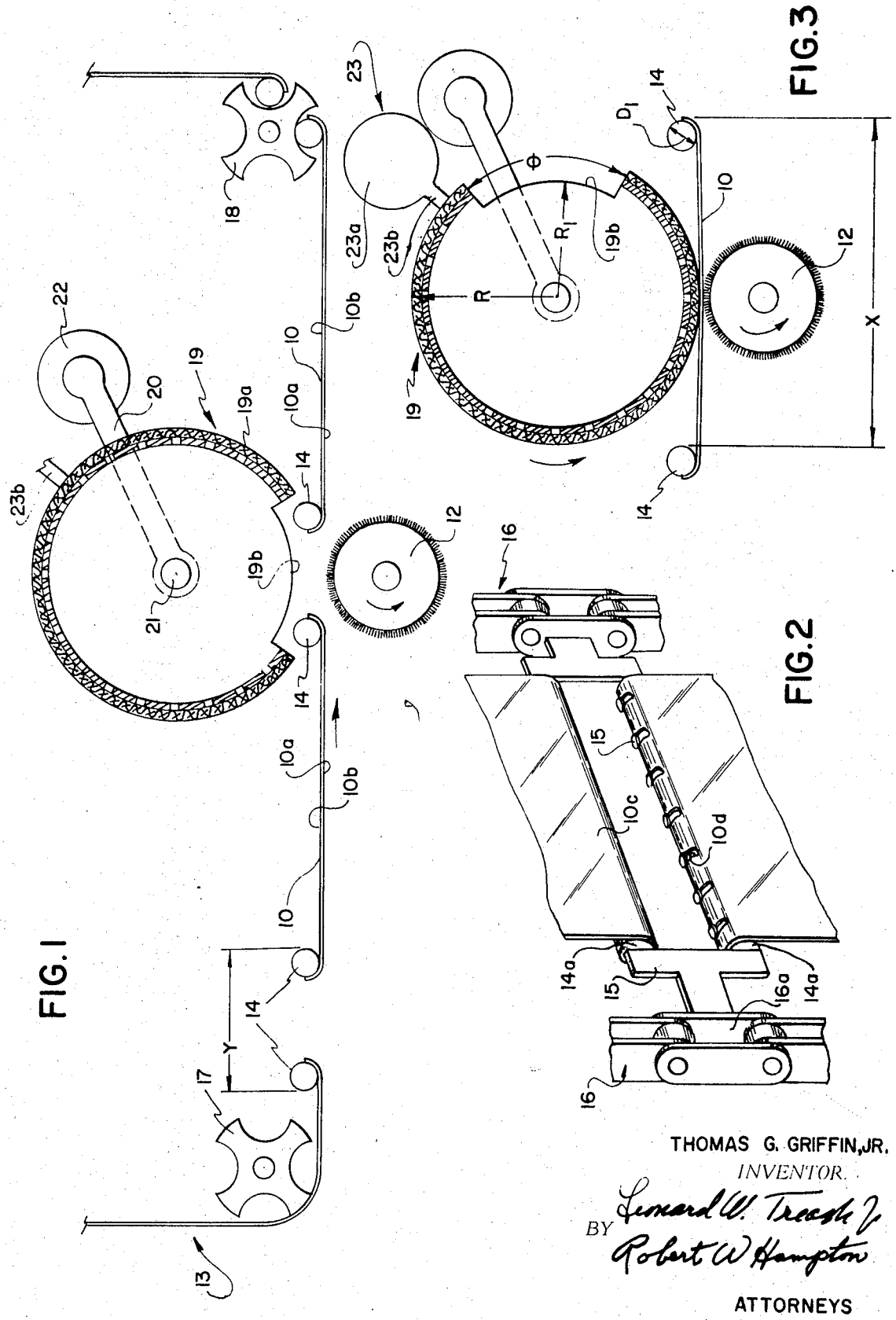
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APPARATUS FOR CLEANING THE SUPPORT OF AN ELECTROPHOTOGRAPHIC MEMBER

