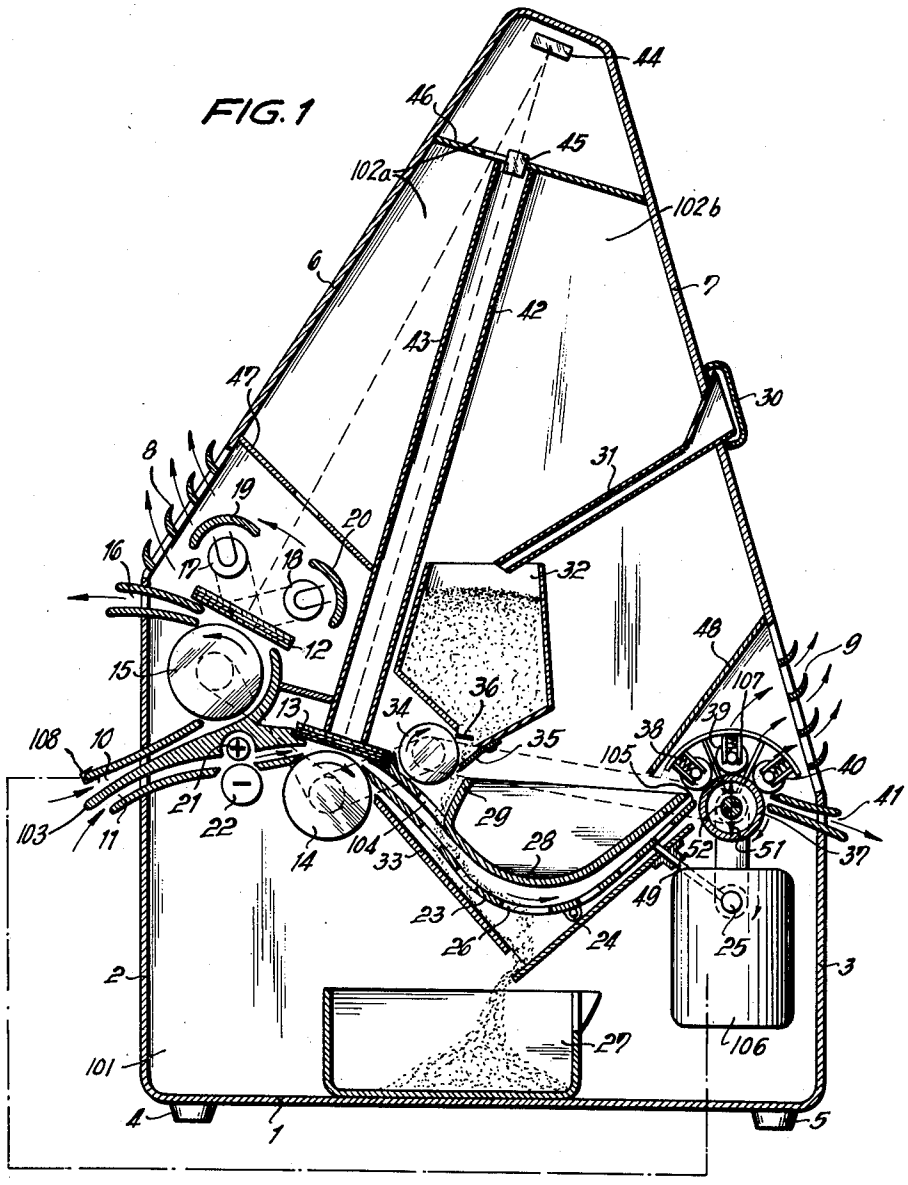
Oct. 24, 1961 W. LIMBERGER 3,005,389

ELECTROPHOTOGRAPHIC COPYING DEVICE

Original Filed March 26, 1957 2 Sheets-Sheet 1

FIG. 1



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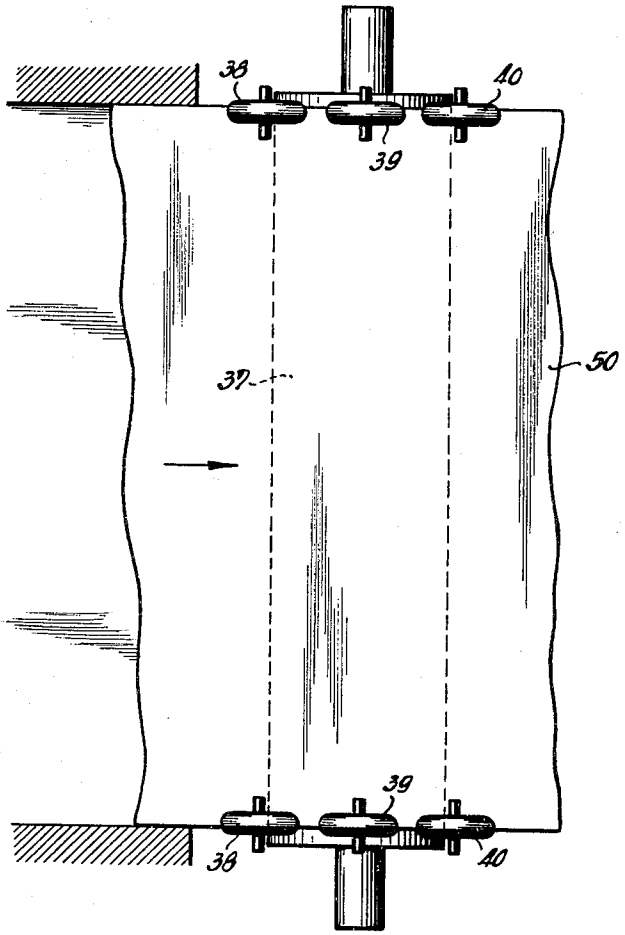
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Original Filed March 26, 1957 2 Sheets-Sheet 2

FIG. 2



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3,005,389

ELECTROPHOTOGRAPHIC COPYING DEVICE

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Original application Mar. 26, 1957, Ser. No. 648,671. Divided and this application Mar. 24, 1958, Ser. No. 727,018
Claims priority, application Germany Mar. 28, 1956
12 Claims. (Cl. 95—1.7)

The present invention relates to a device for the reproduction of a master copy on a flexible carrier having an electrostatically charged photoconductive layer. This application is a division of my copending application Ser. No. 648,671 filed March 26, 1957.

It is known to produce xerographic images on photoconductive layers by first charging them in an electrode assembly and thereafter producing a latent electrostatic image by exposure to illumination. By dusting the layers with a powder, the grains of which serve as carriers for pigment particles, this latent electrostatic image is made visible since the pigment particles adhere to the electrostatic image according to the charge pattern produced by the image illumination. These pigment particles are then fused into the charged layer to form a permanent image.

For manufacturing a readily readable image, an extremely exact control of the processes is necessary particularly with regard to the steps of distributing the powder and guiding the xerographic sheet material. Thus, it is necessary to separate the illuminating section from the developing section of the apparatus so that powder from the latter should not find its way into the former to cloud the path of the light rays. The invention has for its principal object the provision of means for solving this problem in a more satisfactory manner than has heretofore been proposed.

