United States Patent [19]

Weigl

[11] **3,867,027**

[45] **Feb. 18, 1975**

[54] **TRANSPORT ARRANGEMENT FOR THIN SHEET MATERIAL**

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

[22] Filed: **Apr. 19, 1973**

[21] Appl. No.: **352,763**

Related U.S. Application Data

[62] Division of Ser. No. 213,613, Dec. 29, 1971, Pat. No. 3,765,757.

[52] **U.S. Cl.** ..... **355/8,** 161/62, 198/198, 317/2 A, 355/11, 355/16

[51] **Int. Cl.** **G03g 15/22**

[58] **Field of Search** ..... 355/8, 50, 51, 52, 11, 355/16, 3 R; 226/94; 271/193, 18.1; 317/2 R, 2 A, 2 C, 1 H, 2 I; 198/198; 161/62–65, 67, 69

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Primary Examiner—Samuel S. Matthews
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[57] **ABSTRACT**

A transport arrangement for an elongated relatively thin web or continuous sheet of material comprises a means for transporting the material in contact with an electrically conductive body formed of an electrically conductive mat and a plurality of electrically conductive contact members extending from the mat and which are secured to the mat and are in electrical contact with the mat. The web or sheet is engaged by the conductive body at distal segments of the contact members thereby supporting and spacing the material from the mat while the material is transported. The conductive body is positioned on a transport for movement therewith and imparts motion to the web or sheet. Alternatively, the conductive body is maintained stationary and the material is drawn across the body. Through this arrangement the web or sheet is spaced from the surfaces of the transport and other support surfaces thereby advantageously resisting the adhesion of a charged web or sheet to the surface of the transport surface. Additionally, the contact between the contact members and transported material provides countercharge with relatively firm, well defined local contact thereby avoiding sparking and attendant degradation of the sheet.

