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STORAGE AND SUPPLY ENCLOSURES FOR
PHOTOELECTROSTATIC COPY SHEETS

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2 Sheets-Sheet 1

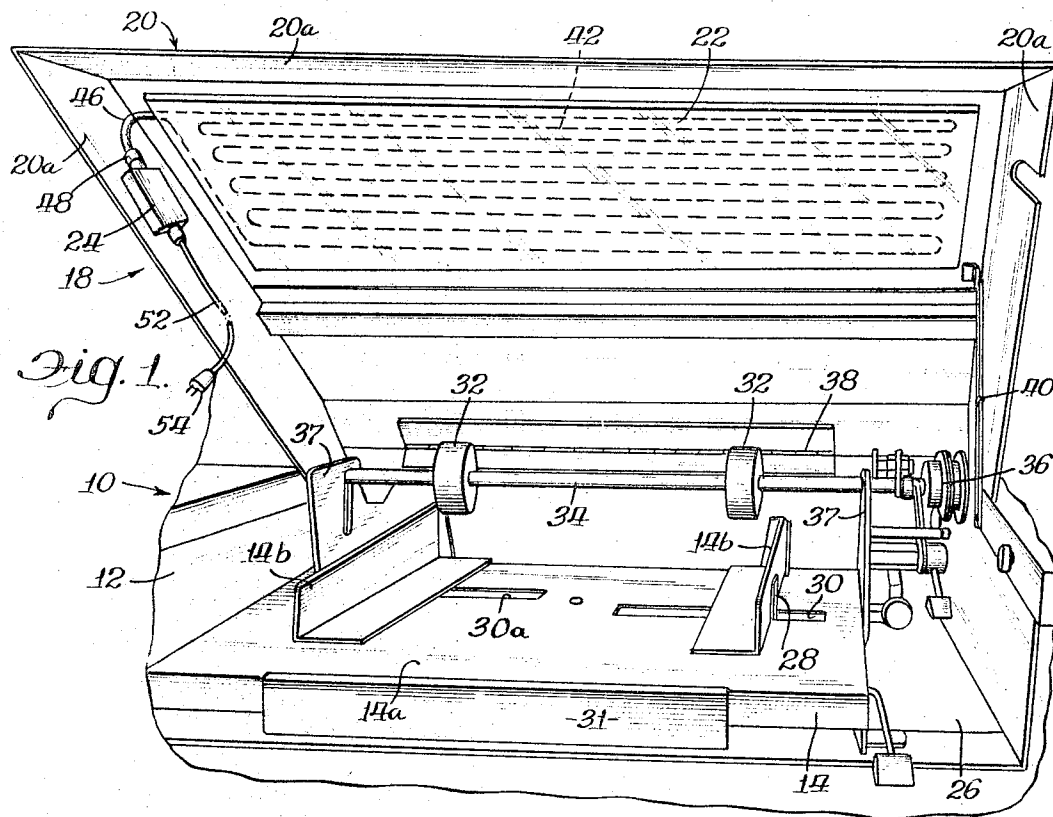
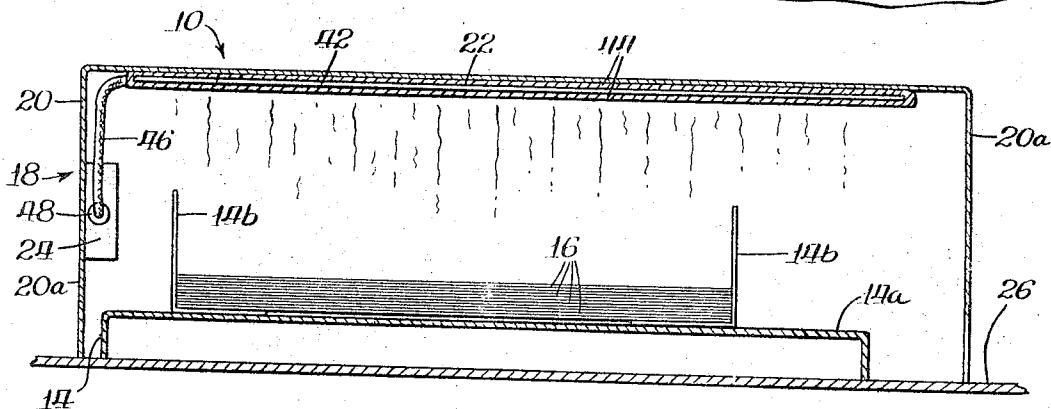


Fig. 2.

