in order to adapt it to different usages and conditions and, accordingly, it is desired to comprehend such modifications within the invention as may fall within the scope of the appended claims.

What is claimed is:

1. A powder dispensing cylinder for an electrostatic powder image fixing apparatus, and comprising a rotatable cylindrical member, means on said cylindrical member for defining magnetic poles on the peripheral surface thereof, said magnetic poles being bands around said surface at an angle of about 45° to the generatrix of the cylinder.

2. A powder dispensing cylinder as claimed in claim 1 wherein said bands are parallel to each other and define alternately North and South poles.

3. A powder dispensing cylinder as claimed in claim 1 wherein said bands are helical around said cylindrical member.

4. A powder dispensing cylinder as claimed in claim 1 wherein said cylindrical member comprises a permanently magnetic material.

5. A powder dispensing cylinder as claimed in claim 4 wherein said material is ceramic.

6. A powder dispensing cylinder as claimed in claim 4 wherein said cylindrical member comprises a plurality of connected disks. thereon.

7. A powder dispensing cylinder as claimed in claim 1 wherein said cylindrical member comprises a nonmagnetic core and a layer of permanently magnetic material thereon.

8. A powder dispensing cylinder as claimed in claim 1 wherein said cylindrical member is one of solid or tubular and comprises a plurality of permanent magnetic disks or rings adhered together and mounted upon a shaft of ferromagnetic or nonferromagnetic material which defines the rotary axis.

9. A powder dispensing cylinder as claimed in claim 1 and comprising additional permanently magnetic ring means being attached to the ends of the cylindrical member and having an outer diameter less than the outer diameter of the cylindrical member.

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