6 Claims, 6 Drawing Figures

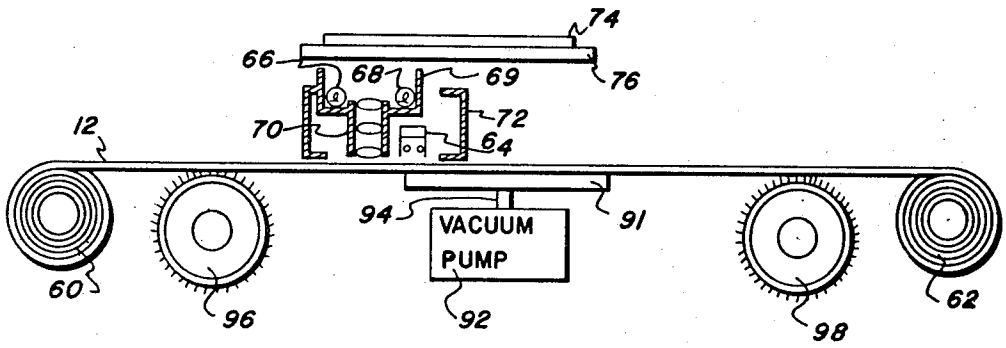


FIG. 1

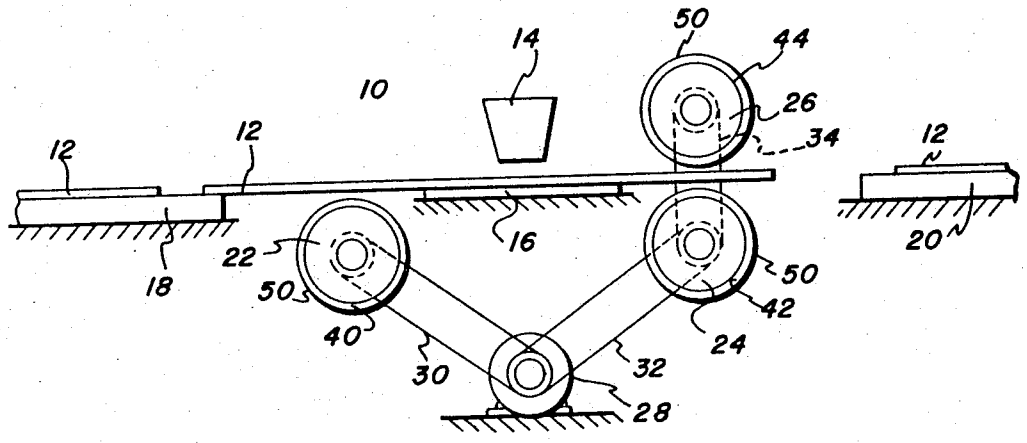


FIG. 2

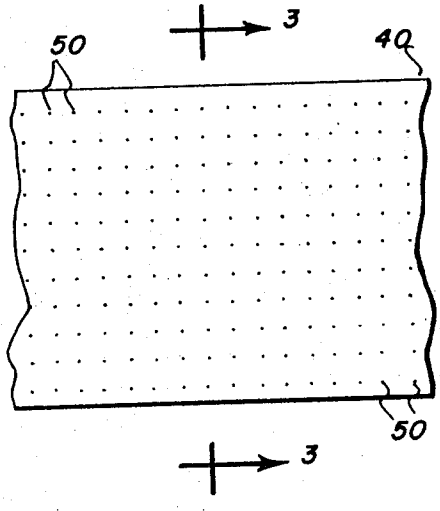


FIG. 3

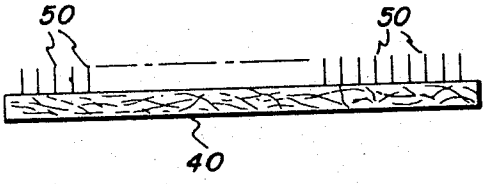
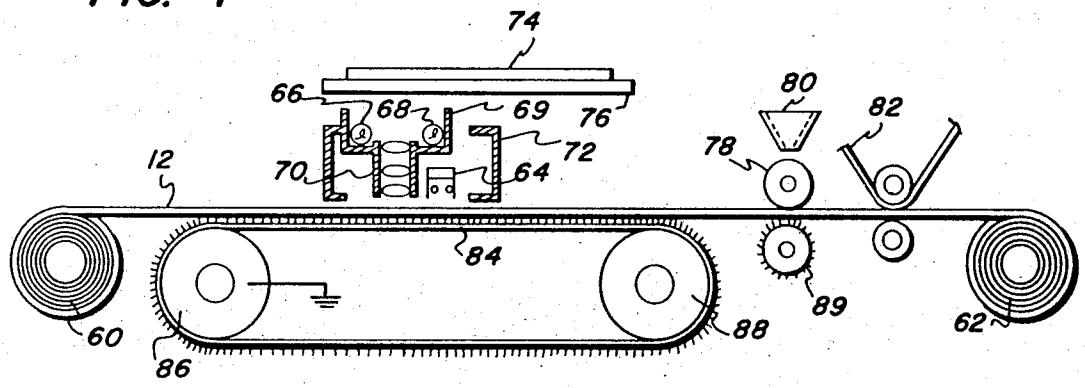


