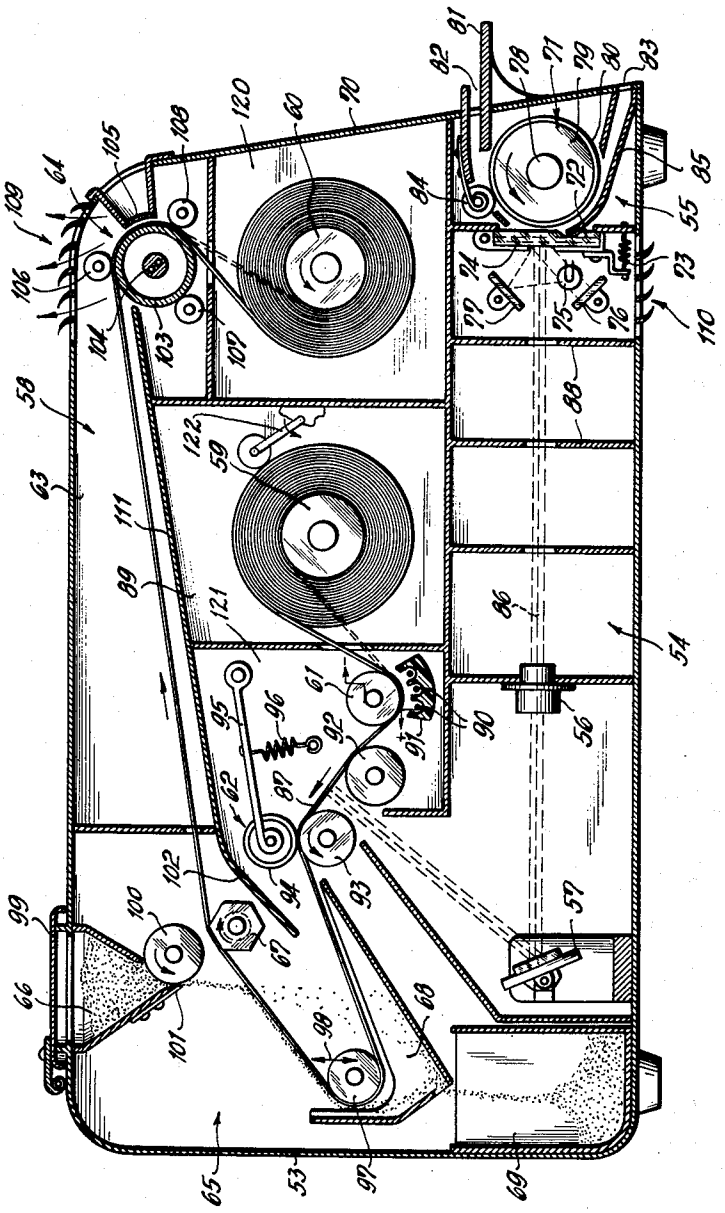
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ELECTROPHOTOGRAPHIC COPYING DEVICE

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ELECTROPHOTOGRAPHIC COPYING DEVICE

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The present invention relates to a device for the reproduction of a master copy on a flexible carrier having an electrostatically charged photoconductive layer.

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. The principal object of this invention is to provide a compact arrangement satisfying this requirement in a device designed for the continuous processing of such sheet material which is in the form of an elongated web.

In the production of copies by a continuous process, the invention contemplates the provision of a housing through which the web carrying the xerographic layer, taken from a supply roller in a dispensing chamber, is guided in a generally horizontal, elongated loop through several additional chambers to a storage roller in a receiving chamber. The additional chambers include an exposure chamber in which the image of a master copy is projected onto the xerographic layer; a developing chamber in which a hopper sprinkles powder at a controlled rate onto the upper run of the looped carrier whose xerographic layer faces outwardly on the loop, this hopper being advantageously positioned in a region of a distinctly sloping loop portion which is engaged by a vibrator serving to insure even distribution of the powder on the carrier surface and to shake off the excess; and a heating chamber in which the remaining powder particles are fused onto the xerographic layer to form a permanent visible image. A projection chamber, containing means for holding the master copy to be reproduced, preferably extends alongside the carrier loop to form an elongated light path for rays reflected by the master copy, this path accommodating optical means such as an objective and diaphragms for controlling the light rays on their way to a mirror which directs them onto the carrier surface. The rays enter the exposure chamber through an aperture which, advantageously, is flanked by two rollers forming a light gate, one of these rollers being driven to stretch the carrier taut across the light gate for accurate focusing.

