United States Patent

Serfahs et al.

[15] **3,653,755**

[45] **Apr. 4, 1972**

[54] COPY SHEET TRANSPORT APPARATUS

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[22] Filed: **Mar. 12, 1970**

[21] Appl. No.: **18,869**

[52] **U.S. Cl.** **355/3**, 355/73, 271/45

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

[58] **Field of Search** 355/3–17, 72, 73; 161/159, 160, 67; 117/17.5; 271/45, 75

[56] **References Cited**

UNITED STATES PATENTS

3,375,806 4/1968 Nost.....355/3 X

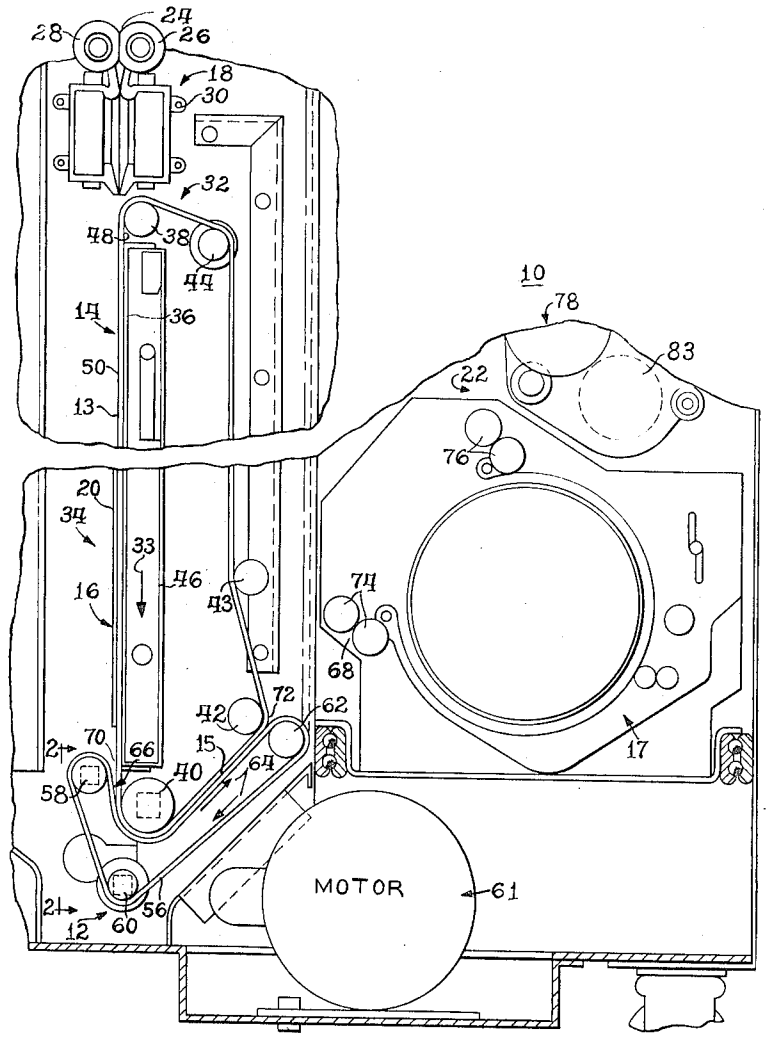
3,528,874 9/1970 Spencer.....161/67 X

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[57] **ABSTRACT**

Apparatus for transporting electrostatically charged and/or imaged copy sheet material in an electrostatic copier is disclosed. The apparatus includes an endless transport member having an exterior surface fabricated of a non-conductive, piled, moisture resistant material, preferably of nylon, orlon, or dacron. A copy sheet is transported with the charged and/or imaged surface thereof in contacting relation with the exterior surface of the transport member to minimize the dissipation of the charge from the copy sheet surface while in transit.