FIG. 4



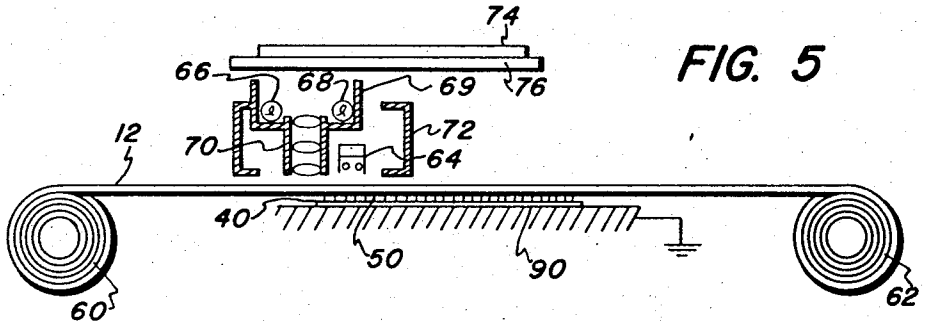


FIG. 5

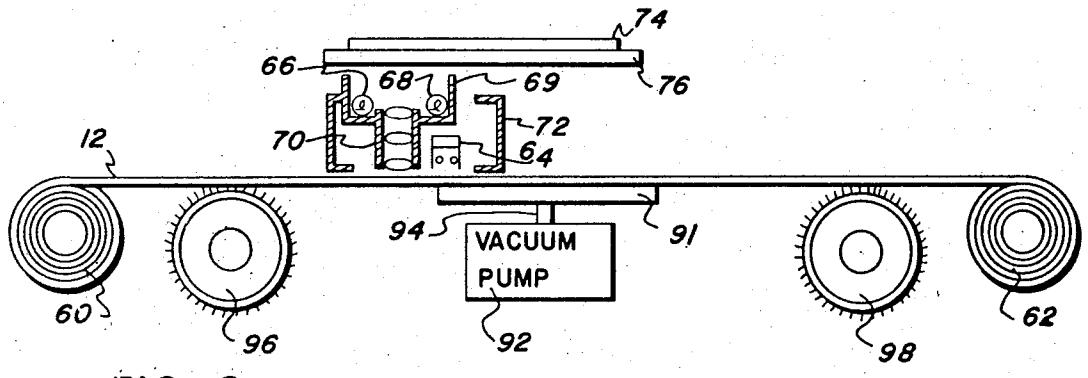


FIG. 6

TRANSPORT ARRANGEMENT FOR THIN SHEET MATERIAL

This application is a division of application Ser. No. 213,613 filed Dec. 29, 1971, now U.S. Pat. No. 3,765,757.

This invention relates to apparatus for the transport of a relatively thin web or sheet of material. The invention relates more particularly to an improved transport apparatus which facilitates the handling and transport of a relatively thin web or sheet of material.

In various processes, relatively thin sheets of material are transported from location to location. The printing industry, the film-coating industry, the image-reproduction industry and the thin-sheet fabricating industry are examples of industries having processes wherein relatively thin sheet materials are moved between different operating stations. Sheet materials of this nature have a thickness on the order of 125 thousandths of an inch or less and are formed either of a dielectric material such as paper or plastic or of an electrically conductive material such as strips of metal.

The transport of relatively thin sheets of material has heretofore met with some difficulty not only because of the relatively small thickness of the material which necessitates careful handling but principally because of electrical effects associated with the transport of material of these small dimensions. When the sheets are formed of a thin dielectric material, a rubbing contact between the sheet material and various transport bodies and surfaces results, through electrostatic friction, in an accumulation of electric charge upon the sheet. Forces of attraction are thus established which cause the sheet material to undesirably adhere to the different surfaces which it contacts.

In addition to the accumulation of a charge by electrostatic friction, some systems such as electrostatic image reproduction systems employ means for deliberately establishing a relatively intense uniform electric charge on the surface of the sheet material. The forces of attraction accompanying these charges are substantially greater than those which are established by electrostatic friction alone and greatly accentuate the problem of sheet adhesion. The adhesion of the charged sheets to transport surfaces renders the maintenance of either a uniform charge or a faithful latent electrostatic image on the sheet a relatively difficult task.

The problems associated with the formation of an electric charge on relatively thin sheet materials is not confined to dielectric materials along. It has been found that relatively thin electrically conductive sheets as well as dielectric sheet materials exhibit a contact potential between the sheet and a transport body or member. The separation of the sheet material from these members during processing results in erratic sparking and electric discharge at the point of the separation. In certain processes, a spark-sensitive film of material is supported on the sheet and is degraded by the discharge. This is true for example in a silver halide filmcoating process wherein the sparking creates undesirable light-exposed spots and spark marks in the emulsion. Similarly, the sparking can create long-lived Lichenberg figures on dielectric recording sheets, which will constitute background to any electrostatic image which may subsequently be developed thereon in any electrostatic reproduction system.