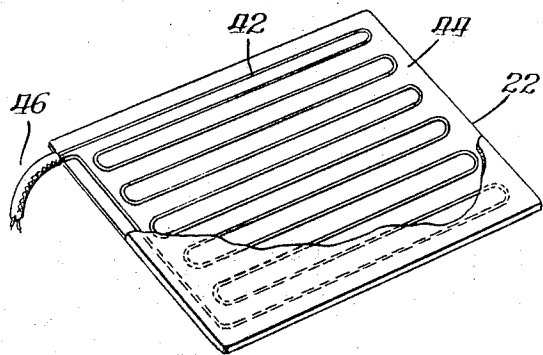


Fig. 3.

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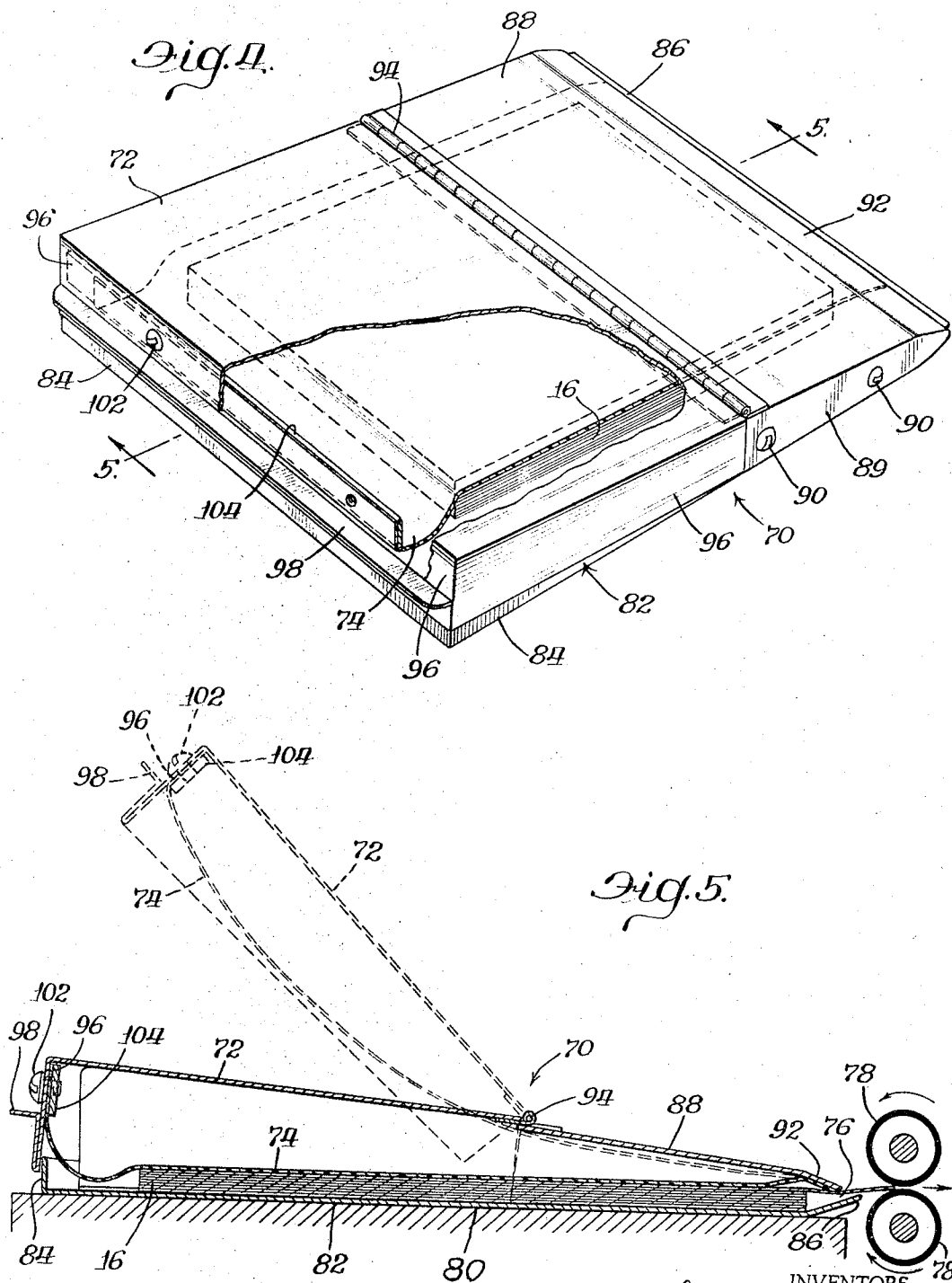
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STORAGE AND SUPPLY ENCLOSURES FOR PHOTOELECTROSTATIC COPY SHEETS