Filed Dec. 5, 1967 2 Sheets-Sheet 1



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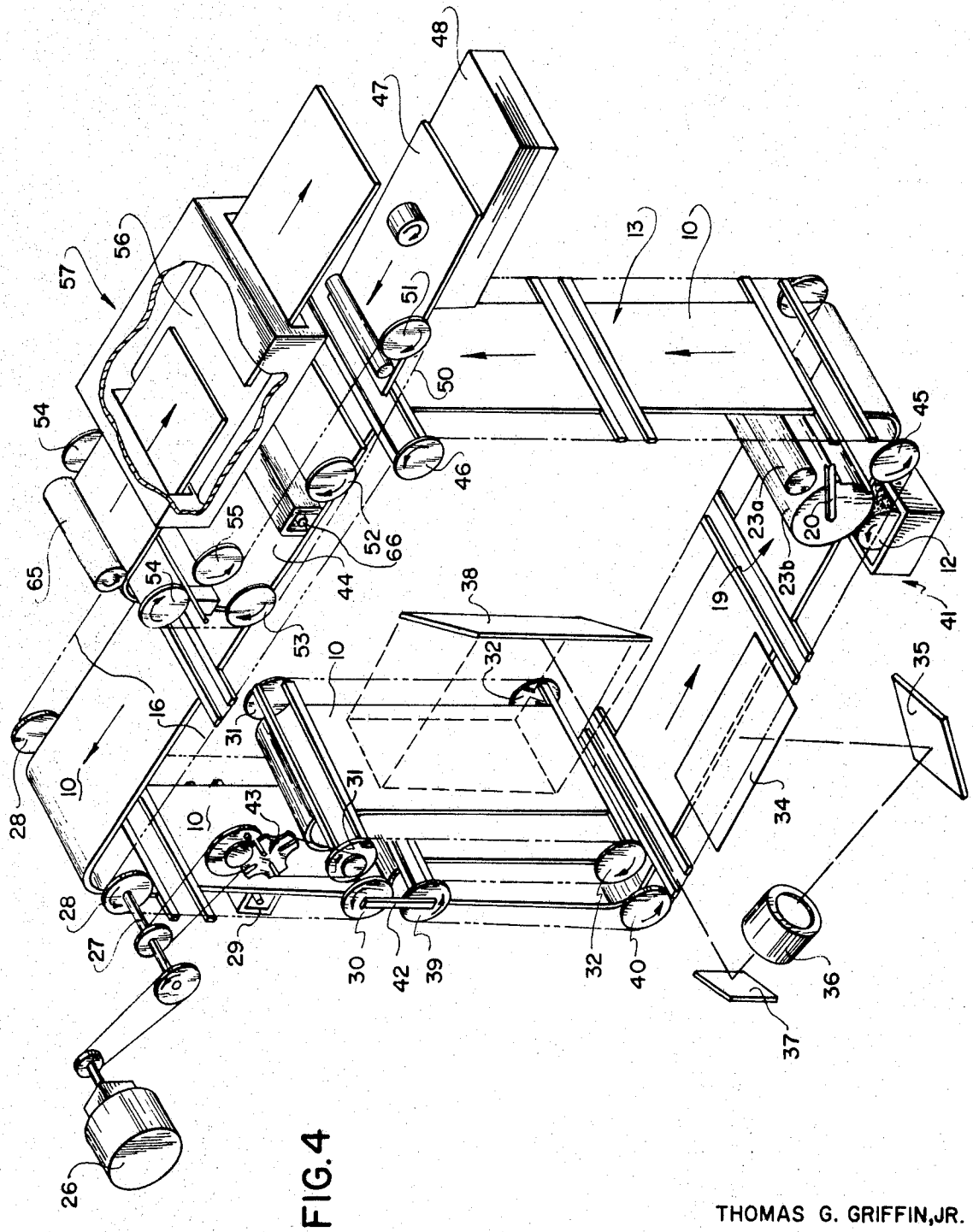


FIG. 4

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APPARATUS FOR CLEANING THE SUPPORT OF AN ELECTROPHOTOGRAPHIC MEMBER

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ABSTRACT OF THE DISCLOSURE

The support of an electrophotosensitive member is cleaned with a brush which also functions as the backing for a toning operation, applying pressure to the base of the sensitive member to urge it toward a toning surface, for example, a magnetic brush. In one embodiment, the photosensitive member is in the form of an endless belt with open spaces between the portions of the member making up the belt; the cleaning brush is relieved to accommodate such open portions and serves as a cap for the toning surface preventing the escape of toner.

