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Forgo et al.

[11] **3,783,828**

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[54] **APPARATUS FOR DEVELOPING LATENT ELECTROSTATIC CHARGE IMAGES**

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[73] Assignee: **Zellweger AG,** Uster, Switzerland

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **118/637**

[51] **Int. Cl.** **G03g 13/08**

[58] **Field of Search** ..... 118/637; 117/17.5; 346/74 ES; 101/1 NQ; 355/3 DD

[56] **References Cited**

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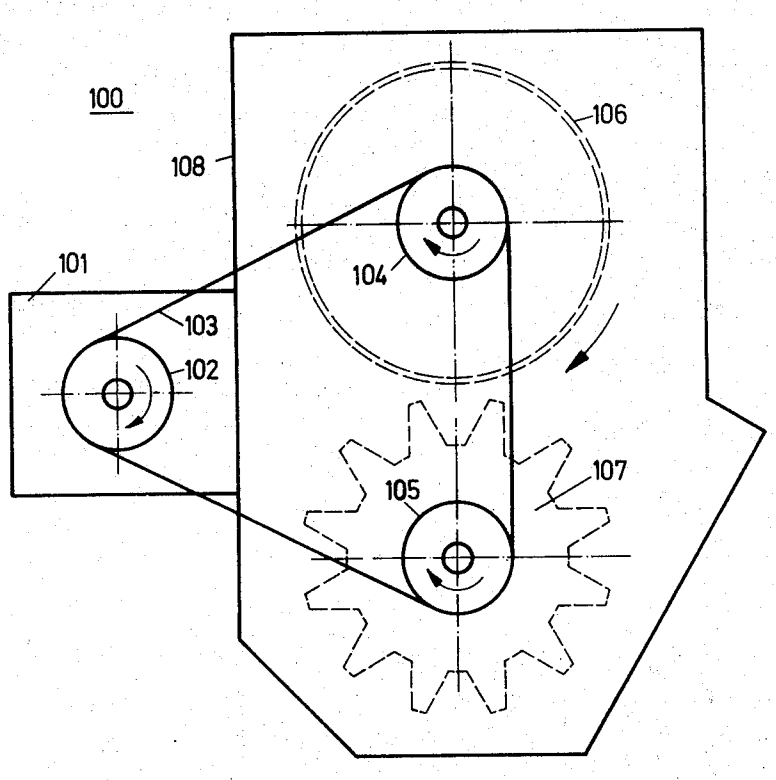
Attorney—Werner W. Kleeman

[57] **ABSTRACT**

An apparatus for developing latent electrostatic charge images by means of a magnetic brush wherein there is provided a rotatably mounted scoop or bucket wheel formed of insulating material and serving for dispensing a mixture of magnetic and toner particles. Above the scoop wheel there is arranged a rotatably mounted drum formed of non-magnetic material and within which there is provided a stationary magnet system with a core of soft magnetic material and prismatic permanent magnets arranged about such core. The magnets starting from the lowest location of the internal compartment of the drum and within the ascending drum wall possess alternating polarity and at least two successive permanent magnets at the upper portion of the inner compartment of the drum have the same polarity.

