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1

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DEVELOPER POWDER APPLICATOR UNIT HAVING A SUPPLY ROLL WITH A MAGNETIZED WORKING SURFACE

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1 Claim. (Cl. 118—620)

This invention relates to copying machines useful in the copying of printed documents and similar graphic originals by methods involving formation of an invisible latent image followed by powder developing of a corresponding permanent visible image. More particularly, the present invention relates to a powder developer module, one important modification being specifically adapted for use in conjunction with a popular form of thermographic copying machine and employing cooperating copy-papers and developer powders as will hereinafter appear.

Developer powders for developing visible images from electrostatic or other latent images ordinarily consist of colored electrosopic powders in conjunction with much larger particles of glass or other carrier media. In some instances magnetic materials serve as the carrier and are themselves oriented in the form of magnetic brushes attached to permanently magnetized handle members. In all cases the loose mass of powder is slid or drawn over the imaged surface to leave a portion of the powder at the image-forming areas.

The present invention introduces a new and improved technique of powder application, which while not restricted thereto, is particularly useful in the developing of permanent visible images from latent images formed by application of a corresponding heat pattern to copy-sheets coated with a hard solid fusible material which fuses to a metastable liquid when heated. A magnetic powder is retained on a magnetic bed as a smooth firm surface coating with which the sheet having the latent image is then placed in momentary sliding contact. The powder is wetted and preferentially retained by the metastable liquid which thereafter soon solidifies. Any traces of loose powder remaining on the sheet are removed by brushing with a soft brush, which in the automatic developer here to be described further serves to eject the copy.

A suitable magnetic powder may consist of "Mapico Black" magnetic iron oxide uniformly dispersed in an equal weight of molten benzil, the cooled and hardened mixture being reduced to fine particle size. The benzil serves as a thermoplastic binder for the magnetic particles. Additional coloring agents, e.g. carbon black or organic dyes, may be included if desired.

In the drawing,

FIGURE 1 is a side elevation, taken along section 1-1 of FIGURE 2, of an illustrative developing device in association with related components of a commercial thermographic copying machine;

FIGURE 2 is a partial plan view corresponding to FIGURE 1, with parts cut away as indicated;

FIGURE 3 is a partial plan view showing a portion of the powder-retaining trough and guide members;

FIGURE 4 is a fragmentary representation in perspective of the structure of FIGURE 3; and

FIGURE 5 is a representation of the surface arrangement of the roll 12 of FIGURES 1 and 2.

The device as illustrated consists essentially of guide members 10 and 11, powder distribution roll 12, trough 13, feed roll 14, ejector roll 15, and guide members 16 and 17 forming parts of an enclosing frame 18. Also shown in FIGURES 1 and 2 are print roll 20, lamp assembly 21, guide roll 22, drive roll 23, belt 24, and guide

2

members 25 and 26 of the thermographic copying machine, in this instance a "Thermo-Fax" copying machine as described in Kuhrmeyer et al. U.S. Patent No. 2,891,165.

The paper guide members 10 and 11 may form a part of the thermographic copying machine but are modified as shown in FIGURE 1. The lower guide member 11 has upturned bottom edge closely aligned with the extended surface of the roll 12 for directing the copy into tangential contact with the latter. The guide 10 has a smooth straight lower edge closely adjacent the tip of the guide 11 and the surface of the roll 12, for a purpose later to be described.

The entire surface of the roll 12 is provided with a uniform pattern of alternating closely spaced magnetic poles. Typically, a non-magnetic roll is covered with small "Alnico" or equivalent bar magnets closely spaced together in rows as illustrated in greater detail in FIGURE 5. Each magnet is approximately $\frac{1}{2}$ " long, $\frac{3}{16}$ " wide and $\frac{1}{8}$ " thick, adjacent magnetic poles being arranged in opposition. The roll is made of aluminum. It is about $\frac{7}{8}$ " in diameter and $8\frac{1}{2}$ " long, and supports a total of 125 uniformly spaced magnets, in ten rows of alternately 12 and 13 magnets, the over-all diameter thus being about $1\frac{1}{4}$ ". The magnets are bonded to the aluminum surface with a strong elastomeric adhesive.

The structure described is convenient to assemble and provides a high strength magnetic field having uniformly spaced small separate zones of high field gradient, in this case with opposing polarity. Another suitable structure but having zones of identical rather than opposite polarity is formed by inserting the small bar magnets lengthwise into radially extending openings in the non-magnetic roll surface with like poles at the surface, again to obtain uniformly spaced small separate zones of high field gradient.