Various solutions have been proposed for reducing the undesirable effects accompanying the formation of adventitious electric charge and the occurrence of a contact potential on relatively thin sheet materials. However, these solutions have not been fully satisfactory. One proposal employs the coating of a thin film of electrically conductive material on a rear surface of the sheet thus providing a ground plane which is transported with the dielectric sheet. This arrangement, however, is relatively expensive and is often not compatible with the various processes employing dielectric sheet materials. Other solutions have employed electrically conductive rubber or metallic transport members or conductive strands suspended in contact with the sheet for discharging an accumulated charge. It has been found, however, that these techniques only partially discharge the accumulated charge on the sheet material and are of little value in correcting the problem associated with contact potential. Furthermore, these techniques which are employed principally for facilitating transport of the sheets by discharging an undesired accumulated charge on a sheet have a limited application since they cannot be employed in processes where an electrostatic charge is deliberately established on a sheet for purposes of image reproduction. In the latter instance, it is not only desirable to avoid the aforementioned disadvantages accompanying the transport of thin sheet but it is further desirable to provide a means for efficiently transferring counter charge to an image retention sheet which is disposed on a thin dielectric sheet in contact with grounded transport surfaces.

Accordingly, it is an object of this invention to provide an improved transport arrangement for transporting relatively thin sheets of dielectric and electrically conductive materials from location to location.

Another object of the invention is to provide an improved transport means which transports relatively thin sheets of dielectric material having electric charge accumulated thereon from location to location without degrading this sheet, a film, or a latent electrostatic image which may be formed thereon.

Another object of the invention is to provide a transport arrangement for relatively thin sheets of material which accumulate an electric charge thereon and which facilitates the separation of the material from the transport arrangement.

Still another object of the invention is to provide a transport arrangement for relatively thin sheet material which substantially reduces the disadvantageous effects resulting from contact potential existing between the sheet and a transport member or surface.

A further object of the invention is the provision of an improved transport means in an electrostatic charging system which is adapted for transferring counter charge to a film which is deposited on a relatively thin electric sheet.

In accordance with the general features of this invention, a transport arrangement for an elongated relatively thin sheet of material comprises an electrically conductive mat and a plurality of electrically conductive contact members extending from and fixed to the mat and in electrical contact with the mat. The mat is positioned with respect to the thin sheet for engaging the sheet at distal segments of the contact members thereby supporting and spacing the sheet from the mat while the sheet is transported. Means are provided for

imparting motion to the sheet material. Through this arrangement, the sheet material is spaced from the surface of the transport body thereby advantageously avoiding the adhesion of a charged sheet to a surface while the contact members, which are flexible, each individually release the thin sheet at the point of engagement as the sheet is moved. Additionally, contact between the contact members and sheet provides for a countercharge to a film supported on a thin dielectric sheet with firm, well defined local contact thereby avoiding sparking and attending degradation of the sheet.

These and other objects and features of the invention will be apparent with reference to the following specification and to the drawings wherein:

FIG. 1 is a schematic illustration of a sheet processing station having a thin-sheet transport arrangement in accordance with one embodiment of this invention;

FIG. 2 is a plan view of a conductive mat which is positioned on transport bodies of the transport arrangement of FIG. 1; FIG. 3 is a sectional view taken along lines 3—3 of FIG. 2;

FIG. 4 is a schematic view of an electrostatic reproduction apparatus employing a transport arrangement constructed in accordance with features of this invention;

FIG. 5 is a schematic view of an electrostatic reproduction apparatus constructed in accordance with an alternative embodiment of the invention; and,

FIG. 6 is an alternative arrangement of the electrostatic reproduction apparatus of FIG. 5.