The invention provides a device for the production of xerographic copies on sheet material in which a housing is subdivided into an upper and lower chamber by a partition forming, within the lower chamber, a preferably horizontal guide channel for the sheets carrying the charged layer which, together with the master copy, are inserted between a pair of synchronously driven feed rollers through slots in the housing wall. The two feed rollers are respectively positioned adjacent a first transparency, mounted inside the upper chamber next to a suitable light source, and a second transparency, included in the partition to form a light-transmitting portion therein. By means of these rollers the master copy is caused to pass below the first transparency while the xerographic sheet advances underneath the second transparency through the guide channel. Walls in the upper chamber divide it into an illumination compartment and a developing compartment, separated from each other, and also define a passage in the shape of a flattened tube above the second transparency through whigh light reflected from the master copy is directed by an appropriate optical system, such as an objective and a mirror, onto the xerographic copying layer whose speed of movement is related to the speed of movement of the master copy in accordance with the desired scale of reproduction. The developing compartment contains, above an opening in the partition, a powder-distributing device for making the latent image visible, followed by a fusing device within the guide channel for fixing the distributed powder to the xerographic layer. Advantageously, an electrode assembly is also provided in the device for charging the xerographic layer ahead of the transparency associated with the guide channel. In a preferred embodiment, the two transparencies are inclined at a small angle with respect to the horizontal,

and to each other, whereby a long, nearly vertical path is provided for the light rays as they pass from the first transparency to the reflecting mirror and back to the second transparency.

Further advantages and features of the invention will appear from the following description of a preferred embodiment given by way of example with reference to the accompanying drawing. It is expressly to be noted that the invention is not limited to the construction illustrated.

In the drawing:

FIG. 1 shows a sectional elevation through a device for producing copies on xerographic sheets in accordance with the invention; and

FIG. 2 is an enlarged top plan view of a detail of the device according to FIG. 1.