CROSS-REFERENCES TO RELATED APPLICATIONS

Reference is made to commonly assigned copending U.S. Pat. application Ser. No. 653,779 entitled "Method of Repetitive Xerography Without Cleaning," filed July 17, 1967 in the names of James G. Jarvis and William C. York.

BACKGROUND OF THE INVENTION

Field of the invention

The invention relates to a method and apparatus for cleaning a photoresponsive member in electrophotography. More specifically, this invention relates to cleaning the support or base of a flexible electrographic member to enable exposure therethrough.

Description of the prior art

In certain forms of electrophotography, a photoelectroresponsive member is charged and exposed to an image of actinic radiation creating a corresponding charge image which is toned and utilized, commonly by transfer. The member is then cleaned and reused.

In the prior art the problem of cleaning has been extensively considered, see for example, U.S. Pat. No. 2,752,271, Walkup, issued on June 26, 1956. In this patent, a cylindrical brush having hair, fibers or the like on its outer surface is adapted to be placed in contact with a xerographic plate following transfer of a toner image therefrom in order to brush any residue of toner from the surface of the plate. In operation, a rotating cylindrical brush is urged against the surface of the plate to be cleaned. During the cleaning operation, the brush is driven in rotation in order to assist in the removal of toning material or the like from the brush after it has passed along the photoresponsive surface. Vacuum can be applied to a hood surrounding the brush in order to draw air through the hood and subsequently to withdraw toning material from the fibers of the brush.

It is sometimes desirable to expose a photoelectroresponsive member through its base, see for example, U.S. Pats. No. 2,843,084 Hayford, issued July 15, 1958 and 3,166,418 Gundlach, issued Jan. 19, 1965 and the previously mentioned Jarvis et al. application. As pointed out in said Jarvis et al. application, exposure through the base can be used in a system which eliminates the necessity to clean the photoconductor of a xerographic plate thereby

reducing waste of toner and scratching and scumming of the photoconductor. If exposure is continually made through such a base in a machine using dry toner, it is advantageous to continuously clean the base for a clear exposure. If the sensitive member is a hard, continuous drum, an ordinary rotating brush in an exhaust hood will adequately clean it. However, when the sensitive member is a flexible web and/or has open spaces through which toner could escape from the toning station, the cleaning member can perform other functions according to the invention.

SUMMARY OF THE INVENTION

It is an object of this invention to clean the support of an electrically photoresponsive member.

It is another object of the invention to provide a backing for a flexible photoelectroresponsive member during toning.

It is another object of the invention to provide a cleaning brush for removing material from the backing of photoelectroresponsive material in the form of an endless belt in which the various connected portions which make up the belt have openings therebetween.

In accordance with the invention, a brush disposed adjacent to the support side of an electrically photoresponsive member both cleans the support so that an exposure may be made through it and acts as a backing for the toning station itself supplying firmness to the member, if flexible, and preventing escape of toner from the toning station.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects and features of the invention will be understood from the following specification and from the drawings, in which:

FIG. 1 is a fragmentary verticle section view showing a photocopying apparatus employing an endless belt of photoresponsive segments and means for cleaning the surface of the segments opposite to that which receives toning material;

FIG. 2 is a fragmentary perspective view showing a portion of the endless belt of photoresponsive material shown in FIG. 1;

FIG. 3 is a vertical section view of the cleaning roller of the invention in engagement with and urging the photoresponsive material toward a toner brush; and

FIG. 4 is a perspective schematic drawing showing photocopying apparatus with which the brush of the invention can be used.