15 Claims, 3 Drawing Figures



PATENTED APR 4 1972

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SHEET 1 OF 2

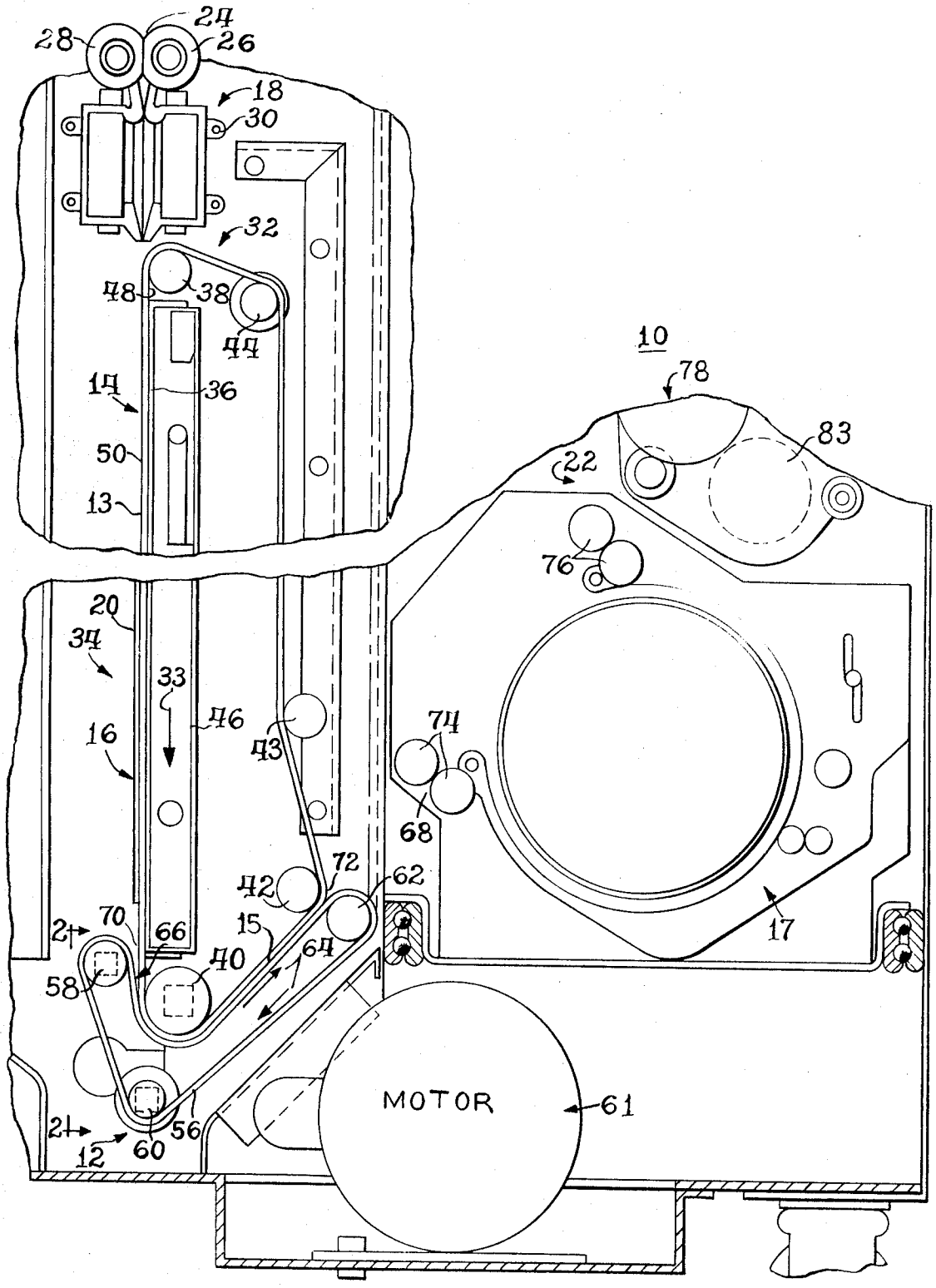


FIG. 1

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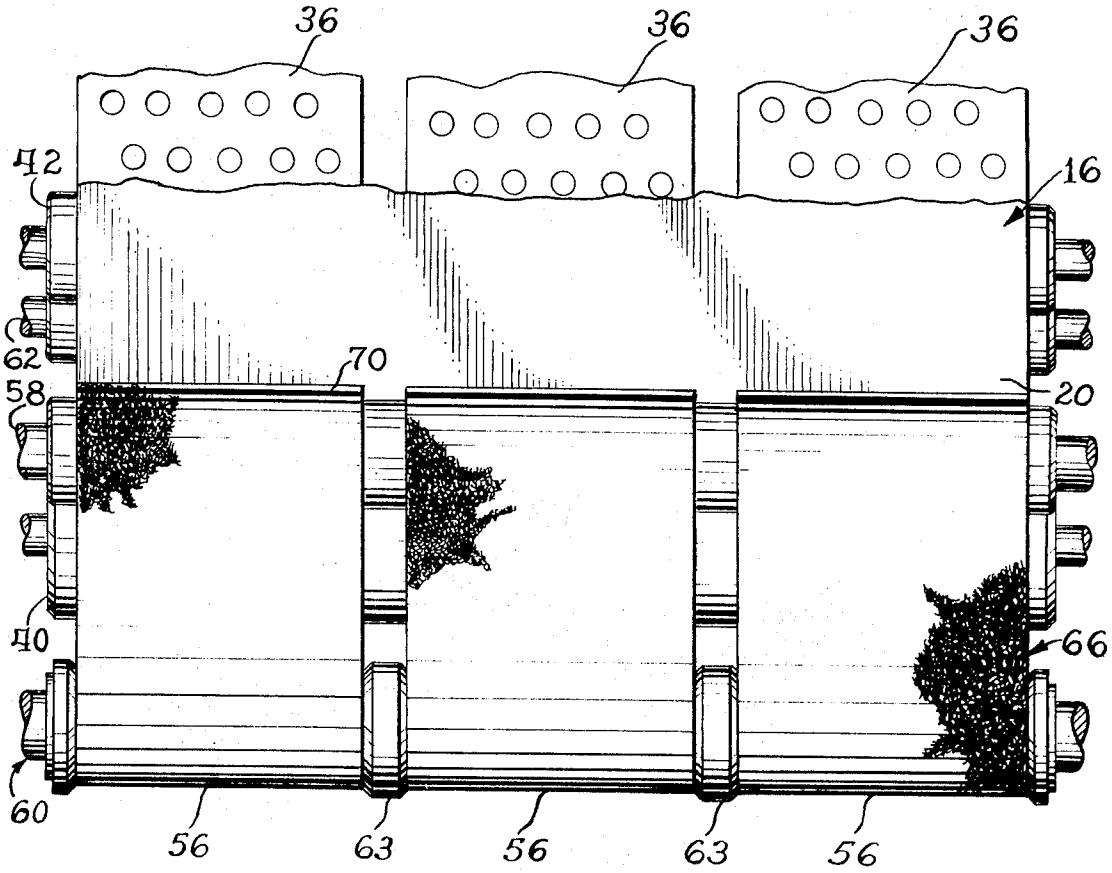


Fig. 2

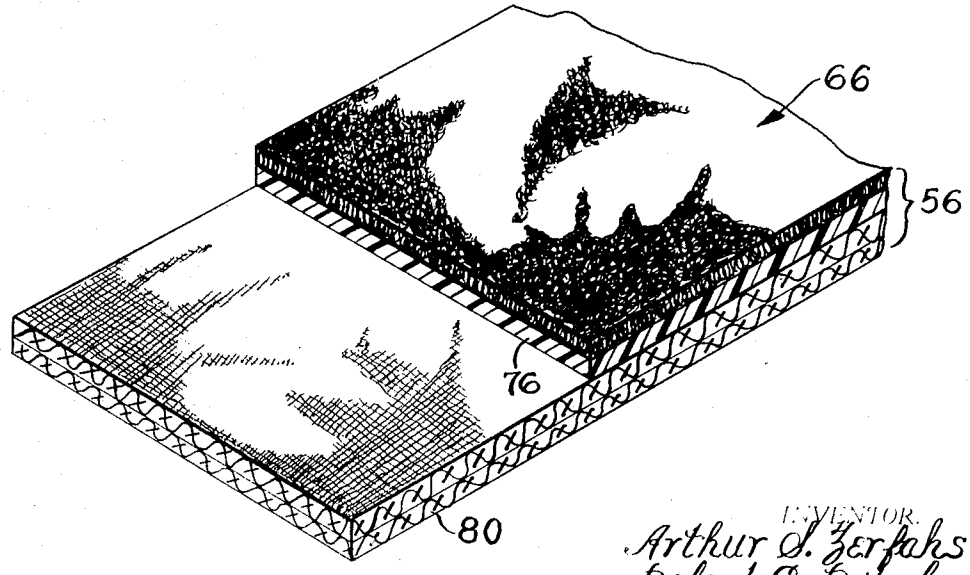


Fig. 3

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COPY SHEET TRANSPORT APPARATUS

BACKGROUND OF THE INVENTION

This invention relates generally to apparatus for transporting documents and the like, and more particularly to apparatus for transporting electrostatically charged and/or imaged copy sheet material in an electrostatic type copying machine.