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ABSTRACT OF THE DISCLOSURE

An electrophotographic copying machine includes an enclosure for a supply of photoconductive material including a layer of a photoconductive medium such as zinc oxide carried on a paper substrate, the substrate initially having a resistivity of 10^8 to 10^{12} ohm-centimeters. The enclosure is constructed to prevent substantial changes in the moisture content of the paper, and is provided with a humidity level controlled electric resistance heater for use in high humidity regions, or with a moisture impermeable sheet overlying the photoconductive material for use in low humidity regions.

This invention relates to photoelectrostatic copying apparatus and more particularly to storage and supply enclosures for copying sheets used with photoelectrostatic copying machines.

One widely used type of printing or copying process makes use of copy sheets having a substrate or layer of paper to one surface of which a layer of photoconductive material, such as zinc oxide, in a resin binder is applied. In carrying out such a process, a copy sheet is fed into a photoelectrostatic copying machine which performs a sequence of operational or functional steps to produce an electrophotographic reproduction of an original on the copy sheet.

More specifically, in such as photoelectrostatic printing or copying machine, the copy sheet is fed through a pair of feed rollers to a charging area, in which area it passes between positive and negative corona discharge assemblies that apply positive and negative charges to opposite surfaces of the photoconductive layer, the negative charge being deposited on the outer surface of the photoconductive layer.

The charged copy sheet is then transported to an exposing stage where light from a suitable source is selectively applied to the photoconductive layer under the control of the original to be copied. The selective illumination of these areas places the illuminated areas in a conductive state so that the charges carried by the copy sheet are dissipated in the illuminated areas, but are retained in the non-illuminated areas. Thus an electrostatic image of charged and non-charged areas is established.

The exposed copy sheet is then transported to a developing stage, wherein a developer material such as an electroscopic powder is deposited onto the electrostatic image, and is selectively held on the copy sheet in accordance with the charged and charge-free areas to form a powder image loosely held on the sheet. For direct printing of a positive copy, positively charged particles are deposited, and are retained on the negatively charged areas of the copy sheet. Conversely, for reversal printing of a negative copy, negatively charged particles are used, and are repelled from the negatively charged areas to the charge-free areas.

The developing stage also includes biasing means for removing stray negative charge from the otherwise charge-free areas of the exposed copy sheet. One such biasing

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means, described in detail in the copending application of Granzow et al., Ser. No. 307,887, filed Sept. 10, 1963, includes a positive corona discharge assembly adjacent the rear or paper side of the copy sheet. By applying a positive discharge to the back surface of the sheet, the biasing means prevents the adherence of the electrostatic powder to the non-image areas of the sheet when positive printing is performed, and intensifies the image when negative printing is performed. After the copy sheet passes through the developing stage, the powder image is rendered permanent either by heating in a fuser oven, or by contact with a fixing agent.

The photoelectrostatic copying apparatus capable of carrying out the above described operation is adapted to function with an electrostatic copying member created on a substrate such as paper. To this end, the electrical resistivity of the paper substrate must be within certain limits so that the copies reproduced have images of proper density and the background area remains free of toner and/or carrier particles.

The resistivity of the photoconductive member is dependent on its moisture content, and it is known that paper will come to an equilibrium moisture content dependent on the humidity of the atmosphere in which it is stored. It will be apparent that an unprotected or open sheet of paper, such as the uppermost sheet in a supply stack, will come to an equilibrium moisture content as determined from the humidity of its surroundings in a very short period of time.