9 Claims, 6 Drawing Figures



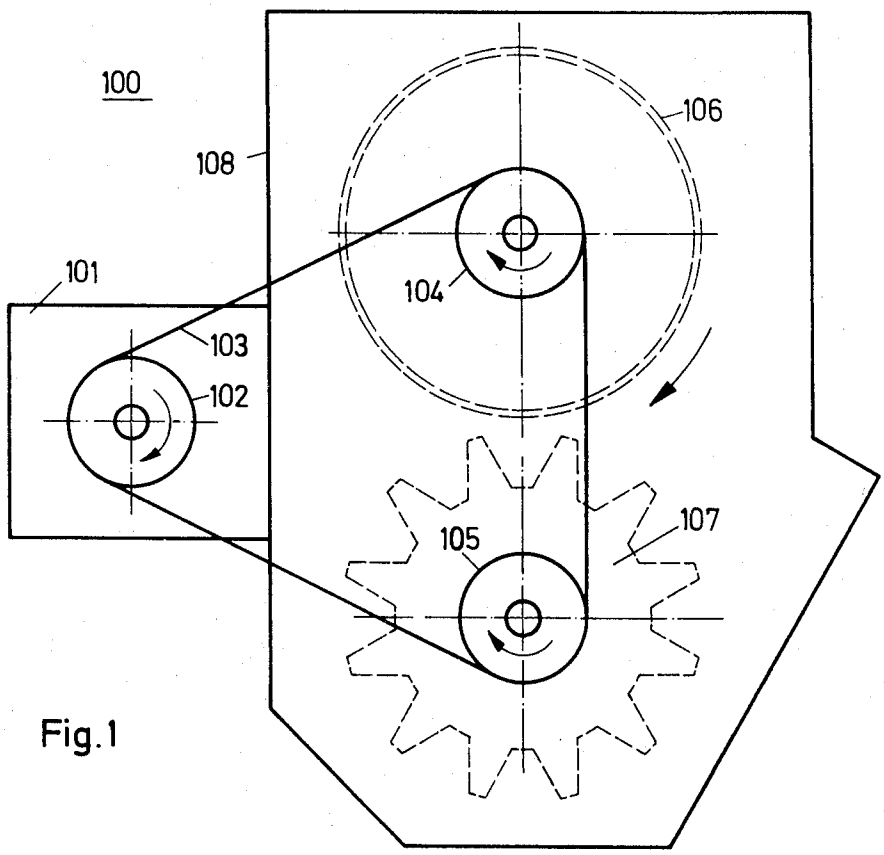


Fig.1

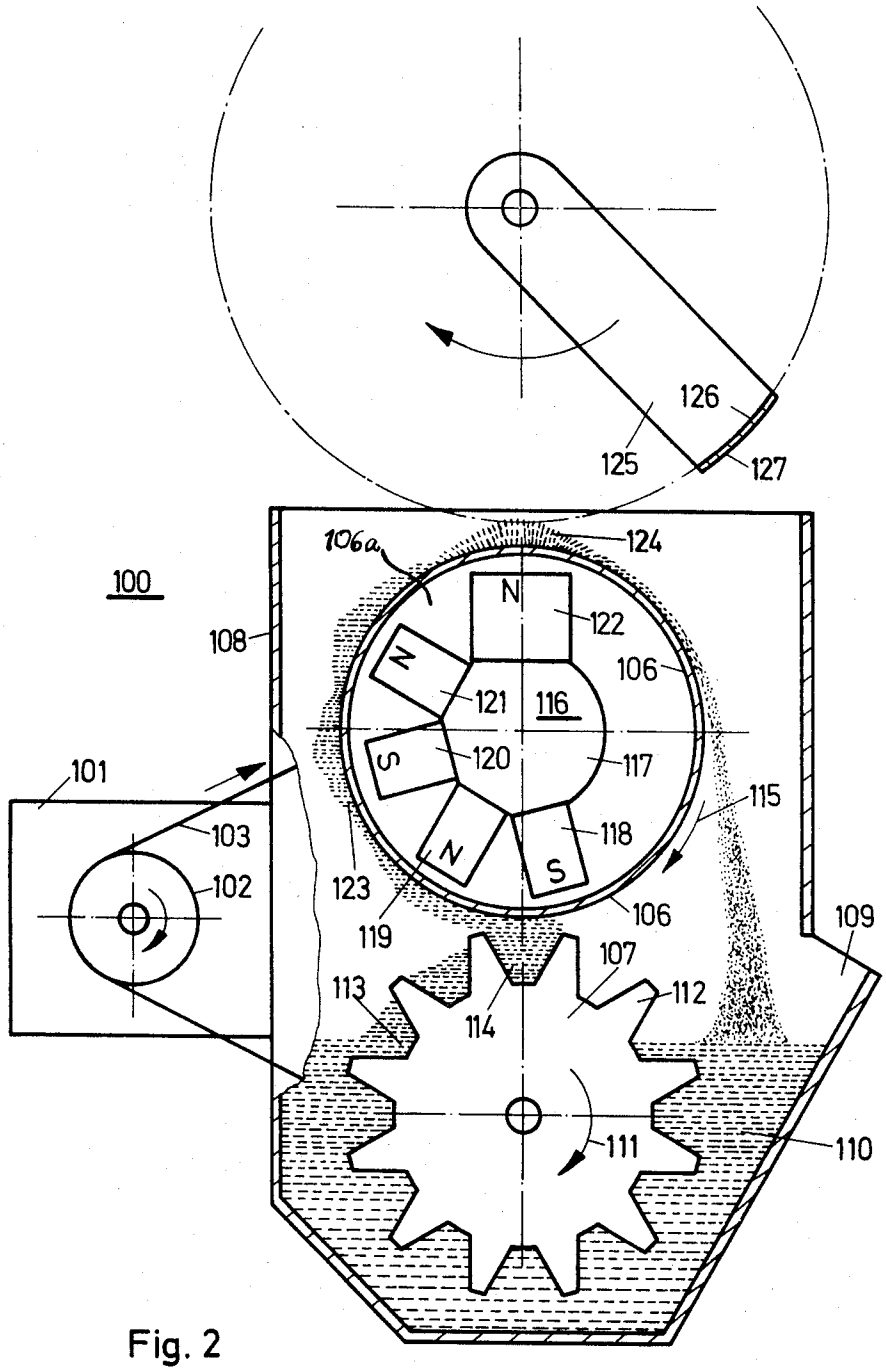