The steps in preparing electrostatic copies of an original, involves the application of a uniform electrostatic charge in the dark to a photoconductive surface, selectively discharging the surface by exposure to a pattern of light and shadow in accordance with the original being copied to provide a latent electrostatic image, and rendering the latent image visible by applying finely divided electroscopic particles.

In copying machines of the type wherein the latent image is developed directly on the photoconductive surface of a copy sheet, it is usually necessary to transport the copy sheet between processing stations, i.e., from the charging station to the exposure station and to the developing station. This means the copy sheet, with an electrostatically charged photoconductive surface, must be transported through the machine with a minimum dissipation of the charge. The latter is difficult to achieve if the processing stations are not immediately adjacent each other in that contact with the charged surface during movement of the sheet can cause the charge to be dissipated. Furthermore, any alteration in the direction of movement of the charged sheet may add to the likelihood of such contact and result in the obliteration of the image from the copy sheet.

SUMMARY OF THE INVENTION

Accordingly, it is a primary object of the present invention to provide in a copying machine, apparatus for transporting charged or electrostatically imaged copy sheets, which minimizes dissipation of the charge on the surface of the sheet during movement thereof through the machine between separated processing stations.

It is another object of the present invention to provide document transporting apparatus of the last-mentioned type for moving a copy sheet having a latent image thereon, from the exposure station to the developing station of an electrostatic copying machine.

It is yet another object of the present invention to provide document transporting apparatus of the above described type capable of moving electrostatically charged copy sheets from a first station to a second station spaced from the first station along the copy sheet path in a copying machine, and changing the direction of movement of the charged sheet with a minimum dissipation of the charge from the surface thereof.

Briefly, a preferred embodiment of the document transporting apparatus according to the invention comprises a plurality of endless belt members mounted in spaced relation with respect to each other on a plurality of spaced rollers, for movement therealong.

Along one portion of the path traversed by the belt members, the outer surfaces of the belts come into contact with the surfaces of another set of transport belt members moving in the same direction. An electrostatically imaged copy sheet is sandwiched and carried between the two sets of moving belts with the charged surface thereof in contacting relation with the surfaces of the belt members of the transporting apparatus of the invention.

The copy sheet contacting surface of each of the endless belt members of the transporting apparatus is fabricated of a non-conductive, moisture resistant material, such as for example, nylon, dacron, orlon or the like and is formed into a soft, piled layer, thereby presenting to the charged copy sheet surface a minimum area of contact. The piled, non-conductive layer is bonded to a layer of flexible material such as, urethane foam, which in turn is bonded to a two-ply layer of woven cotton material. The foam layer renders the belt member pliable so that it conforms easily about the spaced rollers which

define the path traversed by the belt members. The surface resistivity of the piled contacting surface of each transport belt member is preferably in the range of $1 \times 10^9 - 1 \times 10^{10}$ ohms per square. The last-mentioned range, however, is only an approximate one since the surface resistivity of a material varies depending on humidity and surface contamination.

Because of the construction of the belt members including the piled, non-conductive layer, little if any charge is dissipated from the photoconductive surface of the copy sheet as the latter is carried from station-to-station in the copy machine.

DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention and its organization and construction may be had by referring to the description below in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side fragmentary sectional view of a copying machine employing the copy sheet transport apparatus according to the invention;

FIG. 2 is an enlarged sectional view of the transport apparatus of FIG. 1 taken along the line 2—2 therein, and

FIG. 3 is an enlarged, cross-sectional perspective view of a portion of a belt member used in the charged copy sheet transport apparatus according to the invention.

DETAILED DESCRIPTION

Referring now to the drawings in greater detail, FIG. 1 thereof illustrates an electrostatic copying machine **10** in which a copy sheet transport arrangement **12** according to the invention, is employed.

FIG. 1 which shows only a fragmentary portion of the copying machine **10**, illustrates the copy path **14**, along which a copy sheet **16** being processed in the machine, passes between the charging station **18** of the machine whereat a uniform charge is applied to the photoconductive surface **20** of the sheet **16**, and the developer station **22** whereat electroscopic toner powder is applied to the imaged copy sheet for development thereof. For a more detailed illustration of the copy machine **10** discussed in conjunction with the invention herein, see U.S. Pat. application Ser. No. 889,629; Filed, Dec. 31, 1969; entitled, HIGH SPEED PHOTOELECTROSTATIC COPYING MACHINE, and assigned to the same assignee.