Under high humidity conditions, the resistivity of the photoconductive member falls below acceptable levels which seriously affects the quality of reproduction. The copy sheet becomes laterally conductive. When processing copy sheets of certain lengths in the photoelectrostatic apparatus, the leading edge of the sheet enters the developing stage of the copying machine while the trailing edge is being charged in the charging area. When the resistivity is low enough to allow lateral conductivity, the charges imparted to the copy sheet are conducted along the sheet and build up at the leading edge. In the developer, the entire leading edge of the copy sheet will be subjected to the deposition of the oppositely charged electroscopic powder, and an abrogation of the image will result.

In addition, if the resistivity of the copy sheet is too low, the developer biasing means may be rendered inoperative. The positive charges deposited on the back of the sheet are laterally conducted to the transport rollers, which contact the sheet. This has the effect of shorting out the corona discharge from the biasing means and produces a copy with dirty background.

In atmospheres of dry humidity, the moisture content of the copy sheet decreases. An undesirable high resistivity in the paper results. As a result, the photoelectrostatic material does not readily accept an electrostatic charge. This produces images of low density and causes the iron carrier particles of the developer mix to be deposited in the nonimage areas.

In the above described electrostatic copying process, the workable range of resistivities of the substrate as well as the photoconductive layer that will afford consistently high quality reproductions are well defined. The paper layer of the copy sheet should have electrical resistivity within the approximate range of 10^8 ohm-centimeters to 10^{12} ohm-centimeters. The zinc oxide photoconductive layer should have an electrical resistivity within the approximate range of about 10^{13} ohm-centimeters to 10^{16} ohm-centimeters. When the resistivity of the substrate falls below approximately 10^7 ohm-centimeters, the copy sheet becomes laterally conductive, leading to the above enumerated undesirable results.

In reversal type photoelectrostatic printing, the exposed or light struck areas on the photoelectrostatic member

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represent the image areas. The electroscopic powder is repelled by the charged portions since it is designed to have a like charge as the charged portions thereby being directed to the nonimage area. It is desirable that the difference of charge level in the image and nonimage areas range from 150 to 300 volts in order to produce suitably dense, sharp reversal images. The above specified electrical resistivity ranges for the substrate and the photoconductive layer are equally applicable.

When the copy sheets are supplied in packages for use with the photoelectrostatic copying machine, their resistivity is within the proper range. Previous to use the sheets may be unpackaged and placed in a storage enclosure on the copying machine. If the copy sheets are stored and used in an atmosphere in which the relative humidity is within the range of about 40% to 55%, the moisture content of the sheets is such that the electrical resistivity remains within the acceptable ranges. However, if the relative humidity is above this range, moisture content increases and the electrical resistivity may become too low for proper operation. Conversely, if the relative humidity is below this range, the electrical resistivity may increase to an undesirable level.

Accordingly, it is an object of the invention to provide means for controlling the moisture content of photoelectrostatic copy sheets.

It is another object of the invention to provide a photoelectrostatic copying machine in which the above-mentioned difficulties caused by deviant electrical resistivity of copy sheets are avoided.

It is a further object of the invention to provide a copy sheet storage chamber for photoelectrostatic copying machines including means for preventing extremes of relative humidity from adversely affecting the electrical resistivity of copy sheets.

A storage and supply chamber for photoelectrostatic copy machines in accordance with the invention includes a bin associated with a photoelectrostatic copying machine for holding copy sheets in position to be inserted into the machine. A hinged cover is provided, and when the cover is closed, it serves to enclose the copy sheets in the bin. Mounted to the inside of the cover there are provided means for controlling the moisture content of the stored copy sheets. In one embodiment of the invention, an electrical resistance heating pad is provided, and is controlled by a humidity responsive control. This construction is effective in preventing the build up of moisture content as a result of high humidity. In another embodiment, there is provided a flexible sheet of moisture impermeable material which rests on the copy sheets when the cover is closed to prevent reduction of moisture content due to low humidity. In both embodiments of the invention, the moisture content controlling means is removed from its position near the copy sheets when the cover is raised.

Other objects and advantages of the invention will appear from the following description in conjunction with the appended drawings, in which:

FIG. 1 is a partial view of a photoelectrostatic copying machine provided with a copy sheet storage and supply enclosure having moisture content controlling means constructed in accordance with the present invention;

FIG. 2 is an enlarged cross-sectional view of the enclosure of FIG. 1, with the cover closed and with some of the structure omitted;

FIG. 3 is a perspective view partially broken away of the heating pad of FIGS. 1 and 2;

FIG. 4 is a perspective view of a copy sheet enclosure with its casing partly broken away and illustrating an alternative embodiment of the present invention; and

FIG. 5 is an enlarged cross-sectional view in solid lines taken along the line 5—5 of FIG. 4 and showing in broken lines the copy sheet enclosure in its open position.