Referring now to FIG. 1, an exemplary form of processing station 10 is shown to comprise a film coating station for depositing a film of material such as dyed thermoplastic on a sheet 12 of relatively thin material. For purposes of clarity in the illustration, the thickness of the sheet 12 is exaggerated. During the film coating operation, the sheet is moved continuously through the station and slurry is deposited from a hopper source 14 onto the sheet 12 as it is moved across the flat body 16 beneath the hopper. The sheet material 12 is received from a supply table 18 and is transported through the processing station 10 to a receiving or stacking table 20. Transport of the sheet material 12 from the table 18, through the station 10 and to the table 20 is effected by rotating drums 22, 24 and 26 which are driven from an electric motor 28 by drive belts 30, 32, and 34 respectively.

The sheet material 12 is formed of a material having a relatively small thickness which is on the order of 25 thousandths of an inch or less and is formed of a dielectric material such as sheet paper derived from wood pulp or a plastic sheet material such as polypropylene. The dielectric sheet material 12 is moved along the surface of the supply table 18, along the processing surface 16 and is transported by the drums 22, 24 and 26. The contact of the sheet with these bodies has heretofore resulted in an accumulation of an electrostatic charge on the sheet 12. This charge established forces which causes the sheet 12 to adhere to the heretofore smooth surfaces of the drum 22, 24 or 26 as well as other intermediate surfaces such as the surface 16 and interferes with the transport of the material between the supply and stacking tables. Additionally, as the sheet material is separated from the surface 16 in its movement toward the table 20 or as it is separated from contact with the drums 24 and 26, the transport of the sheet 12 has heretofore resulted in sparking at the point of separation due to the existence of a contact potential between the sheet and these surfaces. The sparking results in undesirable marking and degradation of the deposited film on the surface.

In accordance with features of this invention, the transported relatively thin sheet 12 is moved in contact with a plurality of upstanding electrical conductive contact members which are in electrical contact with and secured to an electrically conductive mat. In FIG. 1, a mat 40 is positioned on and is secured to the drum 22 for rotation therewith. Similarly a mat 42 is positioned on and is secured to the drum 24 while a mat 44 is positioned on and is secured to the drum 26. Each of the mats is in electrical contact with the drum and is thus maintained at ground potential which in the usual case is the electric potential of the machine elements. A plurality of electrically conductive upstanding contact members are represented on each of the referred-to mats by reference numeral 50. These contact members although relatively stiff exhibit a slight resiliency and the distal segments thereof can be deflected slightly. Transport of the sheet 12 is therefore accomplished by contacting the sheet 12 with these contact members 50 rather than contacting the sheet 12 with a smooth rolling surface as has been the case heretofore.

In operation, the flexibility of the contact members 50 reduces electrostatic friction between the sheet 12 and the driving and guiding members of the transport arrangement thereby permitting the sheet to slide from a distal segment of one member to a distal segment of another member. Furthermore, this form of transport advantageously eliminates uneven contact of the sheet material 12 with the driving and guiding members since the distal segments of member 50 stretch out wrinkles in the sheet material which would occur from time to time. This arrangement spaces the sheet from a smooth surface and avoids the entrapment of air between the flexible sheet 12 and the driving or guiding surface. In addition, and as indicated in greater detail hereinafter, when a sheet 12 is deliberately being charged as occurs in an electrostatic reproduction system, the distal segments of the existing members 50 will transfer countercharge to the dielectric sheet with firm, well defined local contact during the charging process as well as at the time of separation of the sheet from the mat and contact members, thus assuring that a uniform charge or latent electrostatic image remains firmly and uniformly attached to the dielectric sheet.