It may be mentioned that the illustrated parts of the apparatus, e.g. rollers, cylinders, intermediate walls and the like, are supported on one or both of the side walls of the device.

The housing of the device shown in the drawing consists of a lower, box-shaped chamber **101** and an upper, generally pyramidal chamber **102***a*, **102***b*. Chamber **101** is formed by a base **1** and upstanding end walls **2** and **3** perpendicular thereto. On the lower side of the base **1**, feet **4**, **5** are provided which consist of elastic material, for example rubber, designed to prevent the transfer of vibrations to the device.

Above the end walls **2**, **3**, wall parts **6**, **7** run together upwardly to form the upper chamber. Louvers **8**, **9** are provided in the inclined wall parts **6**, **7** to facilitate the escape of the heat produced by the illuminating device and the fusion device respectively disposed within the compartments **102***a*, **102***b* of that chamber as more fully disclosed hereinafter.

At the end wall **2**, inlet slots **10**, **11** are provided for the master copy and the xerographic sheet. The guide paths extending from these slots lead on the one hand to a first plate **12** for the master copy and on the other hand to a second plate or window **13** for the xerographic sheet. These plates preferably consist of a transparency, i.e. a glass plate which passes ultraviolet or yellow light according to the kind or spectral sensitivity of the paper used, and an opaque supporting frame which is imbedded in the glass and defines a light-transmissive window aperture therein. It will be noted that the two plates **12**, **13** are mounted in close proximity to each other.

Pressure rollers **14**, **15**, serving as feeding means, are arranged beneath the plates **12** and **13**, respectively. These rollers, shown interconnected for synchronized rotation, preferably have an elastic surface. If required, they may be resiliently supported by means of springs with freedom of movement in the directions of the respective platforms.

The roller **15** is so arranged in the housing in the vicinity of the end wall **2** that the master copy, after passage under the plate **12**, is fed directly into an outlet slot **16** where it is discharged from the device. Above the plate **12**, lamps **17**, **18** are provided which illuminate the central section of the plate. Reflectors **19**, **20** are located beyond the lamps.

The division between the lower and upper housing chambers is effected by a partition, formed by shields **103** and **28**, which seals the lower chamber **101** against the illuminating compartment **102***a* but is open toward the developing compartment **102***b* at **104**, **105**. Underneath this partition, in the guide path for the xerographic sheet between the inlet slot **11** and the plate **13**, an electrode assembly **21**, **22** is disposed between which the sheet passes. In the embodiment illustrated, the electrode as-

sembly consists of rollers 21, 22 which are manufactured of electrically conductive material and at the same time serve as part of the feeding mechanism for the sheet. The distance between the rollers 21, 22 is about the same as the thickness of the sheet. The potentials for charging the xerographic layer are applied to these rotary electrodes. In a preferred embodiment, the positive electrode is located above the path for the xerographic layer.

The pressure roller 14 conveys the xerographic sheet after its exposure to a channel defined by the partition member 28 and a vibratory guide member 23. This latter member is swingable about a pivot 24 and is oscillated by a reciprocating rocker arm 49, driven from a motor 106 by an eccentric shaft 25, to remove any loosely adhering developing powder not held by electrostatic attraction. In some instances it will be desirable to vary the amplitudes of the oscillations over the length of the member 23. This can be attained, for example, by supporting the eccentric drive shaft 25, the pivot 24 and other parts of the system by elastic means such as springs or rubber cushions.

The guide member 23 is perforated so that powder passing beneath the xerographic sheet falls onto a chute 33. Particularly in the lowest part of the member 23, outlet openings 26 of large cross-section are provided for the powder so that the excess, through the forces of gravity and vibration, is caused to fall into a container 27 via the chute 33. In order to prevent vortex formation of the powder inside the apparatus, the partition member 28 is bent upwardly at opening 104 to form a funnel 29 aligned with the outlet of the powder-distributing device thereabove.

The powder-distributing device consists essentially of a hopper 32 which is accessible from outside by way of a removable lid 30 and a connecting channel 31. The powder collected in the container 27 can be returned through this channel for re-use in the hopper 32. The base of the hopper 32 runs funnel-shaped to an outlet opening 36, in which a dispensing roller 34 rotates. The roller 34 closes the outlet opening 36 on one side and, preferably by means of depressions in its suitably profiled surface, transports the powder on rotating to the lower elastic lip 35 of the hopper opening 36. By the pressure of the resilient lip 35 on the elastic surface of the roller 34, and by proper dimensioning of the outlet at the base of the hopper 32, a uniform distribution and supply of the powder are insured.