A copy sheet **16** being processed in electrostatic copying machine **10** first enters charging station **18** at the nip **24** of feed rollers **26** and **28**. The copy sheet passes between the double corona charging unit **30** provided in the charging station **18**, whereby a uniform electrostatic charge is applied to the photoconductive surface **20** of the sheet material **16**. From the charging station **18**, the copy sheet **16** is carried along a first portion **13** of path **14** via vacuum belt arrangement **32** in the direction of arrow **33**, to the exposure station **34**, immediately adjacent the charging station.

The vacuum belt arrangement **32** comprises a plurality of perforated, endless belt members **36** (best seen in FIG. 2) mounted for movement in the direction of arrow **33** on rollers **38, 40, 42, 43**, and **44**. A vacuum plenum **46** positioned along path **14** at the back surface **48** of the perforated belts **36** serves to reduce the pressure along the front surface **50** of the belt members **36** to draw copy sheet material **16** thereto. The copy sheet material is thereby maintained in a surface-to-surface relation with belt members **36** and is carried thereby to exposure station **34**.

At exposure station **34**, the uniformly charged photoconductive surface **20**, of copy sheet material **16** is subjected to a pattern of light and dark reflected from an illuminated original document (not shown) to produce, on the photoconductive surface **20** of the copy sheet material **16**, a latent electrostatic image.

Once imaged, the direction of movement of copy sheet **16** is altered. The copy sheet is carried from portion **13** of copy sheet path **14** to portion **15** of the last-mentioned copy sheet

path toward developer station 22, which is spaced a considerable distance from exposure station 34. At the developer station electroscopic developer powder is applied to the photoconductive surface 20 by means of a magnetic brush developer unit 17 of the type disclosed in US. Pat. application, Ser. No. 9,316 filed, Feb. 6, 1970, in the name of Stanley A. Gawron, and assigned to the same assignee for development of the charged image. The transporting of copy sheet 16 from the exposure station 34 to the spaced developer station 22 must be accomplished without the dissipation of the charged image. To achieve this, there is provided the unique copy sheet transport arrangement 12 according to the invention.

The transport arrangement 12 includes a plurality of belt members 56 mounted on rollers 58, 60, 62 spaced from each other in a triangular configuration best seen in FIG. 1. As shown in FIG. 2 each of the rollers includes spacers 63 which serve to separate the belt members 56 from each other axially along the rollers, and serve to maintain correct tracking of the belt members 56 along the path defined by the rollers.

The endless belt members 56, are moved in the direction indicated by arrows 64 to carry a copy sheet 16 in a first direction from the exposure station 34 along leg 13 of the copy sheet path 14 and then in a second direction to the developer station 22 situated along leg 15 of the copy sheet path 14.

The belt arrangement 12 is mounted adjacent roller 40 of the vacuum belt arrangement 32 which carries belt members 36. The outer surface 66 of each of the belt members 56 is in engagement with respective vacuum belt members 36, and both sets of belt members are looped about roller 40 so that a copy sheet exiting the exposure station 34 is carried between the belt members 36, 56 toward the entrance 68 of developer station 22.

Both sets of belt members are moved in the same direction and at substantially the same speed between the exposure and developer stations. To insure an equal speed, rollers 38, 42 and 62 are driven by the same drive motor 61.

Upon entering the nip 70 of belt members 36, 56 the copy sheet is sandwiched between the belt members with the imaged surface 20 contacting the outer surface 66 of belt members 56.

The surface 66 of each belt member 56 permits the imaged photoconductive surface 20 of copy sheet 16 to be engaged thereby with a minimum dissipation of the charge. Surface 66 of each belt member 56 is formed of a piled, non-conductive material, the preferred material having a surface resistivity in the range of $1 \times 10^9 - \times 10^{16}$ ohms per square. Preferable materials available for this purpose are nylon, orlon, or dacron.

The piled characteristic of the material is important since, it permits the copy sheet transported thereon to be carried and contacted at a plurality of pin points rather than over larger areas, thereby preventing the dissipation of the charge on the photoconductive surface over wide discharge paths. Also, being non-conductive, minimum leaking off of the charge from the latent image of the copy sheet is permitted.