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Fig. 2

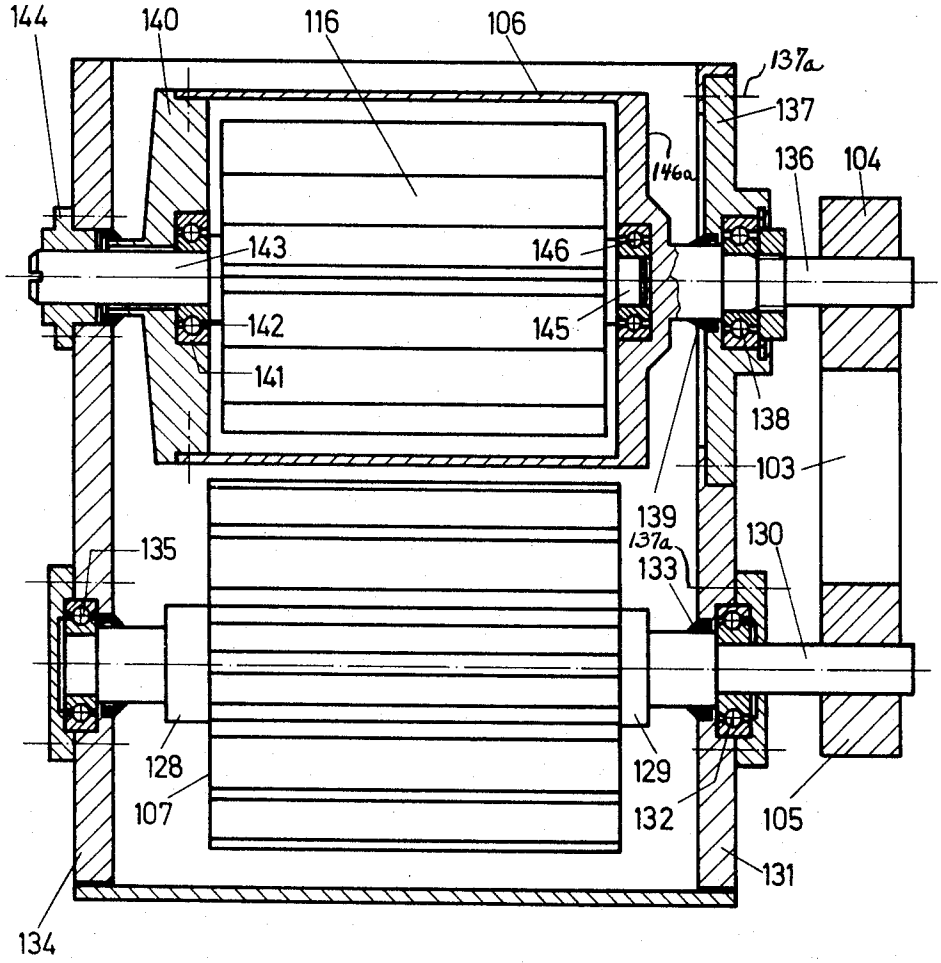
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Fig. 3