After leaving the channel above vibratory member 23, the xerographic sheet passes to a rotating cylinder 37 of a fusion device which, in combination with pressure rollers 38, 39, 40, serves at the same time for the further advance of the sheet over the fusion device to the outlet slot 41. As illustrated schematically in FIG. 1, motor 106 drives the cylinder 37 as well as the rollers 34, 14 and 15.

A heating device 52 is arranged in the cylinder 37, its rising convection heat passing directly to the region of the cylinder which communicates with the xerographic sheet while radiated heat from this source is collected by the cylinder and conveyed by its rotation to the sheet. The device consisting of the rollers 38, 39, 40 and the cylinder 37 with its heating device 52 is arranged to be vertically adjustable with respect to the guide member 23, within partition opening 105, as indicated by the arrow 51 whereby the angle of contact between the sheet and the cylinder 37 can be increased or decreased. This arrangement affords an extremely advantageous, instantaneously effective heating control to satisfy the existing requirements, thus supplementing the control facilities afforded by the adjustability of the swing of the vibratory guide member 23 and, if desired, by the variability of the number of revolutions of the dispensing roller 34.

In FIG. 2, a top plan view of the fusing device 37—40 is shown. The xerographic sheet is indicated in this figure at 50. Under the sheet is located the cylinder 37, whereas at each edge of the sheet there is disposed a respective set of pressure rollers 38, 39, 40. The rollers 38, 39, 40 are preferably mounted with freedom of radial motion relative to the cylinder 37 and are pressed by springs 107 against the periphery of the latter, as illustrated schematically in FIG. 1.

The upper chamber of the housing is divided into its compartments 102*a*, 102*b* by a double wall 42, 43 rising perpendicularly from the plate 13 to form a flattened tube for the passage of light rays reflected by a mirror 44 at the upper end of the housing, the path of these rays being generally transverse to the surface of the sheet 50 by reason of the small relative inclination of plates 12 and 13. These light rays, originating at the lamps 17, 18 and reflected by the master copy underneath the plate 12, traverse an objective 45 before reaching the plate 13 and through it the xerographic sheet. Because of the mounting of the objective 45 in the considerably narrowed section of the apparatus, the objective can be made readily accessible by a cover so that, e.g. in connection with an adjustment of the mirror 44, alterations can be carried out in the image scale. The part of the apparatus containing the mirror 44, representing a portion of the illuminating compartment 102*a*, is tightly sealed by a wall 46 as well as by the wall 42 with respect to the developing compartment 102*b* in which the powder-distributing device 32 is located.

The illuminating or exposure device 17—20 and the fusing device 37—40 are partially covered by sections of the wall parts 6, 7 provided with the louvers 8, 9, so that the generated currents of hot air can escape directly into the atmosphere. Additionally, shields 47, 48 are provided which lead the rising air currents to these louvers 8, 9, so that the inside of the apparatus is protected against the heat developed by the illuminating and fusing devices.

In operation, the master copy and the xerographic sheet are inserted into the slots 10, 11 so that the image of the master copy and the photoconductive layer face each other. Motor 106 may be triggered by a suitable switch in one of the inlet slots, such as a contact 108 arranged in slot 10 in the path of the master copy, to drive the movable elements of the apparatus. As the master copy passes underneath the transparency 12, its image side is illuminated by the lamps 17, 18 and the reflected light rays pass by way of the optical system 44, 45, the light tube formed by wall members 42 and 43 and the transparency 13 to the xerographic layer carried by the sheet 50 which had previously been charged on its passage between the electrodes 21, 22. Next, developing powder from hopper 32 is distributed onto the illuminated layer, the overflow being shaken loose by the vibrator 49 as the sheet ascends the sloping part of guide member 23. The remaining particles, whose distribution corresponds to the latent image formed on the xerographic layer during the exposure step, are then fixed to the layer in the fusion device 37—40 to provide a permanent replica of the master copy.