The material chosen for surface layer 66 of the belt members 56 in addition to having the above characteristics, should be triboelectrically compatible with the material of the vacuum belts 36, to prevent a static electric charge build up which might be detrimental to the latent image because of any interaction of the belt members between nip 70 and the exit point 72 of the copy sheet 16. Furthermore, the material should be sufficiently moisture resistant, since a collection of moisture due to varying environmental humidity may cause a conductive path to the latent image, which could result in a partial or full dissipation of the charge. The moisture resistance of the belt material (surface 66) should be such as not to permit the accumulation of a sufficient moisture content to produce a conductive path even when the environmental relative humidity increases to 70 percent.

The pressure applied against copy sheet 16 between the belt members 56 of the transport arrangement and the vacuum belt members must be sufficient to carry the copy sheet substantially without slipping, yet the pressure must not be so great as to crush the piled surface 66 of belt members 56. It has been found that if the piled surface 66 of each of the belt members 56 was bonded to a layer 76 of flexible material (see FIG. 3) a minimum pressure would be required to maintain each of the belts on the rollers 58, 60, 62, while sufficient pressure could be applied against vacuum belts 36 to carry the copy sheet successfully to developer station 22. A preferred material to provide such flexibility is urethane foam.

Referring to FIG. 3 there is illustrated a preferred embodiment of belt member 56 according to the invention. As mentioned heretofore, the belt member comprises an outer or exterior surface layer of a non-conductive piled material, such as, for example, nylon, dacron, orlon, or the like. The pile thickness or height is approximately five-sixty-fourth of an inch. The piled surface layer is bonded to a urethane foam layer which itself is bonded to a two-ply cotton backing 80 to provide the belt member layers 66 and 76 with support. The foam layer has a thickness of approximately one-sixteenth of an inch, while the two-ply cotton layer is approximately one-thirtysecond of an inch thick.

Each of the three belt members 56 illustrated in FIG. 3 has a width of approximately 2¾inches. The belt members are separated from each other by the width of spacers 63. The overall width of the belt transporting arrangement is sufficient to accommodate standard copy sheet material up to 9 inches wide.

Once successfully transported from exposure station 34 to developer station 22, the imaged copy sheet 16 is carried by feeder roller sets 74, 76 through the developer, whereat magnetic brush developer unit 17 applies electroscopic toner powder to the imaged surface 20 of the sheet 16.

From the developer station 22, the copy sheet is fed into an adjacent fusing station 78, which includes in the copy machine 10, a fusing device 83 for fixing the toner powder applied in station 22 to the copy sheet material by the application of pressure only. For a more detailed explanation of such a fusing device, see U.S. Pat. application, Sr. No. 694,515, filed, Dec. 29, 1967, and assigned to the same assignee.

While the transport arrangement according to the invention is illustrated herein as operating in conjunction with another belt arrangement to transport copy sheets in sandwiched fashion from a first to a second station in a copying machine, the arrangement is capable of functioning by itself along a substantially horizontal path in the manner of a conveyor arrangement, as well as in conjunction with other forms of associated transporting means, such as, for example, feed rollers, etc.

While a particular embodiment of the transporting arrangement has been shown and described, it should be understood that the invention is not limited thereto since many modifications may be made. It is therefore contemplated to cover by the present application any and all such modifications as fall within the true spirit and scope of the appended claims.

What we claim is:

1. In an electrostatic copying machine equipped with charging, exposing and developing stations for imaging a photoconductive member having a photoconductive surface and means for transporting the photoconductive member between said stations, the combination comprising:

first conveyor means for transporting a charged member from the charging station to the exposure station with the photoconductive surface of said member facing in the first direction where said surface is imparted an electrostatic charge pattern,

second conveyor means for feeding said member to a developing station with said member facing in a second direction opposite to said first direction,

third conveyor means for transporting said member from said exposure station to said developing station and being adapted to receive said member with its photoconductive surface in direct contact with the surface of the third conveyor means, said third conveyor means being con-

structed of a base material having deposited thereon a layer of a piled or brush-like configuration of fibers selected from the group consisting of nylon, dacron, and orlon, said charge pattern bearing photoconductive surface of said member being directly supported by said piled fibers above the base material thereby preserving the charge pattern on said photoconductive surface.

2. Apparatus as claimed in claim 1 wherein the surface resistivity of said layer of piled fibers is in the range of 1×10^{10} to 1×10^{16} ohms per square.