DESCRIPTION OF THE PREFERRED EMBODIMENT

According to FIG. 1, an electrostatic image is formed on an electrically photosensitive member such as a flexible sheet **10** having a transparent conductive backing **10***b* and a photoconductive layer **10***a* by charging the photoconductive layer and exposing it through the backing **10***b*. Powdered toner is applied to the resulting electrostatic image on photoconductive layer **10***a* by a toner brush **12**. In order to insure proper distribution of the toner material, it is necessary to control the depth of penetration of the flexible sheet **10** into the toner brush.

As shown in FIGS. 1 and 2, sheets **10** can be connected to one another to form an endless belt **13**. End portions **10***c* of each of the sheets are secured to rods **14** by hooks **15** which engage a plurality of corresponding openings **10***d* in the end portions of the sheets. Pairs of adjacent rods **14** are connected to one another by links **15** which in turn are attached to plated **16***a* of a roller chain **16**.

Belt **13** is driven from left to right as viewed in FIG. 1. Sprockets **17** and **18** are adapted to engage end portions **14***a* of adjacent pairs of rods **14**. Thus, along the reach

of belt **13** shown in FIG. 1, the belt can be supported and tensioned by sprockets **17** and **18**.

In addition to the previously mentioned problem of maintaining the proper engagement between the flexible sheet **10** and the toner brush, it is also important to safeguard against the distribution of dust of fine toner particles upon the outer surface of the backing of the flexible sheet. If the optical image is to be projected through the transparent backing of the sheet **10**, toner material, dust or other foreign material, if allowed to collect on the other surface of the transparent backing, would interfere with and be detrimental to the image. If the flexible sheet is to be advanced with respect to the toner brush at a relatively high speed in order to obtain a relatively high rate of production from the apparatus, the toner brush necessarily must rotate with a relatively high surface speed and consequently can throw off toner particles thereby causing a toner dust problem.

In order to remove dust from the surface of the transparent backing **10***b*, there is provided cleaning brush **19** extending substantially transversely with respect to the belt, that is, at right angles to the path of its travel, and having its periphery adjacent to the surface of the sheets. Thus, brush **19** can be pivotally mounted in an adjustable manner by an arm **20** which is connected to a shaft **21** upon which the brush is pivotally mounted. A support **22** for the arm **20** is conditioned to position the arm **20** in an adjustable manner and thereby control the engagement of the periphery of the brush with the adjacent surface of the belt **13**.

An outer surface or covering **19***a* of the brush is made of a material having high nap such as that of fur or fiber or a brush-type fabric which is suitable for the removing of fine toner particles are dust from the sheet. The covering **19***a* of the brush can be of a material having a location in the triboelectric order, such that in response to friction between the surface of the brush and the sheet, the toner particles and any possible dust will be attracted and held by the material forming the outer surface of the brush.

To facilitate the transfer of material from the surface of the sheet to the brush, the brush can be operated with a peripheral speed which is different than that of the sheet so that the resulting skid or slip of the brush with respect to the sheet will cause a scrubbing or brushing action which facilitates the cleaning of the sheet.

As shown in FIG. 3, brush **19** can be provided with a vacuum pickoff system **23** to remove toner which has been cleaned from the sheets by the covering of the cleaning brush. The vacuum pickoff system includes manifold **23***a* and conduit **23***b* containing an elongated slot exposed to the outer surface of the cleaning brush.

The rods **14** of the belt **13** extend above the surface of the sheets which is to be engaged by the cleaning brush **19** (FIG. 1). Since it is undesirable for the surface of the brush to contact the rods **14**, brush **19** is provided with a relieved portion **19***b* which can accommodate the rods **14**. Thus, the relieved portion interrupts the surface of the brush **19**. In operation, the brush **19** is driven in synchronism with the belt **13** so that relieved portion **19***b* approaches belt **13** at the same time adjacent rods **14** are passing near to brush **19**. In this way, the rods can pass through the opening of relieved portion **19***b* without interfering with the operation of the cleaning brush.