Having reference now to the drawings and particularly to FIGS. 1-3, there is illustrated a storage and supply en-

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closure 10 constructed in accordance with the present invention. The storage chamber 10 is adapted to be used in conjunction with a photoelectrostatic copy machine 12, a portion of which is shown in FIG. 1, and which is of the type adapted to make photoelectrostatic reproductions from a graphic original on a photoconductive member. Accordingly, the supply enclosure 10 is provided with a sheet supply receptacle 14 for holding a supply of photoelectrostatic copy sheets 16 (FIG. 2), having a photoconductive layer applied on one side. However, the invention is applicable to any type of photoconductive material which may be used in a photoelectrostatic copy machine.

In accordance with the invention, the storage and supply enclosure 10 is equipped with means, designated generally at 18, for controlling the moisture content of the copy sheets 16 when they are stored in the receptacle or bin 14. To this end the enclosure 10 is equipped with a hinged cover 20 in which is mounted an electric resistance heating pad 22. The heating pad 22 is provided with a humidity responsive control 24 adapted to energize the heating pad 22 when a predetermined relative humidity is reached. Energization of the heating pad 22 serves to reduce the moisture content of the photoelectrostatic copy sheets 16 so that their resistivity does not decrease to a point where proper functioning of the electrostatic copying process is hindered.

In order to provide space for the storage and supply enclosure 10, the photoelectrostatic copying machine 12 is provided with a recessed portion 26. The receptacle 14 is positioned within the recess 26 and includes a base 14a and a pair of adjustable side flanges 14b. The flanges 14b are laterally adjustable by means including fingers 28 extending through slots 30 and 30a in the base 14a to accommodate copy sheets of varying width. The bin or receptacle 14 is provided with an extension shelf 31 which may be extended to accommodate copy sheets of any length.

The storage and supply enclosure 10 includes a pair of friction feed rollers 32 mounted on a feed roller shaft 34 for feeding copy sheets out of the bin 14 and into the copying machine 12. A drive mechanism 36 is arranged so that the feed roller shaft 34 is actuated to advance a copy sheet when it is desired to make a copy. The feed roller shaft is mounted on a pair of support brackets 37 and is adapted to be moved downwardly to place the rollers 32 into frictional engagement with the copy sheets 16.

The cover 20 may be formed of light gauge sheet metal and includes downwardly extending flanges 20a along three edges. The fourth edge of the cover 20 is hinged to the copying machine 12 by means of a hinge 38. The cover 20 is illustrated in its open position in FIG. 1, and is adapted to be held open by a folding arm 40. When the cover 20 is lowered to its closed position, as illustrated in FIG. 2, the flanges 20a rest against the surface 26 to close the enclosure 10 and enclose the copy sheets 16 held in the bin 14.

The assembly 18 for controlling the moisture content of the copy sheets 16 is mounted on the underside of the cover 20. The heating pad 22 is suitably fastened against the underside of the cover 20 so that it is suspended above the bin 14 when the cover 20 is closed. As can best be seen in FIG. 2, the heating pad 22 is wider than the copy sheets 16, and is long enough to overlie a substantial part of the copy sheets. The heating pad 22 includes a convoluted heating element 42 encased in electrical insulating material 44 and terminating in an electric cord 46 having a suitable connector 48 engageable with the humidity responsive control 24.

This control means 24 is mounted in the enclosure 10 upon one of the flanges 20a. The control 24 is provided, as shown, with a cord 52 and plug 54 for connection to a suitable source of electrical power. The control 24 may be of any suitable type adapted to actuate the heating element 42 when the humidity within the enclosure 10 increases above a predetermined value.

In the illustrated embodiment, the assembly 18 is adapted to be connected to a 110 volt 60 cycle AC outlet and the heating pad 22 includes a 50 or 60 watt heating element. The pad 22 is about 10 inches by 14 inches in size, and the control 24 is adapted to energize the heating element 42 when the humidity increases above about 55%.