Fig 4b

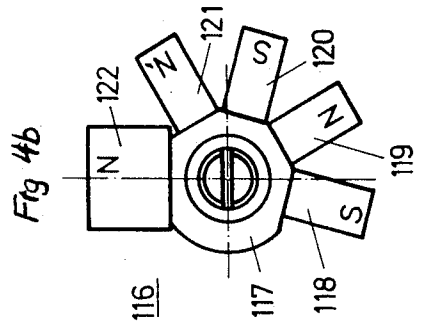
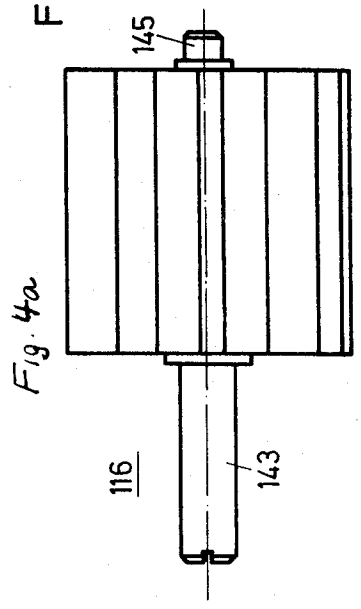


Fig. 4

Fig. 4a



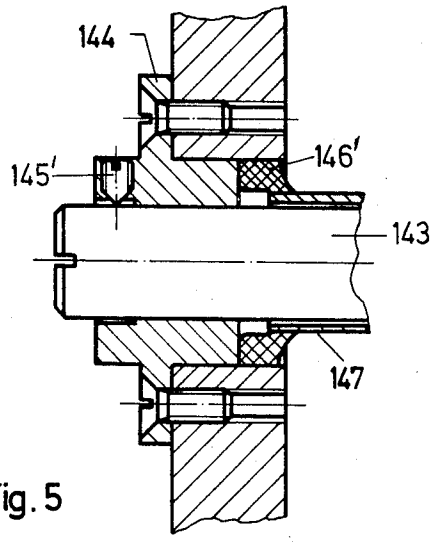


Fig. 5

APPARATUS FOR DEVELOPING LATENT ELECTROSTATIC CHARGE IMAGES

BACKGROUND OF THE INVENTION

The present invention relates to a new and improved apparatus for developing latent electrostatic charge images.

The invention is especially directed to a developer or developing apparatus for an electrostatic printing device. The development function takes place by covering a carrier of a latent electrostatic charge image with a so-called magnetic brush. Equipment for carrying out electrostatic printing techniques are known to the art wherein owing to an electrical discharge between an electrode arrangement and a carrier for electrical charges there is produced a latent electrostatic charge image. This latent electrostatic charge image is dry developed in known manner, for instance by means of the aforementioned magnetic brush. Electrostatic printing equipment suitable for such purposes has been discussed in the publication entitled "Taschenbuch der Nachrichtenverarbeitung", Karl Steinbuch, 2nd edition, Springer Publishers, Berlin/Heidelberg/New York, 1967, Library of Congress Catalogue Card No. 67–21079, page 696, FIGS. 5.7/5 and associated text. The carrier upon which the latent electrostatic charge image is produced can be a so-called dielectric paper. Such dielectric paper consists of a paper base of a predetermined electrical conductivity with a dielectric coating applied thereto, which for instance can contain zinc sulfide. Various examples of such paper has been disclosed in the commonly assigned, copending United States application, Ser. No. 263,671, filed June 16, 1972, of Walter Strohschneider, entitled "Laminated Article" to which reference may be readily had.

In order to develop the latent charge image the coated side of the aforementioned carrier is wiped with a magnetic brush. The bristles of the magnetic brush consist of magnetic particles which adhere to one another by magnetic force, and embedded in the bristles are numerous static electrically charged toner particles. In this regard attention is invited to the commonly assigned, copending United States application, Ser. No. 272,064, filed filed July 14, 1972, of one of the coinventors of this development, Garbor Forgo, entitled "Method and Apparatus For Improving The Contrast During Electrostatic Printing."

Although different constructional embodiments of magnetic brushes are known to the art, still it has been found that for producing very exact printed images, for instance coded images as such are required upon the labels for marking commercially sold articles, the heretofore known magnetic brushes produce unsatisfactory results.

SUMMARY OF THE INVENTION

Therefore it is a primary object of the present invention to provide a new and improved construction of apparatus for developing latent electrostatic charge images.

Another and more specific object of the present invention relates to an improved developer or developing apparatus which possesses extremely compact and above all uniform magnetic brushes.

