Jan. 12, 1971 W. KNECHTEL 3,553,832

METHOD OF MAKING A POWDER DISPENSING CYLINDER FOR AN ELECTROSTATIC POWDER FIXING DEVICE

Original Filed Jan. 16, 1967

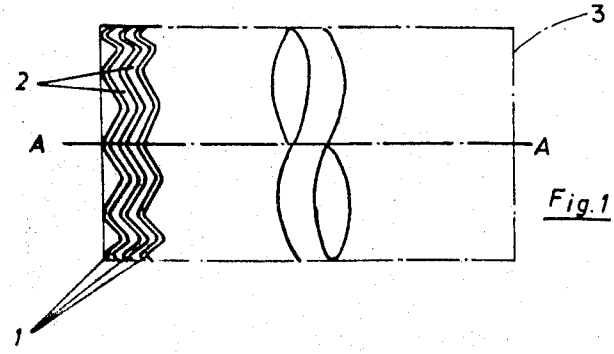


Fig. 1

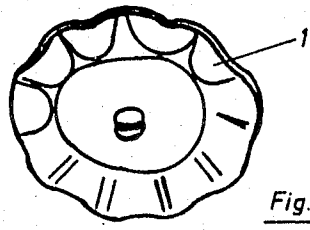


Fig. 2

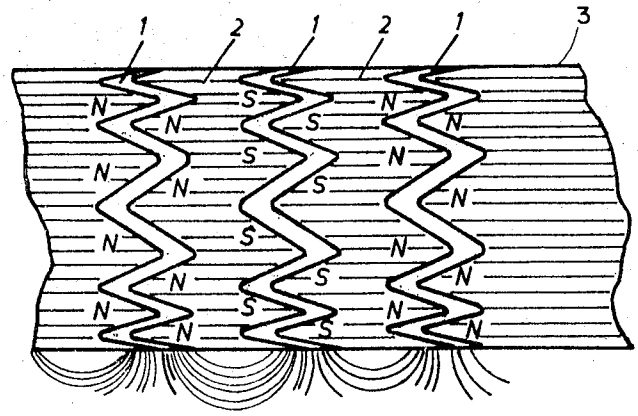


Fig. 3

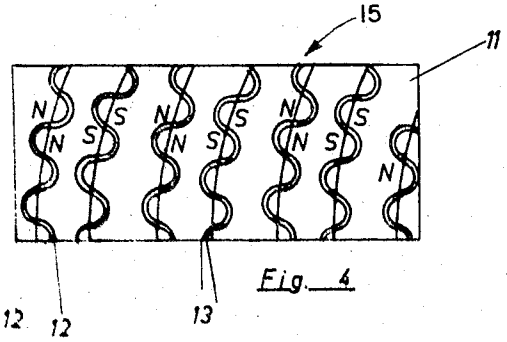


Fig. 4

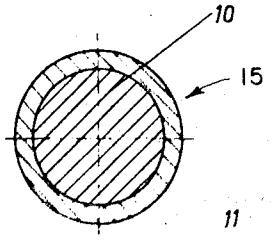


Fig. 5

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METHOD OF MAKING A POWDER DISPENSING CYLINDER FOR AN ELECTROSTATIC POWDER FIXING DEVICE

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Original application Jan. 16, 1967, Ser. No. 609,386, now Patent No. 3,464,383, dated Sept. 2, 1969. Divided and this application Jan. 10, 1969, Ser. No. 833,207

Int. Cl. H01f 7/06

U.S. Cl. 29—607 1 Claim

ABSTRACT OF THE DISCLOSURE

The present invention relates to an electrostatic powder image printing system, more particularly, to a magnetic cylinder for uniformly dispensing toner powder in a powder image fixing device.

This application is a division of application No. 609,386, filed Jan. 16, 1967, now Pat. No. 3,464,383.