The operation of the assembly 18 will be obvious from the preceding description. The heating element is effective to prevent the moisture content of the copy sheets 16 from increasing and thereby lowering the resistivity of the copy sheets to unsatisfactory levels. It will be appreciated that the assembly 18 in combination with the cover 20 provides an economical and efficient moisture content control of great value in geographical areas which frequently experience high relative humidity.

Having reference now to FIGS. 4 and 5 there is illustrated another embodiment of the invention. The numeral 70 generally designates another form of storage and supply enclosure embodying the present invention and adapted for use with a photoelectrostatic copying machine. The enclosure 70 includes a hinged cover 72 and is adapted to enclose a supply of copy sheets 16 which can be manually fed through an elongated slot 76 (FIG. 5) in the enclosure 70 through a pair of opposed rollers 78, and into the copying machine. The enclosure 70 is adapted to rest upon a suitable platform 80 provided on the copying machine.

In accordance with the invention the enclosure 70 is provided with means for controlling the moisture content of the copy sheets 16, it being understood that the moisture content of the copy sheets 16, when they are removed from their original package and placed in the enclosure 70, is within the acceptable range. However, if the copying machine is to be secured in an atmosphere where the relative humidity is below about 40% the exposed copy sheet on the top of the pile will dry out to the point where the electrical resistivity of the sheet is too high for satisfactory operation. According to a novel feature of the invention a flexible moisture impermeable sheet 74 is suspended from the cover 72 to overlie the copy sheets 16 to prevent their drying out.

The enclosure 70 may be formed of a light weight material such as sheet metal and includes a lower casing portion or bin 82 bounded on three edges by an upwardly extending flange 84. The fourth edge is provided with a gradually rising guiding flange 86 to guide copy sheets through the slot 76 and into the feed rollers 78. An upper casing portion 88 is provided with downwardly extending flanges 89 which are fastened to the flanges 84 by means of suitable fasteners 90. An edge of the upper casing portion 88 is provided with a guiding flange 92 which cooperates with the guide flange 86.

The cover 72 is hinged to the upper casing 88 by means of a hinge 94 and includes downwardly extending flanges 96 which overlie the flanges 84 when the cover is closed. The cover 72 is provided with a handle 98, which may be formed integrally with a flange 96, and which allows the cover 72 to be raised when it is desired to place copy sheets into the enclosure 70 or to manually advance a copy sheet into the copy machine.

The sheet 74, which is mounted within the enclosure 70 to prevent evaporation of moisture from the copy sheets 16, may be formed of rubber, plastic, or other flexible material. One end of the sheet 74 is fixed to the cover 72 by means of fasteners 102 which pass through a flange 96, through openings provided in the sheet and are threaded into a clamping element 104. It will be understood that the clamping element 104 will hold the sheet 74 tightly against the cover 72. The other end of the sheet 74 is secured to the underside of the guiding flange 92 associated with the upper casing 88 and in order to present a smooth surface for the passage of the copy sheets, the sheet 74 is glued or otherwise bonded to the flange 92.

It can be seen that due to the provision of the moisture containing sheet 74 in the enclosure 70, the evaporation of the moisture from the copy sheets 16 will be prevented. In addition, when the cover 72 is raised, the sheet 74 will be lifted to provide access to the copy sheets 16, as illustrated in broken lines in FIG. 5.

Although the present invention has been described with reference to specific illustrative embodiments, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In combination with a photoelectrostatic copying machine, a storage and supply enclosure for electrostatic copy sheets comprising, a receptacle mounted on said machine for holding said electrostatic copy sheets in a position for insertion into said machine, a cover mounted for pivotal movement with respect to said receptacle and movable between an open position and a closed position, said cover having a downwardly extending flange adapted to overlie said receptacle and effectively isolate said electrostatic copy sheets when said cover is in its closed position, said cover in its open position providing access to said receptacle, and means positioned within the enclosure for controlling the moisture content of the electrostatic copy sheets in said receptacle, said moisture controlling means including a sheet form element having a width at least as great as the width of said copy sheets, said sheet form element mounted at least partly to said cover in a position to overlie said receptacle and said electrostatic copy sheets when said cover is in its closed position and adapted to be moved to a position spaced from said receptacle and said electrostatic copy sheets when said cover is moved to its open position.