Yet a further significant object of the present invention relates to a novel developer for latent electrostatic charge images which is extremely reliable in operation,

relatively simple in construction, and produces a good development of such latent electrostatic charge images.

Now in order to implement these and still further objects of the invention, which will become more readily apparent as the description proceeds, the present invention concerns an apparatus for developing latent electrostatic charge images by means of a magnetic brush, and which is manifested by the features that there is provided a rotatably mounted scoop or bucket wheel for a mixture of magnetic and toner particles and formed of insulating material. A rotatably mounted drum formed of non-magnetic material is arranged above the scoop or bucket wheel. The rotatably mounted drum possesses an internal compartment within which there is arranged a stationary magnetic system having a core of soft magnetic material and a number of prismatic permanent magnets arranged about such core. Starting from the lowermost location of the internal compartment of the drum the permanent magnets arranged in succession within the ascending drum wall possess alternating polarity and at least two successive permanent magnets at the upper portion of the internal compartment of the drum possess the same polarity.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above, will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

FIG. **1** is a front schematic view of a preferred constructional manifestation of developer or developing device designed according to the teachings of this invention;

FIG. **2** is a view of the developer similar to the showing of FIG. **1**, but partially in section in a direction transverse to the axial direction thereof;

FIG. **3** is a sectional view of the developer taken substantially along the axial direction thereof;

FIG. **4**, consisting of FIGS. **4***a* and **4***b* , shows two different views of the magnet system of the developer, and specifically FIG. **4***a* a front view of such magnet system and FIG. **4***b* an end view of such magnet system; and

FIG. **5** is a fragmentary view showing details of the mounting of the magnet system depicted in FIG. **4**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Describing now the drawings, the exemplary embodiment of developer or developer unit **100** depicted in FIG. **1** will be understood to be provided with a drive means, such as the drive motor **101** equipped with standard reduction gearing. This drive motor **101** drives through the agency of a belt pulley **102** and a drive belt **103** the further belt pulleys **104** and **105**. The direction of rotation of the aforementioned belt pulleys **102, 104** and **105** has been indicated by the arrows depicted in FIG. **1**. Rotation of the belt pulley **104** is transmitted to a drum **106** and the rotation of the belt pulley **105** to a dispensing device in the form of a scoop or bucket wheel **107**. The belt pulleys **104** and **105** are located externally of a housing **108** of the developer **100**. Accordingly, the drive belt **103** runs outside of the housing **108** over the belt pulley **102** of the drive motor **101** secured to such developer housing **108**.

Continuing, FIG. 2 will be understood to constitute a substantially vertical sectional view through the developer 100 of FIG. 1, wherein however the section does not extend through the drive motor 102. Housing 108 of the developer 100 is provided with a lateral opening 109 through which there can be infed toner 110. This toner 110 is admixed with magnetic particles introduced into the developer or developing unit 100. The scoop or bucket wheel 107, driven by the belt pulley 105, is formed of any suitable insulating material, for instance the commercially available product of Dupont De Nemours & Company, of Wilmington, Del., and known in the trade as DELRIN, or a similar insulating material.

The scoop or bucket wheel 107 is provided at its periphery with the mutually spaced, radially extending ribs or fingers 112 between each two neighboring ones of which there is formed the grooves or pockets 114, as clearly shown in FIG. 2. Now during such time as the scoop wheel 107 rotates in the direction of the arrow 111 the ribs or fingers 112 thereof move through the toner 110 at the bottom region of the developer housing 108. Consequently, the toner particles are static electrically charged. In the exemplary embodiment under consideration there is selected, by way of example, as the material for the toner an insulating material which due to friction is positively charged. The toner 110 together with the admixed magnetic particles are thus elevationally conveyed within the grooves or pockets 113 of the scoop wheel 107. At the highest location of the scoop or bucket wheel 107 a pocket or groove 114 is situated at a small spacing, for instance of several millimeters, from the outer surface of drum 106.

Now this drum 106 consists of non-magnetic material, for instance is formed of an aluminum alloy or brass and rotates in the direction of the arrow 115. A stationary magnet system 116 is arranged internally of the inner compartment 106*a* of the drum 106. The stationary magnet system 116 consists of a core 117 of soft magnetic material and permanent magnets 118, 119, 120, 121 and 122 arranged about this core 117.

