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Allen

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[54] **CONDUCTIVE BLOCK TRANSFER SYSTEM**

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[73] Assignee: **Xerox Corporation,** Stamford, Conn.

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[52] **U.S. Cl.** ..... **355/3 R,** 96/1.4, 117/17.5, 250/325

[51] **Int. Cl.** **G03g 15/00,** G03g 15/16

[58] **Field of Search** ..... 355/3 R, 17; 96/1.4; 117/17.5; 250/324, 325, 326

[56] **References Cited**

UNITED STATES PATENTS

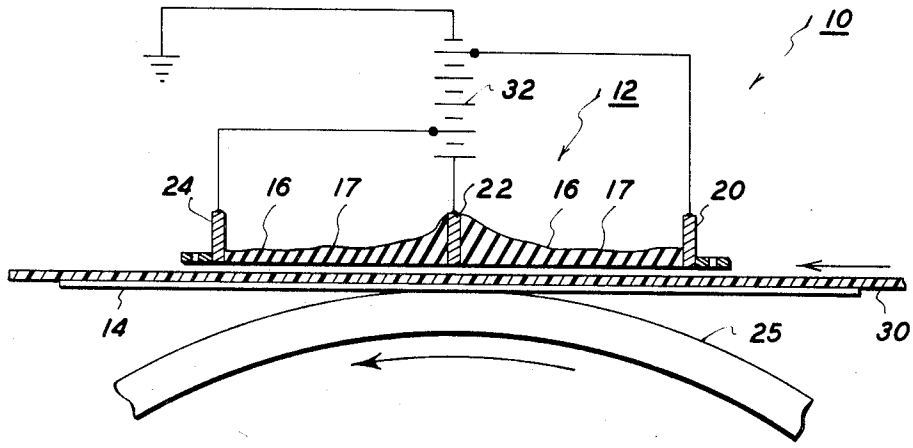
3,147,679	9/1964	Schaffert	355/17 X
3,642,362	2/1972	Mueller	355/3 R
3,647,292	3/1972	Weikel	355/3 R

Primary Examiner—Robert P. Greiner

[57] **ABSTRACT**

An electrostatographic copying system in which an image is formed on an imaging surface and transferred with electrical transfer fields at a transfer station to a copy sheet, where the copy sheet is preferably transported through the transfer station on a belt. The transfer fields are generated by a variable thickness, irregularly resistive block containing spaced electrode conductors. The conductors are variably biased to effect tailored transfer fields.