2. In an apparatus for making electrophotographic reproductions from a graphic original the combination comprising, photoconductive means adapted to be selectively exposed in accordance with said graphic original, a cover pivotally movable with respect to said photoconductive means between a closed position in which said cover defines at least in part an enclosure for said photoconductive means and an open position, and means for controlling the moisture content of said photoconductive means, said moisture controlling means including a thin flexible moisture impermeable sheet mounted at one end to said cover whereby said sheet overlies said photoconductive means when said cover is in its closed position and whereby said sheet is spaced from said photoconductive means when said cover is moved to its open position.

3. The combination of claim 1 wherein said sheet form element constitutes an electrical resistance heating pad, and said moisture controlling means additionally includes a control unit responsive to relative humidity within the enclosure to activate said electrical resistance heating element when the relative humidity within the enclosure reaches a predetermined level.

4. The combination of claim 1 wherein said sheet form element constitutes a flexible moisture impermeable sheet adapted to rest upon said electrostatic copy sheets when said cover is in its closed position.

5. In an apparatus for making electrophotographic reproductions of a graphic original, the combination comprising a supply of photoconductive sheet material upon which copies are to be made, an enclosure for said supply of sheet material, means for supporting said supply of sheet material within said enclosure, drive means for advancing a portion of said supply of sheet material away from said supporting means when a copy is desired, an electric resistance heater disposed within said enclosure, and control means responsive to relative humidity in said enclosure for energizing said heater upon the relative humidity in said enclosure reaching a predetermined value.

6. In an apparatus for making electrophotographic reproductions of a graphic original, the combination comprising a supply of photoconductive sheet material upon which copies are to be made, an enclosure for said supply of sheet material, means for supporting said supply of sheet material within said enclosure, drive means for advancing a portion of said supply of sheet material away from said supporting means when a copy is desired, and an electric resistance heater disposed within said enclosure and positioned with respect to said supporting means so as to direct heat at the surface of the portion of said sheet material next to be advanced.

7. In an apparatus for making electrophotographic reproductions of a graphic original, the combination comprising a supply of photoconductive sheet material upon which copies are to be made, an enclosure for said supply of sheet material, means for supporting said supply of sheet material within said enclosure, drive means for advancing a portion of said supply of sheet material away from said supporting means when a copy is desired, an electric resistance heater disposed within said enclosure and positioned with respect to said supporting means so as to direct heat at the surface of the portion of said sheet material next to be advanced, and control means responsive to relative humidity in said enclosure for energizing said heater upon the relative humidity in said enclosure reaching a predetermined value.

8. In an apparatus for making electrophotographic reproductions from a graphic original, the combination comprising a supply of photoconductive material including a substrate whose resistivity varies in accordance with the equilibrium moisture content reached upon exposure to the atmosphere, said substrate having an initial predetermined moisture content, an enclosure for said supply of material, means for supporting said supply of material within said enclosure, drive means for advancing a portion of said supply of material away from said supporting means when a copy is desired thereby exposing another portion of said supply of material next to be advanced, and means located within said enclosure and in proximity to said next to be advanced portion of material for preventing substantial changes in the equilibrium moisture content of the substrate of said next to be advanced portion of material.

9. The combination of claim 8, said last mentioned means comprising a sheet of moisture impermeable material resting upon said next to be advanced portion.

10. The combination of claim 8, said last mentioned means comprising heating means, and control means responsive to humidity within said enclosure for energizing said heating means when the humidity within said enclosure exceeds a predetermined level.

11. In an apparatus for making electrophotographic reproductions from a graphic original, the combination comprising:

an enclosure which provides a storage chamber for photoconductive material adapted to be selectively exposed in accordance with said graphic original,

a supply of photoconductive material within said enclosure, said material having a base support which upon being exposed to an atmosphere having a predetermined relative humidity level is equilibrated to a given moisture content,

and a moisture control assembly for controlling the relative humidity of said atmosphere within said enclosure so that the moisture content of said base is governed,

said assembly including heater means juxtaposed said material mounted within said enclosure in position to be adjacent said photoconductive material, said heater means operating to control the relative humidity in said atmosphere whereby the moisture content of the base support is governed.

12. The combination as defined in claim 11 including drive means for withdrawing a portion of said supply from the enclosure.

13. The combination as defined in claim 11 including a control unit responsive to the relative humidity in said enclosure for energizing said heater means when the relative humidity in said enclosure exceeds said predetermined level so that the moisture content of said base support is prevented from exceeding said given content.

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