In FIG. 3, the arc of relieved portion **19***b* is defined by the symbol θ. The radius of brush **19** to its outer periphery is defined by the symbol R, while the radius to the surface of relieved portion **19***b* is defined by the symbol R_1. The diameter of rods **14** is defined by the symbol D_1. The center line distance between successive leading or trailing bars **14** is defined by the symbol X. The distance between the opposite sides of rods **14** is defined by the symbol Y as shown in FIG. 1. Based upon the symbols defined above, the following dimensional relationships exist between belt **13**, rods **14**, and brush **19**:

Eq 1: $\frac{R=X(100-\text{Slip }\%)}{200\pi}$ (Brushing action opposite direction of belt).

Eq 2: $\frac{R=X(100+\text{Slip }\%)}{200\pi}$ (Brushing action in direction of traverse).

Eq 3: $$\theta=\frac{45000\ Y}{X(100-\text{Slip }\%)}$$

Eq 4: $$R_1=R-1.25\ D_1$$

As shown in FIG. 3, the cleaning brush **19** is positioned in alignment with the toning brush **12** with the centerline of brush **19** mounted substantially vertically above the centerline of the toning brush **12** and at a height which places the outer periphery of the cleaning brush **19** slightly below the normal line of travel of the sheet **10**. By way of example, the outer periphery of the brush can be approximately one-eighth of an inch below normal line **24**. As a result, the surface of the brush is urged into engagement with the surface of the sheet and thereby provides positive contact which controls the engagement of the opposite side of the sheet with the toning brush **12**. In this way, the cleaning brush **19** can serve the dual functions of cleaning one surface of the sheet and of controlling the engagement of the opposite surface of the sheet into the toner brush **12**. In other words, brush **19** simultaneously serves as a cleaning brush and a back-up roll.

FIG. 4 shows a photocopying apparatus which can employ the cleaning brush **19** of the invention. A motor **26** serves as a constant-speed drive to a shaft **27** which is coupled to sprockets **28** in engagement with drive chains **16**. Chains **16** advance an endless belt **13** above sprockets **28, 30, 31, 32, 39, 40, 45** and **46**. Such sprockets are shown as circular discs in FIG. 4 for convenience, but are preferably relieved in the same manner as sprockets **17** and **18** in FIG. 1.

The chains advance the belt through a series of xerographic stations including a corona charger **29**, an exposing station which includes a projector which directs light from an original **34** to a mirror **35** through a lens **36** to a mirror **37** to a mirror **38** and directed through a transparent backing **10***b* to a surface **10***a* of a sheet **10** of belt **13**.

In order to expose sheet **10** to an optical image, it is necessary that the movement of the belt at the exposure station adjacent be terminated. In order to accomplish an interruption of the motion of the sheets at the exposure station, the endless belt is provided with a loop extending about sprockets **31** and **32**. The loop returns to the main line of travel of the belt at sprockets **39**. Beyond sprockets **39**, the belt passes about sprockets **40** and then travels toward a toning station **41**, including toner brushes **11** and **12**.

Sprockets **30** and **39** have their supporting shafts connected to one another by links **42**. The drive to sprocket **31** extending from shaft **27** includes a geneva **43** connected to sprocket **31**. As a result, sprocket **31** is driven with an intermittent motion. Whenever the geneva is in a dwell position, sprockets **30** and **39** travel downwardly as viewed in FIG. 4 in response to the continuous drive of shaft **27**. When the geneva enters upon its advancing position, chains **16** are moved with respect to sprockets **31** and **32** and as a result sprockets **30** and **39** travel upwardly as viewed in FIG. 4.

Upon exposure of sheet **10** to the optical image reflected from mirror **38**, the exposed sheet bearing an electrostatic image corresponding to the exposed optical image is advanced by chains **16** along with endless belt **13** adjacent to sprockets **32**, sprockets **39** and sprockets **40**. Beyond sprockets **40** the sheet **10** is advanced between a toner brush **12** and cleaning brush **19**. The

cleaning brush as described with respect to FIG. 3 urges sheet **10** into the covering of toner brush **12** and at the same time removes any toner material or dust particles from the side of the sheet opposite the toner brushes.