10 Claims, 2 Drawing Figures



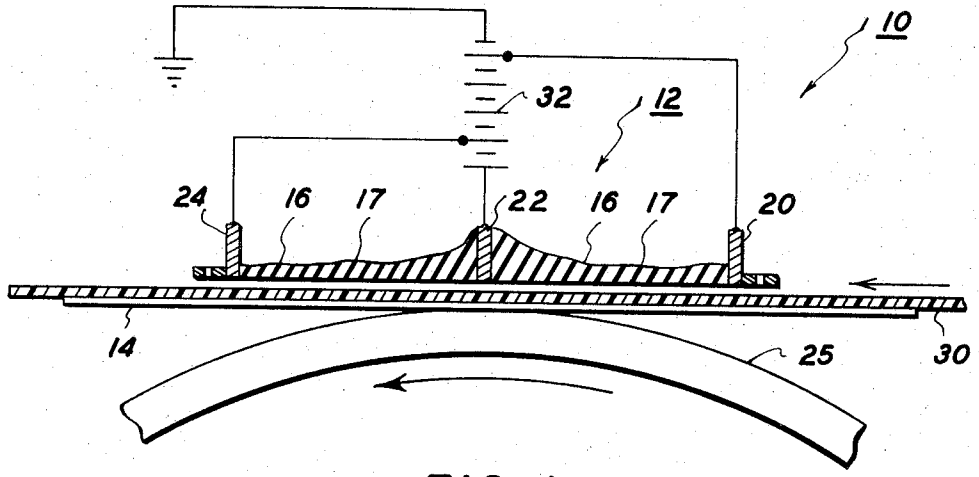

10
32
12
24
16
17
22
16
17
20
14
25
30

FIG. 1

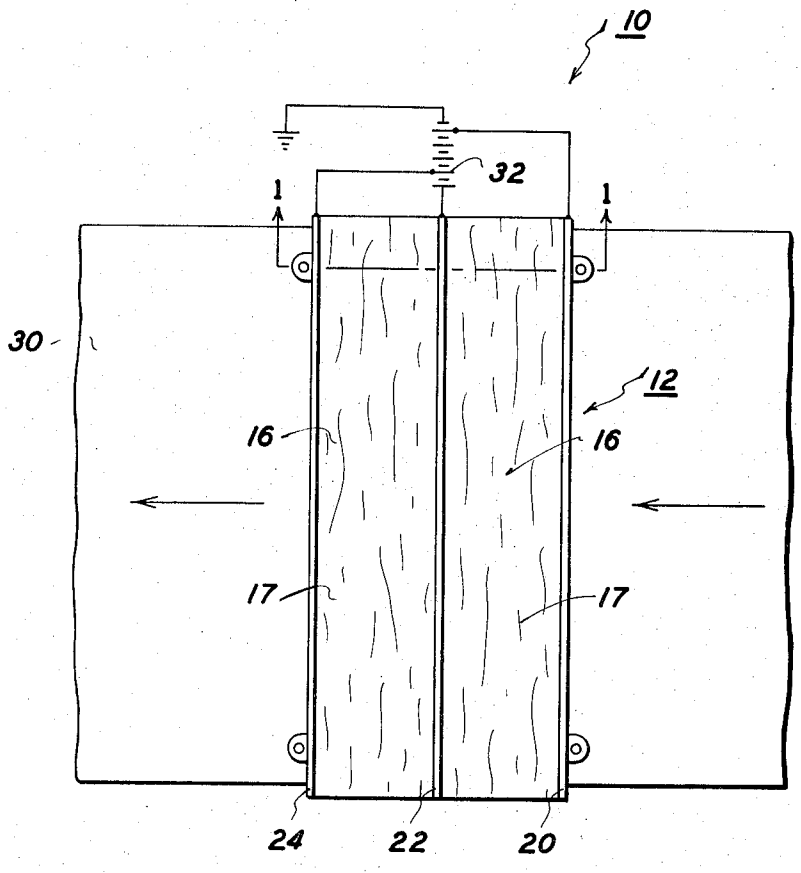

10
32
1
1
30
12
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16
17
17
24
22
20

FIG. 2

CONDUCTIVE BLOCK TRANSFER SYSTEM

The present invention relates to an electrostatographic copying system in which image transfer is effected by tailored transfer fields from a resistive transfer member.

In the conventional transfer station in xerography, toner is transferred from the photoreceptor (the original support and imaging surface) to the copy paper (the final support surface). Such development material tranfers are also required in other electrostatographic processing steps, such as electrophoretic development. In xerography, developer transfer is most commonly achieved by electrostatic force fields created by D.C. charges applied to the back of the copy paper (opposite from the side contacting the toner-bearing photoreceptor) sufficient to overcome the charges holding the toner to the photoreceptor and to attract most of the toner to transfer over onto the paper. These xerographic transfer fields are generally provided in one of two ways, by ion emission from a transfer corotron onto the paper, as in U.S. Pat No. 2,807,233, or by a D.C. biased transfer roller or belt rolling along the back of the paper. Examples of bias roller transfer systems are described in allowed U.S. Patent application, Ser. No. 309,562 filed Nov. 24, 1972 by Thomas Meagher, and in U.S. Pat. Nos. 2,807,233; 3,043,684; 3,267,840; 3,328,193; 3,598,580; 3,625,146; 3,630,591; 3,691,993; 3,702,482; and 3,684,364. U.S. Pat. No. 3,328,193 discloses a transfer system with spaced multiple rollers at different biases.