The arrangement and the poles of the permanent magnets 118 to 122 is chosen such that the magnets 118 and 119 which at least approximately are situated opposite to the momentarily uppermost located pocket 114 of the rotating scoop wheel 107 have poles which are of opposite polarity at the region of the inside of the associated drum 106. In other words, the permanent magnet 118 has a south pole, designated as an S-pole closest to the inside wall of the drum 106 and the permanent magnet 119 has a north pole, designated as a N-pole, at its face closest to the inside wall or surface of such drum, and as best seen by referring to FIG. 2. Owing to the magnetic field prevailing between these poles the toner particles which contain magnetic particles therein are attracted out of the uppermost located pocket 114 of the scoop wheel 107 to the outer surface of the drum 106. Owing to the provision of the magnet system 116 the particles adhering to the outer surface of the drum 106 are upwardly conveyed along the left side of such rotating drum. Thus at the lower and at the left ascending portion of the drum 106 there is formed a more or less compact coating 123 owing to the alternating poles of the magnet system 116. At the uppermost location of the drum 106 externally of the magnet 122 the lines of force extend radially however. This approximately radial direction of the lines of force is present because at the last successively arranged magnets 121 and 122 the same pole, in the present case a respective N-pole, is present at the outside of each such magnet 121 and 122, as shown. Hence, by virtue of the radially extending lines of force there is formed in known manner and owing to the mutually adhering magnetic particles the previously discussed magnetic brush 124. In order to impart an advantageous form to the magnetic brush 124 it is especially advantageous to design the uppermost permanent magnet 122 so as to be somewhat wider than the remaining magnets 118 to 121. This magnetic brush 124 attains, for instance, a bristle length of about 5 to 10 millimeters. The magnetic brush 124 contains numerous static electrically positively charged toner particles.

Continuing, it will be also recognized by referring further to FIG. 2 that the developer 100 is arranged slightly below the pivotal region of a rotating arm 125 in such a manner that the end face 126 of this rotating arm 125, together with an article, assumed for instance to be a label 127 adhering thereto and having a latent, negative electrostatic charge image, approaches the magnetic brush 124 formed at the drum 106 above the magnet 122, to such an extent that the bristles of this magnetic brush 124 wipe over such label 127.

Consequently, positive toner particles are attracted from the magnetic brush 124 by the negatively charged locations of the surface of the label 127. As a result the latent charge image is rendered visible and there may occur, for instance, subsequent thereto the fixation of the visible latent charge image during such time as it is moved past a suitable heat radiation source.

Owing to rotation of the drum 106 the magnetic particles together with the toner particles adhering thereto finally depart from the region of the magnetic 122, so that they no longer adhere to the outer surface of the drum 106 and fall back into the lower portion of the developer housing 108.

The arrangement of the permanent magnets 118 to 122 of the magnet system 116 as depicted in and discussed in conjunction with FIG. 2 provides a very reliable conveying and distribution of the toner material and a very advantageous form of the magnetic brush with a minimum expenditure of magnetic material. The selected gear-like configuration of the scoop wheel 107 allows such to be manufactured quite easily, and apart from a good admixing of the toner material, also provides a forceful static electrical charging of the toner particles.

In FIG. 3 there is shown a further secitonal view through the developer 100, and wherein specifically there is depicated an advantageous constructional arrangement of the mounting of the scoop wheel 107, the drum 106 and the magnet system 116. In particular, it will be understood that the scoop wheel 107 is secured by means of the hubs 128 and 129 upon a shaft 130. The right-end of shaft 130 carries the belt pulley 105. Upon passage of the shaft 130 through the right-hand wall 131 of the developer housing 108 this shaft 130 is mounted in a suitable ball bearing 132. Upon passage of the shaft 130 into the interior of the housing 108 there is provided a sealing collar 133 formed of a suitable elastomeric material in order to protect the ball bearing 132 against the entry of toner material and magnetic particles. The left-hand end of the shaft 130

is mounted in analogous fashion in a ball bearing **135** arranged at the left-hand housing wall **134.**