What I claim is:

1. An electrophotographic copying device for the reproduction of a master copy on a flexible carrier having an electrically chargeable photoconductive surface, comprising a housing, a first frame, a first transparency in said first frame, first feed means for advancing below said first transparency the master copy to be reproduced, a second frame positioned close to said first frame and inclined at a small angle relatively thereto, a second transparency in said second frame, second feed means for advancing said carrier below said second transparency, partition means including said second frame in said housing defining a generally horizontal channel for the passage of the carrier with its photoconductive surface facing upward, walls rising substantially vertically from said second

frame within said housing and forming an elongated flattened light tube terminating at said second transparency, optical focusing means of large focal length in said housing for directing light rays from said master copy through said first transparency, said light tube and said second transparency onto the upper surface of said carrier, said focusing means including a reflector aligned with said light tube at a location remote from said second transparency, the entire path of said light rays being generally transverse to said carrier surface, shield means including said second frame and said walls isolating said optical means from said channel, electrode means positioned in said channel ahead of said second transparency for producing an electric charge in said photoconductive surface, hopper means positioned above said channel beyond said second transparency for depositing a developing powder onto the illuminated photoconductive carrier surface, thereby converting the latent image on said surface into a visible replica of said master copy, heating means positioned in said channel beyond said hopper means for fusing said powder onto said surface and forming a permanent duplicate of said master copy on said carrier, and feed means for successively advancing said carrier through said channel past said electrode means, said second transparency, said hopper means and said heating means.

2. A device according to claim 1 wherein said frames are inclined at small angles with respect to the horizontal.

3. A device according to claim 1 wherein said housing has a side wall provided with an entrance slot for said master copy, an exit slot for said master copy and an admission slot for said carrier, said first feed means including a roller positioned between said entrance and exit slots.

4. A device according to claim 1 wherein said housing is provided with upwardly sloping side walls converging at a location above the upper end of said light passage.

5. A device according to claim 4 wherein said optical means comprises a light source positioned underneath one of said sloping walls, said heating means being positioned underneath the other of said sloping walls, said sloping walls being provided with louvers and with respective guide panels for directing hot air from said light source and from said heating means into the atmosphere by way of said louvers, respectively.

6. An electrophotographic device for the reproduction of a master copy on a flexible carrier having an electrically charged photoconductive surface, comprising a housing, partition means dividing said housing into a first and a second chamber, said partition being being provided with a window, walls in said first chamber extending substantially perpendicularly from said partition means on opposite sides of said window and forming an elongated flattened light tube terminating at said window, means including said walls in said first chamber dividing the latter into two mutually isolated compartments, a transparent plate in one of said compartments near said partition means and said walls, a first driven roller positioned in one of said compartments close to said plate for advancing the master copy to be reproduced past said plate, a second driven roller coupled with said first roller and positioned in said second chamber close to said window for advancing the flexible carrier past said window, means including said partition means forming between said rollers a first guide path for said master copy and a second guide path for said carrier, guide means in said second chamber extending adjacent said partition means and forming therewith an extension of said second guide path consituting a channel for the movement of said carrier with its photoconductive surface facing said partition means, said partition means having an opening leading to the other of said compartments, optical focusing means of large focal length in said first chamber for directing light rays from said master copy through said plate, said light tube and said window onto the photoconductive surface of said carrier, said focusing means including a reflector aligned with said light tube at a location remote from said window, the entire path of said light rays being generally transverse to said carrier surface, hopper means in said other of said compartments adjacent said opening for depositing a developing powder onto the illuminated photoconductive carrier surface, thereby converting the latent image on said surface into a visible replica of said master copy, and heating means positioned in said channel beyond said opening for fusing said powder onto said surface and forming a permanent duplicate of said master copy on said carrier.

7. A device according to claim 6 wherein said hopper means comprises a funnel and a powder-dispensing roller synchronized with said rollers adjacent the mouth of said funnel.

8. A device according to claim 7 wherein said funnel is provided at its mouth with a depending lip elastically engaging the periphery of said roller.

9. A device according to claim 6, further comprising vibratory means positioned in said channel beyond said hopper means for rocking said carrier and removing loosely adhering powder therefrom.

10. A device according to claim 9 wherein said partition means extends generally horizontally and includes a sloping movable wall portion, said vibratory means comprising a rocker mechanism connected with said movable wall portion to impart oscillatory motion thereto.

11. A device according to claim 6 wherein said heating means comprises a rotatable heated roller positioned to support said carrier from below and co-operating roller means positioned to bear from above upon the photoconductive carrier surface.

12. A device according to claim 11, comprising mounting means for said heated roller and for said co-operating roller means enabling vertical adjustment thereof.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,005,389 October 24, 1961

Walter Limberger

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 49, after "partition" insert -- means --; same line 49, strike out "being", second occurrence.

Signed and sealed this 28th day of January 1964.

(SEAL)
Attest:
ERNEST W. SWIDER

Attesting Officer

EDWIN L. REYNOLDS

Acting Commissioner of Patents

UNITED STATES PATENT OFFICE

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