The transfer electrostatic fields and transfer contact pressure are critical for good transferred image quality. So is accurate sheet registration. Further, the copy sheet typically acquires a tacking charge and the imaging surface has a charge on it as well. Thus the copy sheet must be either mechanically or electrostatically stripped (separated) from the imaging surface at the exit of the transfer station or process, yet without disrupting the transferred image, which is typically unfused at that point and easily disturbed by either mechanical or electrical forces. A tranfer belt system, in which the copy sheet is moved through the entire transfer station held on a belt surface, is thus a preferred copy sheet handling system for transfer. Such systems are described in further detail in the U.S. Patent application (D/73586) filed concurrently with this application by Narenda S. Goel and Gerald M. Fletcher entitled "Belt Transfer System" and commonly assigned.

Considering references to prior transfer belt systems, U.S. Pat. No. 3,332,328 issued July 25, 1967 to C. F. Roth, Jr. discloses a xerographic transfer station including an endless loop belt for carrying the copy sheets through the transfer station, including contact with the xerographic drum, and corona charging means for placing a transfer charge on the back of the endless transfer belt.

U.S. Pat. No. 3,357,325 issued Dec. 12, 1967 to R. H. Eichorn et al. also contains these same basic features, plus additional D.C. corona charging means to charge the sheet of copy paper on the belt prior to transfer, so as to hold the paper on the belt electrostatically. It should be noted, however, that the charging of the paper (or belt) in this manner contributes to the total transfer potential, which is generally undesirable unless this additional charge can be held constant. A transfer corona generator is tilted relative to the back of the belt to provide the Eichorn transfer field.

U.S. Pat. No. 3,647,292 issued Mar. 7, 1972 to D. J. Weikel, Jr. discloses a uniform transfer belt system for carrying a copy sheet through the transfer station, vacuum means for holding the sheet on the belt, and transfer field generating means, which in one embodiment includes multiple stationary transfer electrodes in a stationary segmented plate with different (increasing) applied potentials acting at the back of the transfer belt. This reference is therefore particularly relevant to the present invention.

U.S. Pat. No. 3,644,034 issued Feb. 22, 1972 to R. L. Nelson discloses a segmented wide conductive strip transfer belt to which two different bias potentials are applied by two support rollers to those segments passing over the rollers. The conductive segments are separated by 1/16 inch insulative segments.

The most desirable aspects of a transfer system are high transfer efficiency with no image defects and high reliability, including insensitivity to external machine variables (relative humidity, paper type, etc.), where both are achieved with minimal complexity and cost. As noted, an important aspect of reliability associated with the transfer system is reliable paper handling. This must include good paper-to-photoconductor contact before application of an electric field sufficient for transfer. A bias belt transfer system offers the possibility of a reliable paper handling system with high transfer efficiency and less image defects. A belt transfer system can take many forms. Its main distinguishing feature is the presence of a belt to which the paper is tacked reliably and then is carried through the transfer system and eventually on to the fusing system.

The bias belt can provide the optimum geometry that will cause stripping of the paper away from the photoconductor after transfer, thus reducing the transfer stripping interactions that can occur in conventional corona or bias roll transfer systems. Belt transport into the transfer region can also remove the criticality of the paper lead-in configuration found in corona systems. Continuous sheet transport in and through the transfer region on the belt minimizes the chance of defects due to speed mismatch. The problem of insuring good paper-to-photoreceptor contact with thick papers and small photoconductor radii in corona transfer systems is eliminated in belt systems since it is only required to tack the paper to the infinite radius (substantially flat) belt, not the photoconductor. Further, lower nip pressures may be designed with more flexibility than a bias roller transfer system. Subsequent stripping of the copy sheet from the belt can be accomplished by using a sharp exit path radius; e.g. running the belt around a small radius roller, to make use of the inherent beam strength self-stripping action of the copy sheet.

In addition to paper transport gains, a belt transfer system offers potential special features. Among them are: simultaneous duplex, by initial toner image transfer to the belt and then reversing the charge of the toner (by corona treatment) before the next transfer pass; carrying paper directly to or through the fuser; and image preservation i.e. multiple copies from the same latent image.