In the usual and well known 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 thereon. Subsequently, the latent image is 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 then electrostatically transferred to a paper web upon which the image is affixed by a fixing device. As a result, the powder image is permanently adhered to the paper web.

The fixing device essentially comprises a toner powder which is an electrostatically charged, finely divided material, such as an electroscopic powder. Various arrangements have been devised for dispensing the toner powder onto the paper web to fix the image thereon. A common form of a powder dispenser comprises a cylinder which contacts both the paper web and the toner powder to distribute the powder on the web. However, it has been found that the powder will be non-uniformly deposited upon the moving paper web if the powder was not initially uniformly distributed on the surface of the cylinder. Therefore, numerous attempts have been made to deposit the powder as uniformly as possible on the cylinder surface.

In a proposed cylinder construction, the cylinder itself constituted an independent magnetic pole and has positioned adjacent to it a second magnetic pole of opposite polarity so that the lines of magnetic flux between the two poles will extend radially of the cylinder along the entire length thereof. While a uniform distribution of powder has been achieved with such a construction, it has been found that such an arrangement is expensive to construct and requires considerably increased overall dimensions of the apparatus.

It has therefore been proposed to construct the cylinder itself in the form of a permanent magnet with the lines of flux extending in or near the surface of the cylinder. In this cylinder, local accumulations of the powder on the surface of the cylinder resulted in a non-uniform distribution of the powder upon the traveling paper web. In an attempt to avoid this difficulty the cylinder was rotated at a peripheral speed greater than the speed of the traveling paper web. However, this increased rotation of the cylinder did not completely eliminate this difficulty since if the cylinder rotated too rapidly the powder would be released as a dust which would then settle on the paper web even in those areas which were not electrostatically charged. When the cylinder was rotated relatively slower, the powder would appear as longitudinal

bands along the cylinder or as transverse bands across the paper web.

It was further proposed to construct such a cylinder of individual magnet disks which were inclined to the axis of rotation of the cylinder. Thus, when the cylinder rotated the magnetic field would be moved across the traveling paper web parallel to the axis of rotation. This proposal was unsatisfactory in that while longitudinal bands were eliminated from the paper web undulating bands were formed in their stead.

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 device.

It is another object of the present invention to provide such a magnetic cylinder having a uniform magnetic field upon the peripheral surface thereof.

It is an additional object of the present invention to provide a magnetic cylinder which will uniformly dispense toner powder upon a traveling web without any dust-like diffusion of the powder.

In one aspect of the present invention there is provided a magnetic cylinder wherein the north and south magnetic poles extend along the peripheral surface of the cylinder. A plurality of circumferentially undulating alternately spaced north and south pole magnetic elements are positioned on the peripheral surface of the cylindrical member. The undulations of the north and south pole elements correspond so that a plurality of closely spaced adjacent pairs of north and south poles are defined along the peripheral surface of the cylindrical member. The magnetic elements may either be circular or helical.

In one embodiment of the invention a plurality of aligned magnetic disks made of magnetic rubber are stacked to form a cylinder with the disks being of alternate north and south polarity. Pre-formed steel disks may be interposed between the magnetic disks.

In another embodiment of the invention a layer of magnetic rubber is positioned about a cylindrical core. The magnetic rubber is then magnetized to form a plurality of closely spaced undulating north and south magnetic elements along the peripheral surface of the cylinder.

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 wherein:

FIG. 1 is an elevational view of a portion of the magnetic cylinder according to the present invention and showing the circumferentially extending magnetic pole elements;

FIG. 2 is a perspective piew of a disk used in the construction of the present invention;

FIG. 3 is a view similar to that of FIG. 1 but in enlarged scale and showing the polar elements together with the magnetic lines of force established by these elements;

FIG. 4 is a view similar to that of FIG. 1 but showing another embodiment of the present invention wherein magnetic rubber is positioned over a cylindrical core; and

FIG. 5 is a transverse sectional view of the magnetic cylinder illustrated in FIG. 4.