Beyond the toning station the endless belt passes adjacent to sprockets **45** and **46** and then advances adjacent to a transfer station where the toned image on the sheet is transferred to a receiving surface such as a copy paper **47** from a paper supply **48**. Copy paper **47** is advanced by a conveying belt **49** which is driven by a chain **50** extending about sprockets **51–55**. Beyond sprockets **51** belt **49** presses copy paper **47** against sheet **10** so that the electrostatic toned image on the sheet may be transferred to the copy paper in response to the charge applied to the sheet by corona generator **66**. After the image is transferred, the copy paper is advanced beyond sprockets **54** and beneath a roller **65** to a surface **56**. Surface **56** supports the copy paper with its toned image for travel through the fusing station including fuser unit **57**. Beyond the fuser unit, a completed copy is discharged from the apparatus.

In accordance with the invention, the provision of cleaning brush **19** facilitates the toning operation performed by toner brush **12** in that the cleaning brush serves as a backup roller which urges sheet **10** into engagement with the surface of toner brush **12** and prevents escape of toner between sheets. In addition, it can be seen in FIG. 4 that cleaning brush **19** is available to maintain the surface of the endless belt disposed opposite the toner brushes free of unwanted toner material and any foreign material such as dust in order that the optical image can be projected through the transparent backing of the sheet.

Thus, the invention provides the advantages of enabling the cleaning brush to maintain the flatness of the sheet and its controlled engagement with the toning brush which at the same time enabling the side of the sheet opposite the toning brush to be continually cleaned.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

I claim:

1. A photocopying apparatus comprising:
- a reusable electrically photoresponsive member having first and second surfaces,
- means for projecting a pattern of actinic radiation through said second surface to create an electrostatic image on said first surface,
- means adjacent said first surface for toning said electrostatic image,
- means adjacent said second surface for cleaning said second surface, said means for cleaning being positioned in opposed relationship to said toning means.

2. A photocopying apparatus according to claim **1** wherein:
- said photoresponsive member is a flexible web,
- said toning means is adapted to contact said first surface during toning, and

- said cleaning means provides a backing to support said photoresponsive member during toning.

3. A photocopying apparatus according to claim **1** wherein:
- said photoresponsive member includes spaced photoresponsive sheets disposed in end-to-end relation, and
- said cleaning means is positioned to prevent escape of toner between sheets.

4. A photocopying apparatus comprising:
- a reusable electrically photoresponsive endless belt having first and second surfaces,
- means for moving said belt through a series of stations,
- a charging station for creating a uniform electrostatic charge on said first surface,
- an exposing station for protecting a pattern of actinic radiation through said second surface to said first surface to create an electrostatic image on said first surface,
- a toning station for applying toner to said electrostatic image to form a toner image defined by said electrostatic image,
- a transfer station for transferring said toner image to a receiving medium, and
- a cleaning station for cleaning said second surface positioned in opposed relationship to said toning station to provide a backup member for said belt at said toning station.

5. A photocopying apparatus according to claim **4** wherein:
- said cleaning station includes a rotatable brush, and
- means for applying a vacuum to the surface of said brush.

6. A photocopying apparatus according to claim **4** wherein said toning station includes a toning brush adapted to hold toner on its periphery triboelectrically and to rotatingly engage said first surface.

7. A photocopying apparatus according to claim **4** wherein said endless belt includes a plurality of photoresponsive sheets connected together in end-to-end spaced relation and said cleaning station comprises:
- a rotatable brush having a longitudinal axis extending transversely with respect to the direction of motion of said belt and a periphery engaging said second surface of said belt, said brush having a relieved portion corresponding in length to the spacing between the spaced end portions of adjacent photoresponsive sheets, and
- means for rotating said brush about its longitudinal axis in a predetermined phase relationship with respect to said belt, so that said relieved portion is in a facing relationship with said belt when said spaced end portions are adjacent said brush.

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