The trough 13 in which the roll 12 rotates contains a magnetic developer powder 27 which is taken up by the magnetic surface of the roll and leveled by a blade 28 formed of the in-turned edge of the sheet material forming the trough. As the roll 12 is rotated past the blade 28, it attracts and maintains a smooth continuous and compact powder surface coating, the diameter being maintained at just over $1\frac{1}{4}$ inches. The specific dimensions given are not critical but will serve to indicate the type of surface and the manner in which it is obtained.

At the side of the trough 13 opposite the blade 28 there is provided a series of thin guide plates 29 uniformly spaced along supporting rods 30 and supporting at their forward tips a smoothing bar 31. The bar 31 and the rounded upper edges of the plates 29 lie beneath the feed roll 14 for directing the composite against the roll 15.

The soft surface of the ejector roll 15 contacts the feed roll 14 and serves as a portion of the ejector chute otherwise defined by guide members 16 and 17.

The rolls 12, 14 and 15 are positively driven, e.g. by suitable gear train, and preferably but not necessarily from the same source of power employed in rotating the drive roll 23 of the copying machine. The surface speed of the feed roll 14 is the same as that of the belt 24 and rolls 20, 22 and 23, whereas roll 12 is driven at approximately three times, and roll 15 at approximately five times that surface speed.

The production of copies proceeds as follows. A couplet or composite of a graphic original 32 and copy-sheet 33, each with the print surface upward, is fed into the machine between guide members 25 and 26, and passes around roll 20, beneath belt 24, and past the focus of lamp assembly 21. The radiation from the lamp produces a heat pattern corresponding to the differentially radiation-absorptive printed indicia on the graphic original. Conduction of the heat pattern to the copy-sheet 33 fuses

the corresponding areas of the coating on that sheet and reduces the coating to a metastable liquid. The composite advances between the guides 10 and 11, the latter directing the forward edge of the two sheets into tangency with the comparatively rapidly advancing surface of the powder distribution roll 12, and thereafter against the surface of the feed roll 14. The sheets continue across the roll 12, past the upper surface of the smoothing bar 31, and into contact with the surface of the roll 14. The latter re-directs the composite across the upper edges of the plates 29, against the roll 15, and into the nip between rolls 14 and 15. From there the composite is directed between guide members 16 and 17 and from the machine, where the completed copy is separated from the original.

As the trailing edge of the composite reaches the lower edge of the guide 10, the rapid rotation of the powder distribution roll 12 has a tendency to force powder from the surface of the roll between the edges of the two sheets. This tendency is overcome by the snap action of the two stiff, resiliently flexible, paper sheets immediately the trailing edge has passed the lower edge of the guide, as induced by the position of the bar 31 somewhat above the line connecting the upper surface of roll 12 and the lower surface of roll 14, i.e. toward the feed roll from the interconnecting plane of tangency. By this action the two sheets are lifted above and out of contact with the surface of the roll 12 during the critical terminal period of their travel past the developing area.

The feed roll 14, operating at the surface speed of the thermographic copying machine, is composed of extremely soft and resilient urethane foam or sponge, which exerts against the contacting sheet material a mild pulling action just sufficient to cause the sheets to advance when under light restraining tension. Increased drive is provided by the cooperative effects of the two rolls 14 and 15, the latter also serving to remove from the powdered copy-sheet surface any small traces of loose powder which may remain. Roll 15 for this purpose consists of a hard supporting roll having a soft fibrous surface covering 34, for example of sheepskin. Some of the loose powder may remain adhered to the fibrous surface, but much of it is detached and remains within and on the bottom of the

frame 18 which may periodically be detached for cleaning. In practice it is found that very little of the magnetic powder is removed from the magnetic surface of the drum 12 other than the portion which is permanently retained at the image areas of the copy-sheet, any loosened powder being magnetically attracted to the surface of the powder supply roll 12.

What is claimed is as follows:

1. A powder applicator unit comprising: an open trough-like receptacle for magnetic developer powder; a scraper bar along the forward edge of said open receptacle; a powder supply roll having a magnetized working surface having a pattern of uniformly spaced small separate zones of high field gradient and capable of attracting and retaining a thick deposit of a magnetic developer powder, said roll dipping into said receptacle and rotatable with its surface in close uniform proximity to said scraper bar; a soft compressible feed roll parallel to said supply roll and above the rearward edge of said receptacle; a smoothing bar between said supply roll and said feed roll and with its free smoothing surface disposed toward said feed roll from the interconnecting plane of tangency between the said rolls; a plurality of narrow guide plates closely spaced from said feed roll and extending from said smoothing bar; and a soft fibrous-surfaced ejector roll parallel to and in light surface contact with said feed roll and beyond said guide plates; said supply roll, feed roll, and ejector roll being interconnected for positive rotation at relative surface speeds of approximately three, one and five respectively and in a direction for urging a copy-sheet through said unit from said supply roll to said ejector roll.

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