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 plurality of steel disks **1**, as illustrated in FIG. 2, and a plurality of magnetic disks **2** are alternately aligned as shown in FIG. 1 to form a magnetic cylinder **3**. The steel disks **1** have their periphery corrugated with the magnetic disks **2** also being corrugated. If desired the magnetic disks may merely be flat disks of magnetic rubber, a suitable synthetic resin or the like, which are flexed into the proper position

when the plurality of pre-formed steel disks are compressed to form the cylinder.

The magnetic rubber disks **2** provide the magnetic flux distribution as shown in FIG. 3. The distribution of the magnetic flux may be seen along the lower portion of the cylinder **3** shown in FIG. 3. It will be apparent that with this construction of the magnetic cylinder there will be a uniform distribution of the magnetic field along the entire length of the cylinder. As a result, the toner powder will become deposited uniformly over the entire peripheral surface of the magnetic cylinder.

During rotation of the cylinder any irregularities in the thickness of the layer of powder on the cylinder will be quickly smoothed out by the back and forth movement of the magnetic field in the axial direction. As a result, the picture that is to be developed and fixed will be subjected to a uniform deposition of powder.

The positioning of the steel disks between the magnetic disks in the assembly of the magnetic cylinder will enable the magnetic lines of force to pass outwardly from the surface of the cylinder in the manner as schematically illustrated in FIG. 3.

The assembly of the pre-formed steel disks and magnetic rubber disks in this manner will form a magnetic cylinder having a cylindrical outer surface but with magnetic polar elements defining circumferentially undulating paths about the peripheral surface of the cylinder. These paths of the magnetic elements are substantially circular but it is pointed out that these paths may be made helical in shape.

A further embodiment of the present invention is illustrated in FIGS. 4 and 5. In this embodiment there is provided a cylindrical core **10** over which a cylinder of magnetic rubber **11** is fitted to form the cylinder indicated generally at **15**. After assembly, the rubber cylinder **11** is then magnetized so that pairs of magnetic elements **12** and **13** will be formed as illustrated in FIG. 4. The distribution of the magnetic lines of force from this arrangement of the magnetic polar elements will be the same as illustrated in FIG. 3.

In a further modification, the magnetic disk elements may be formed from a thermoplastic material into the shapes as shown for the steel disk in FIG. 2. A plurality of these preformed plastic elements are then assembled to form the cylinder.

A simple but effective method for carrying out the magnitization of the cylinder illustrated in FIGS. 4 and 5 will next be described. A pair of spaced electrically conducting wires are helically wound about the outer surface of the magnetic cylinder **11**. These wires are undulated or corrugated into substantially the shape as shown

in FIG. 4. The ends of the wires are then connected and direct current passed through the wires. The result will be to define a plurality of circumferential undulating magnetic members along the peripheral surface of the cylinder.

Thus it can be seen that the present invention provides a magnetic cylinder wherein the north and south magnetic poles are arranged annularly or helically or the like about the peripheral surface of the cylinder in an undulating manner. The north pole elements are arranged in contiguous pairs alternately with contiguous pairs of south pole elements. The resulting arrangement of north and south pole magnetic elements provide a uniform distribution of magnetic flux along the entire peripheral surface of the cylinder. As a result the toner powder will adhere to the peripheral surface of the magnetic cylinder in a uniform layer. The uniform distribution of the toner powder on the magnetic cylinder will enable the toner powder to be uniformly dispensed upon a moving paper web to fix the image thereon.

It will be 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 this invention as may fall within the scope of the appended claim.

I claim:

1. In a process for making a powder dispensing cylinder for an electrostatic powder image fixing device with the cylinder having circumferentially undulating alternatingly spaced north and south pole magnetic elements on the periphery thereof, the steps of applying a layer of magnetic rubber upon a cylindrical core member, winding a pair of spaced electrically conducting wires helically around the outer surface of the layer of magnetic rubber, connecting together one pair of ends of said wires, and passing a direct current through said wires.

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