Drum **106** is provided with a shaft **136** which upon passage thereof through a detachable cover **137** is mounted at a ball bearing **138** at the right-hand housing wall **131.** The detachable cover **137** can be removably secured to the housing wall **31** by any suitable attachment means, such as the schematically indicated attachment screws **137***a*. At this point it is to be mentioned that the ball bearing **138** is protected against the penetration of toner particles and magnetic particles, by means of a sealing collar **139** or equivalent device formed of elastomeric material, analogous to the ball bearing **132.** The belt pulley **104** for driving the drum **106** is seated upon the shaft **136.**

Now at the left end of the drum **106** there is secured a flange **140.** This flange **140** possesses a central bore or opening **141** in which there is arranged a ball bearing **142.** Drum **106** is mounted by means of this ball bearing **142** upon a journal or axle piece **143.** This journal **143** constitutes an axial extension of the core **117** of the magnet system **116.** The left-hand end of the journal **143** is fixed by means of a bushing **144** secured at the left-hand housing wall **134.**

Turning now to FIG. **4** such shows details of the magnet system **116** of the developer **100,** and specifically FIG. **4***a* shows a front view of the magnet system and FIG. **4***b* an end view thereof looking in axial direction. The core **117** of the magnet system **116** is rigidly connected with the housing **108** owing to the fixed clamping of its journal **143** at the bushing **144.** A journal or axle piece **145** at the right-hand end of the core **117** engages with a further ball bearing **146** which is inserted into a flange **146***a* located at the right-hand side of the drum **106.**

FIG. **5** shows details of the mounting of the journal **143** at the left-hand housing wall **134.** The bushing **144** is threadably connected with this housing wall **134.** A positioning screw **145'** serves to fix the journal **143** and the bushing **144.** Upon releasing the positioning or set screw **145'** it is possible to adjust the magnet system **116** so that it assumes its optimum angular position is such a manner that the magnetic brush **124** is formed at a location which is optimum for wiping across the labels **127.**

In order to suppress penetration of the magnetizable particles in the toner and the toner itself into the magnetic system **116** located within the internal compartment **106***a* of the drum **106** a collar **146'** formed of elastic or elastomeric sealing material is embedded in the bore of the housing wall **134** which accommodates the bushing **144.** This collar **146'** slides upon a tubular- or pipe-shaped extension **147** of the flange **140** of the drum **106.**

After releasing the attachment screws by means of which the releasable cover **137** has been secured to the right-hand located housing wall **131,** as best seen by referring to FIG. **3,** and after releasing the positioning or set screw **145'** of FIG. **5,** it is possible to remove the entire drum **106** together with the magnet system **116** from the developer housing **108,** as such may be required, for instance, for cleaning- or revision purposes.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims. ACCORDINGLY,

What is claimed is:

1. An apparatus for developing latent electrostatic charge images by means of a magnetic brush, comprising a rotatably mounted scoop wheel formed of insulating material for a mixture of magnetic particles and toner particles, a rotatably mounted drum formed of non-magnetic material arranged above said scoop wheel, said rotatably mounted drum being bounded by a drum wall internally of which there is provided an internal compartment, a stationary magnet system arranged within said internal compartment of said drum, said stationary magnet system comprising a core of soft magnetic material and permanent magnets arranged about said core, the permanent magnets, starting from the position of the lowermost location of the internal compartment of the drum and successively arranged within the ascending drum wall, possessing alternating polarity, at least two successive permanent magnets arranged at the upper portion of the internal compartment of the drum possessing the same polarity.

2. The apparatus as defined in claim **1,** further including a drive motor for driving said scoop wheel and said drum.

3. The apparatus as defined in claim **1,** further including a housing for said scoop wheel and said drum, and drive means for said scoop wheel and said drum located externally of said housing.

4. The apparatus as defined in claim **1,** wherein the insulating material from which said scoop wheel is formed is DELRIN.

5. The apparatus as defined in claim **1,** wherein said scoop wheel is provided at its outer surface with substantially axially parallelly extending ribs and grooves.

6. The apparatus as defined in claim **1,** further including a housing for said scoop wheel and said drum, a cover detachably secured to said housing, and means for securing said drum to said cover.

7. The apparatus as defined in claim **6,** further including a journal, said drum being mounted upon said journal.

8. The apparatus as defined in claim **6,** wherein said housing includes a housing wall, and means for adjustably securing said journal to said housing wall.

9. The apparatus as defined in claim **8,** wherein said journal is rigidly connected with said magnet system.

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