FIGS. 2 and 3 illustrate in greater detail the structural arrangement of one embodiment of a mat and extending contact members. The mats 40, 42 and 44 are flexible and are woven for example of an electrically conductive fiber such as stainless steel. The material including its distal segments, is formed of a metalized yarn or staple by electrostatic flocking or alternatively by mechanically interweaving these members into the mat. An assembled mat and contact members thus resembles a rug having a pile or nap of raised contact members extending from the mat. In a preferred arrangement, the mat and extending contact members have a total thickness of about .6 inches and a contact member density of about $1 \times 10^6/\text{in.}^2$. In an alternative arrangement, the mat and extending contact members may be formed of soft metalized or tin oxide coated fiberglass. The brush or contact member material may

initially be assembled after which the assembly of mat and contact members is made electrically conductive by vacuum aluminizing or by electrolic depositing of metal. Assembly of the mat and contact members can also be accomplished by weaving conductive materials comprising very fine stainless steel yarn or the like. To be effective, more than 10 percent of the fibers should be metallic or metalized. In still another arrangement, a fabric mat having loops formed therein and constituting extending members is metallized and laminated to foam rubber for example. Electrical contact, however, is provided with the metallized fabric.

An electrostatic reproduction apparatus is illustrated in FIG. **4** wherein a relatively thin sheet of dielectric material is supplied in the form of a continuous strip from a supply reel **60** to a take-up reel **62.** The strip **12** is coated with a photosensitive image retention material and a uniform electrostatic charge is established on this material. The sheet is then exposed to a light pattern in order to form a latent electrostatic image. After formation of the latent electrostatic image, the sheet is transported to developing and fixing stations. A means for establishing a uniform charge on the surface **12** and for exposing the surface to provide a latent electrostatic image comprises a corotron **64,** a light source including lamps **66** and **68,** a light shield and a strip lens assembly **70.** A lamp and strip lens arrangement of this type is described in greater detail in U.S. Pat. Nos. 3,584,950 and 3,584,952, the disclosure of which is incorporated herein by reference. These elements are mounted on a transport **72** which during the image formation process travels toward the right as viewed in FIG. **4.** This assembly sequentially focuses image elements of a subject image **74,** such as a document which is to be reproduced and which is positioned on a transparent body such as a plate of glass **76,** on the photosensitive surface **12.** The corotron **64** during this transport establishes an electrostatic charge on the surface immediately prior to the focusing and exposure of the subject image elements. During this process the movement of the sheet **12** may be halted until this imaging step is completed. The assembly of the corotron and lamp and lens assembly will then return to its initial starting point in order to provide a sequential exposure. The latent electrostatic image which is thus formed on the sheet **12** is then transported to s developing station while a succeeding segment of the sheet **12** is simultaneously moved toward the imaging station and is positioned for exposure. Development of the image on the sheet **12** is accomplished, e.g. by applying a polar liquid developer to the sheet with a coating roller **78** which is wetted from a reservoir **80.** The sheet **12** is then transported to a printing station where a record medium such as paper **82** is brought into contact with the developed image and this image is transferred to the paper **82.** Means can be provided for fixing the image to the sheet of paper. The strip of paper **82** bearing the transferred image is conveyed to a station, not illustrated, where it is cut and stored or passed to other utility devices while the sheet **12** is taken up by the roller **62.** A liquid development electrostatic reproduction apparatus of this type is described in detail in U.S. Pat. No. 3,084,043.

The establishment of an electric charge on the sheet **12** of the reproduction apparatus of FIG. **4** is accomplished by the corotron **64.** The structure and method of operation of a corotron is well known in the art. Generally speaking, a relatively high electric potential is applied between the corotron members and a ground plane upon which the sheet **12** is supported in order to provide a high potential between the sheet **12** and the corotron for depositing charge on the sheet. In the embodiment of the invention illustrated in FIG. **4,** a ground plane is provided by the conductive mat and contact members **84.** The contact members make firm contact with the sheet on its lower surface and effectively establish the sheet **12** at ground potential. When the sheet is stepped to the developing station, the rollers **86** and **88** provide motion of the endless belt **84** and tranport the sheet **12.** As indicated hereinbefore, the separation of the sheet **12** from the endless belt as the belt rotates about the drum **88** will occur without the sparking which occurred in prior art arrangements. Transport of the sheet **12** through a developing station is also enhanced by use of a drive member **89** having a conductive mat constructed in accordance with this invention positioned thereon for contact with the sheet **12.**