The difficulties of successful image transfer are well known. In the pretransfer (prenip) region, before the copy paper contacts the image, if the transfer fields are high the image is susceptible to transfer across the air

gap, leading to decreased resolution and, in general, to fuzzy images. Further, if there is prenip ionization, it may lead to strobing defects, loss of transfer efficiency, or "splotchy" transfer and lower latitude of system operation. In the postnip region, at the photoconductor-paper separation area, if the transfer fields are low (say, less than approximately 12 volts per micron for lines and 6 volts per micron for solid areas) hollow characters may be generated, especially with smooth papers, high toner pile heights and high nip pressures (greater than approximately 1 pound per square inch). On the other hand, if the fields in the postnip region are improper the resulting ionization may cause image instability. In the nip region itself, to achieve high transfer efficiency and "permanent" transfer, the transfer field should be as large as possible (greater than approximately 20 volts per micron). To achieve these different fields in adjacent regions consistently and with appropriate transitions is difficult.

The transfer system of the invention may be utilized in any desired path, orientation or configuration. It may be utilized for transfer with an imaging surface which has any desired configuration, such as a cylinder or a belt. Belt imaging surface photoconductors in electrographic copying systems are exemplified by U.S. Pat. No. 3,093,039 to Rheinfrank; U.S. Pat. No. 3,707,138 to Cartright, and U.S. Pat. No. 3,719,165 to Trachienberg, et al.

The above-cited and other references teach details of various suitable exemplary xerographic structures, materials and functions to those skilled in the art. Further examples are disclosed in the books *Electrophotography* by R. M. Schaffert, and *Xerography and Related Processes* by John H. Dessauer and Harold E. Clark, both first published in 1965 by Focal Press Ltd., London, England. All references cited herein are incorporated in this specification.

Further objects, features and advantages of the present invention pertain to the particular apparatus, steps and details whereby the above-mentioned aspects of the invention are attained. Accordingly, the invention will be better understood by reference to the following description and to the drawings forming a part thereof, wherein:

FIG. **1** is a cross-sectional side view of an exemplary electrostatographic image transfer system in accordance with the present invention; and

FIG. **2** is a top plan view of the system of FIG. **1.**

Referring now to FIGS. **1** and **2,** there is illustrated therein an exemplary transfer system **10** in accordance with the invention. The system **10** provides the advantages described above of a pre-selected tailored transfer field, where the transfer fields can be continuously tailored to the desired levels through the entire transfer station **12** along the path of movement of the copy sheet **14** through the transfer station. This is accomplished here by a single integral unitary transfer block **16** which may be readily mass produced as an integral molding by conventional molding techniques. In operation the block **16** is fixed in position and contains no moving parts.

The transfer block **16** here contains only three parallel spaced conductive bars integrally molded into a resistive material **17,** which may be resistive rubber, compressed carbon, resistive plastic, or other suitable conventional resistive material. These three bars form a prenip electrode **20,** a nip electrode **22** and a postnip electrode **24,** and are respectively so positioned with respect to the image transfer nip formed between the copy sheet **14** and the photoconductive imaging surface **25.**

The entire block **16,** including the electrodes **20, 22** and **24,** has a uniform configuration transversely of the direction of motion of the copy sheet **14.** That is, the cross-section of FIG. **1** would be the same in any perpendicular plane through the block (through FIG. **2**) in the direction of motion of the copy sheet.

The copy sheet **14** may be transported through the transfer station by any suitable transport means. The dielectric transport belt **30** shown here is preferred. Sheet retention may be electrostatic or vacuum. An advantage of the transport belt **30** arrangement is that the transport belt positively controls the paper position and adapts to differences in paper thickness, etc. The transfer block **16** is preferably held in a fixed position space slightly behind the belt, with a smooth planar surface adapted to easily slide against the back of the belt in the event they should make contact. With this arrangement the distance between any point on the block **16** and the adjacent point on the imaging surface **25** is always constant, since the imaging surface is also substantially fixed in position. Thus, if the fixed point on the block **16** is provided with a constant electrical transfer bias potential the transfer field at that point will also remain substantially constant, substantially independent of changes in position of the belt or copy sheet, as long as ionization does not occur. This is unlike a conventional bias transfer roller system, where the biased roller rides on the back of the copy sheet and the copy sheet thereby determines the transfer gap dimension. The block **16** could, of course, be movably mounted to ride against the back of the belt **30,** if desired.