3. Apparatus as claimed in claim 1 wherein said third conveyor means includes an endless member mounted for movement on a plurality of rotatable roller means and wherein said piled fibers is relatively moisture resistant, whereby moisture accumulation therein is substantially eliminated to prevent discharging of the charge on said copy sheet material during movement thereof.

4. Apparatus as claimed in claim 3 wherein said piled fibers are bonded to a second layer of material to provide flexibility to said third conveyor means, and wherein said second layer of material is in turn bonded to said base material.

45. Apparatus as claimed in claim 4 wherein said second, layer comprises urethane foam and wherein said base material comprises cotton.

6. In an electrostatic copying machine, apparatus for transporting copy sheet material having an electrostatically charged surface along a predetermined path from a first processing station to a second processing station, said apparatus including first and second copy sheet material transport assemblies for moving said copy sheet at substantially the same speed between said stations along said path with the electrostatically charged surface of said copy sheet facing in a first direction on said first transport assembly and facing in a second direction opposite said first direction on said second transport assembly, a third copy sheet material transport assembly in contacting relation with a portion of said first transport assembly forming a turn-around location for changing the direction in which said electrostatically charged surface of said copy sheet faces, said copy sheet material being carried in sandwiched fashion between said first and third conveyor assemblies and having its electrostatically charged surface in contact relation with said third transport assembly, said third transport assembly being constructed of base material having a surface formed of a piled or brush-like configuration of fibers selected from the group consisting of nylon, dacron and orlon, said piled fibers minimizing dissipation of the charge from the electrostatically charged surface of said copy sheet during movement of said copy sheet from said first station through said turn-around location to said second station.

6. Apparatus as claimed in claim 6 wherein the surface resistivity of said piled fibers is in the range of 1×10^{9} to 1×10^{16} ohms per square.

8. Apparatus as claimed in claim 7 wherein said first and third transport assemblies each comprises an endless member mounted for continuous movement between said first and second stations.

9. Apparatus as claimed in claim 8 wherein said first transport assembly includes a continuous member mounted for movement along a path, a portion of which coincides with said endless member of said third transport assembly and being in pressure contact therewith, and wherein the pressure provided by said endless members on the charged copy sheet material carried therebetween is sufficient to transport said sheet material substantially without slipping, yet not great enough to crush the piled surface of said endless member of said third transport assembly.

10. A transport member as defined in claim 6 wherein said base material includes a layer bonded thereto and to said piled fibers, said layer flexibility to said third transport assembly.

11. A transport member as defined in claim 10 wherein said base material is fabricated of multi-ply cotton material and wherein said intermediate layer comprises urethane foam, the thickness of said cotton layer being approximately twice that of said foam layer.

12. An apparatus for making copies of an original electrostatically on copy sheet material transported along a copy sheet path sequentially past a charging station whereat a uniform charge is applied to a surface of said sheet material, an exposure station whereat said charged surface is exposed to a pattern of light and shadow in accordance with said original to produce a latent image on said surface, and a developing station whereat electroscopic toner powder is applied to said surface for development of said latent image, transport means for transporting said imaged copy sheet material from said exposure station to said developing station substantially without dissipation of said charge image, said transport means including an endless belt mounted on a plurality of roller members providing a vertical and a first horizontal span of said belt over the path of movement, said copy sheet material being retained on said vertical span of the belt during exposure with said charged surface facing in a direction away from said belt, a second endless belt mounted for movement in a continuous path provided with a second horizontal span in contiguous contacting relation with said first horizontal span, said copy material being transported in sandwiched fashion between said belts with the changed surface thereof in contacting relation with said second belt, said second endless belt being formed of a piled or brush-like, non-conductive, moisture resistant, said material providing a minimum area of contact with the charged surface of said material thereby minimizing dissipation of the charge on said copy material as said copy material passes from said vertical position to said horizontal position.

13. Apparatus as claimed in claim 12 wherein the surface resistivity of the surface of said piled fibers is in the range of 1×10^{9} to 1×10^{16} ohms per square.

14. Apparatus as defined in claim 12 wherein said transport means carry said copy material in a first direction along a first portion of the path between said exposure and developing stations, and in a second direction along a second portion of the path between said lastmentioned stations.

15. Apparatus as defined in claim 14 wherein the endless members of said transport means are looped about a single roller member at the point in said path whereat the direction of movement of said copy material is altered, thereby to effectively change the direction of movement of said copy sheet with a minimum of disturbance of the charged image on the surface thereof.

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