An alternative embodiment of the invention wherein the conductive mat and contact members are maintained stationary and wherein a relatively thin sheet is drawn across the stationary contact members is illustrated in FIG. **5.** Those elements of FIG. **5** performing functions similar to elements to FIG. **4** bear the same reference numerals. The sheet **12** comprises, for example, 15 percent by weight of phthalocyanine dispersed in a binder film of polypropylene. The phthalocyanine renders the film photoconductive and the sheet **12** is self-supporting. A mat **40** is mechanically secured to a metal surface **90** by any suitable means. The mat can be secured to the grounded surface **90** by metal strips which are laid along edges of the mat and are bolted to its surface. Mechanical contact between the lower surface of the sheet **12** and the contact members provides a relatively good, effective contact for the flow of countercharge to the photoreceptive material. A latent electrostatic image is produced on the photoreceptive material in the same manner as was described with respect to FIG. **4.** After exposure and formation of a latent electrostatic image, the sheet **12** is advanced to a developing and printing station as was described with respect to FIG. **4.** The embodiment of FIG. **5** is particularly advantageous in that a uniform countercharge is applied to the sheet while advancement of the sheet from the imaging station is not accompanied by disturbance of the charge because of the point contact and light resilience of the contact members.

FIG. **6** illustrates an alternative arrangement of the reproduction apparatus of FIG. **5.** Those elements of FIG. **6** performing functions similar to elements of FIGS. **4** and **5** bear the same reference numerals. The sheet **12** in the embodiment of FIG. **6** at the image formation station is drawn over a shallow tray **91** to which is coupled a vacuum pump **92** through a suitable conduit **94.** A vacuum is formed in this tray and causes the sheet **12** to be stiffly stretched and maintained in a uniform level plane. After exposure and the formation of a latent electrostatic image on the sheet, as was described with respect to FIG. **4,** the drum rollers **96** and **98** each of which includes an electrically conductive mat and extending contact members in accordance with the invention are rotated in order to transport that section of the sheet **12** bearing a latent image to the de-

veloping station and to advance a successive segment of the sheet 12 to the imaging station for exposure.

Thus an improved arrangement for transporting relatively thin sheets of material in contact with a conductive rug formed of a mat and extending contact members has been described which advantageously avoids the adhesion of the sheet to various transport members and surfaces, which reduces sparking, and facilitates its handling. The invention further advantageously provides for the effective transfer of countercharge to relatively thin sheets of dielectric material.

While there have been described particular features and embodiments of the invention, it will be apparent to those skilled in the art that modifications may be made therein without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. An apparatus for image formation comprising:

a photoreceptor surface upon which a latent electrostatic image is to be formed;

means for transporting said photoreceptor surface, said transporting means comprising a transport body, means for imparting motion to said body, said body having secured thereon an electrically conductive mat and a plurality of electrically conductive contact members secured to and in electrical contact with the mat and extending from said mat for supporting and transporting said photoreceptor surface near distal segments of said contact members at a spaced-apart location from said body for advancing said photoreceptor upon motion of said transport body;

means for transporting in sequence along a path spaced apart from and adjacent to said photoreceptor surface a corona source for establishing a uniform electrostatic charge upon said photoreceptor surface, and a projection means for projecting activating electromagnetic radiation at said photoreceptor surface in image configuration; and

means for developing said image by contacting said image with a developer material.

2. The apparatus of claim 1 wherein said corona source comprises a corotron.

3. The apparatus of claim 1 wherein said transported projection means comprises a strip lens.

4. The apparatus of claim 1 wherein said transport body comprises a rotating drum.

5. The apparatus of claim 1 wherein said transport means is arranged as a endless belt.

6. The apparatus of claim 1 wherein said photoreceptor surface comprises a dielectric material.

* * * * *