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.

The sole figure of the drawing shows a section through a device according to the invention for manufacturing copies by a continuous process.

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 53 shown in the drawing is divided into several sections including a projection chamber 54 containing an illumination device 55, an objective 56 and a mirror 57; a dispensing chamber 89 with a supply roller 59; a receiving chamber 120 with a storage roller 60; an exposure chamber 121 containing rollers 61, 93, 94, driven roller 93 being part of a carrier-feeding mechanism or driving device 62 (together with pressure roller 94) and defining with roller 92 a light gate while roller 61 constitutes one of the electrodes of a charging device whose other electrode is indicated at 90; a heating chamber 63 closed with respect to the other chambers, forming an elongated channel at the end of which above the storage roller 60 a fusing device 64 is provided; and a developing chamber 65 enclosing a powder-distributing device 66, a vibrator 67 and a collector 68 for excess powder which is guided into a removable container 69 in the lower part of the section 65.

All sections of the housing are separated by partitions which merely have slits for the passage of the web 87 carrying the xerographic layer and for its illumination by light rays from a master copy to be reproduced. The separate sections are thus effectively isolated from one another. In the preferred embodiment illustrated, the section 54 is provided above the vase of the housing 53 and beneath the sections 120, 89, 121 and 58. The section 65 extends between the base and the cover of the housing 53 at the left-hand end of the latter.

The section 54 begins at the right-hand side wall 70 of the housing 53. Next to this side wall is the illuminating device 55 which consists essentially of a pressure roller 71 and a pivoted glass plate 72 which is drawn onto the surface of the roller 71 by a spring 73. The pressure roller 71 consists of a central core of metal 78 with a rubber covering 79. The surface of the roller 71 is formed from a fabric 80. In the glass plate 72 there is included a layer 74 which can also serve as a support. This layer masks all but the central region of the contact zone of the plate 72 with the roller so as to form a slot which is illuminated by the light source 75, for example a quartz lamp. Mirrors 76 and 77 are arranged symmetrically with respect to the light from the slot in the glass plate 72. The mirrors 76 and 77 are made adjustable. Above and below the pressure roller 71 the housing wall 70 is provided with slots 82 and 83 for introducing and discharging the master copy (not shown), these slots leading to the glass plate 72. Behind the inlet slot 82, which is disposed above a supporting table 81 for the master copy, a roller 84 presses the master copy onto the roller 71 so that this copy is guided safely behind the glass plate 72. The glass plate 72 is preferably so arranged that its pivotal axis lies at the side of the inlet slot 82, i.e. along its upper edge.

A guide member 85 extending toward the outlet slot 83 for the master copy engages a notch in the glass plate 72, located beneath the illuminated section, thereby insuring that the master copy is guided to the outlet slot 83.

The light rays 86 reflected from the master copy are focused by the objective 56 and reflected by the mirror 57 onto the electrostatic layer on web 87. By the use of an objective and the mirror, images having the sharp definition of contact copies are produced. Between the objective 56 and the illuminating device 55, light baffles 88 are provided whose central apertures define the cross-section of the beam 86.

In the chamber 89 the supply roller 59 is mounted in the side walls of the housing. The web 87 with the charged layer is drawn from the roller 59 through the charging or forming device 91, 61. Roller 61, constituting the negative electrode of the device, is in contact

with the layer-free side of the web. Opposite this roller is located the positive electrode in the form of several wires 90 which are arranged transverse to the direction of movement of the web and at a certain distance therefrom. The wires 90 are imbedded in a synthetic-resin body 91 which has recesses for these wires. Preferably, no direct contact occurs between the insulating body and the wires 90. Advantageously, the size of the recesses in the body 91 conforms to the shape of the lines of force of the electric field. The body 91 serves both as a protection for the wires and a guard to prevent, for example in a case of damage to the paper forming the web 87, direct contact of the web with the wires 90.