The transfer electrodes **20, 22** and **24,** are preferably connected to different voltage output taps of a common conventional D.C. bias voltage source **32.** As may be seen, the prenip electrode **22** is biased to a much lower potential (a few hundred volts or less) than the nip and postnip electrodes, which may be biased to 3,000 – 5,000 volts, for example, depending on the transfer gaps, the dielectric constant of the belt, etc. To keep the transfer bias voltages relatively low a relatively thin belt, say of less than 25 mils thickness or less, is preferred.

The block **16** provides a novel non-linear tailoring of the transfer fields generated by the block **16** in the areas between the electrodes **20, 22** and **24,** i.e. along the paper path. If the block **16** were of uniform resistivity and thickness of material **17** between these electrodes, the voltage at any point between the electrodes would be simply a linear function of its distance from the electrodes. However, with the present arrangement this relationship is substantially altered.

The block **16** can be molded of a homogeneous resistive material **17,** but the thickness of the material **17** is varied by substantially varying the height of the upper surface of the block **16** between the electrodes in the direction of the paper path. Thus, the resistance between electrodes is definitely non-linear, and does not vary linearly with distance from the electrode. Accordingly the transfer fields generated by the block **16** vary in that same non-linear relationship determined by the block thickness. Further, these resistances, and transfer fields, are preferably made non-symmetrical about the nip center line and the nip electrode **24** as shown. The

bulk resistance of the material **17** itself is not critical as long as it is uniform, since it will affect only power losses, not voltages, with a constant bias voltage supply **32.** The voltages along the block are determined by the block thickness here.

The block **16** is shown, for example, with the material **17** substantially thicker in the areas adjacent the nip electrode **24,** this providing a lower resistance over these areas which causes the bias level on the electrode **24** to dominate in these areas. In contrast, the thinner cross-section of the block **16** as the prenip electrode is approached creates a higher resistance there, decreasing the potential applied by the nip electrode **24** in these areas.

Any desired block contour may be readily selected for a desired transfer field contour, empirically or by standard methods. The upper mold surface for the block **16** may then be contoured accordingly. (The reference book *Classical Electrodynamics* by John David Jackson, published 1962 by John Wiley and Sons, New York, New York, may be referred to in regard to field contours, etc.)

The transfer system disclosed herein is presently considered to be preferred; however, it is contemplated that further variations and modifications within the purview of those skilled in the art can be made herein. The following claims are intended to cover all such variations and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In an electrostatographic copying system in which an image is formed on an imaging surface and transferred at a transfer station to a copy sheet by electrical transfer fields generated by electrical transfer means, the improvement comprising:

copy sheet transport means for transporting a copy sheet through said transfer station;

said electrical transfer means comprising tailored transfer field generating means for generating said electrical transfer fields between said copy sheet and said imaging surface at said transfer station in a predetermined variable intensity transfer field pattern,

said tailored transfer field generating means including a plurality of differently electrically biased conductive electrodes spaced from one another along the path of said copy sheet through said transfer station and variable resistive means interconnecting said conductive electrodes to provide a varying resistance, and therefore a varying transfer field potential, between said conductive electrodes along the path of said copy sheet through said transfer station.

2. The copying system of claim **1,** wherein said conductive electrodes and said variable resistance means are substantially uniform in the dimension transverse the direction of movement of said copy sheet through said transfer station.

3. The copying system of claim **1** wherein said variable resistance means comprises a resistive material of uniform bulk resistivity but selectively varied thickness in the direction of movement of said copy sheet through said transfer station.

4. The copying system of claim **1** wherein said conductive electrodes are at least two parallel bars.

5. The copying system of claim **1** wherein there are three said conductive electrodes.

6. The copying system of claim **1** wherein a common power supply having different voltage outputs is connected to different ones of said conductive electrodes.

7. The copying system of claim **3** wherein said tailored transfer field generating means is an integral molding of said conductive electrodes in said resistive material to form a unitary stationary block.

8. The copying system of claim **3** wherein the thickness of said resistive material varies non-symmetrically.

9. The copying system of claim **7** wherein said conductive electrodes are at least two parallel conductive bars and wherein a common power supply having different voltage outputs is connected to different ones of said conductive bars.

10. The copying system of claim **9** wherein there are three said conductive bars, located respectively in a prenip, nip, and postnip area of said transfer station.

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