Located behind the charging device 91, 61 are the supporting roller 92 and the driving roller 93 located on the downstream side of the former, the roller 93 cooperating with a contact device 62 including a pressure roller 94 (or preferably two such pressure rollers) arranged above the roller 93. The pressure rollers 94, provided with a rounded running surface, are mounted in a lever 95 which is urged by means of a spring 96 in the direction of the driving roller 93, so that the pressure rollers 94 are forced by the spring 96 against the driving roller 93 to cause entrainment of the web 87 and to stretch the latter taut across the rollers 92, 93 in the region where the image of the master copy is projected upon it by the objective 56; it will be noted that this objective is of large focal length, determined by the extent of the light path from roller 71 to gate 92, 93, to minimize the effect of any carrier undulations upon the sharpness of the projected image.

In the embodiment shown, the driving device 62, 93 lies near the left-hand end wall of the exposure chamber 121. The wall parts of this chamber preferably consist of conductive material and are grounded to shield the forming device 61, 90.

By the use of the roller 93 for withdrawing the web 87 from the roller 59, the velocity of the web can be maintained independent of the changing radii of the supply roller 59 and the storage roller 60. At the supply roller 59, a friction brake indicated schematically at 122 is provided, for example a cork-disc brake, in order to impose a sufficient tension on the web 87. The storage roller 60 is driven (as indicated by its arrow) by the same motor (not shown) which drives the roller 93 and may be coupled with that motor by means of a suitable governor which automatically allows for the changes in roller speed necessitated by the varying diameter and insures a continuous feeding of the web.

Behind the driving device 62, 94 the web 87 is guided over a roller 97 as well as the vibrator 67 to the fusing device 64. The vibrator 67 consists essentially of a drum with polygonal cross-section. In a particularly preferred embodiment, this drum is divided into several (e.g. five) discs of which alternate ones (i.e. the two outer discs and the central one) have the polygonal cross-section with rounded corners visible in full lines whereas the intermediate discs are cylindrical and of a smaller diameter as illustrated in dotted lines. The drum of the vibrator 67 is rotated more rapidly than the feed roller 93 of the apparatus so that the web 87 is vigorously oscillated in the region between the vibrator 67 and the roller 97 as well as on its travel to the fusing device 64. The roller 97 is arranged at a lower level than the drum 67, so that the section of the web between the roller 97 and the drum 67 has a certain inclination. This inclination can be varied, as indicated by the arrow 98, by the vertically adjustable mounting of the deflecting roller 97, its setting being determined by the kind of copy to be manufactured and the speed of advance of the carrier web 87 for the xerographic layer.

Above this inclined section, the powder-distributing device 66 is suspended in the cover of the housing 53; this device consists essentially of a funnel-shaped hopper accessible through a lid 99 and provided at its lower end with a rotating distributing roller 100 by which the powder is fed past an elastically constructed edge strip 101. The surface of the roller 100 preferably consists of elastic profiled material. The direction of rotation of the roller 100 is so chosen that its surface moves towards the lower edge of the hopper mouth. The speed of rotation of the roller 100 is preferably adjustable, in accordance with the copies to be prepared.

Beneath the roller 97 and the drum 67 there is located a collecting funnel 68 which receives powder falling from the layer support and leads it into the container 69. Overlying the driving device 62, 93 and projecting into the housing section 65 is a guiding surface 102 which pivotably extends below the drum 67 toward the collecting funnel 68. The overhanging surface 102 is the end of the inclined partition 111 which forms the lower boundary of heating chamber 58 and likewise serves to direct to the collector 68 any excess powder which falls over the sides of the narrower web 87 as it passes beyond the vibrator 67.

The fusing device 64 consists essentially of a cylinder 103 of good heat-conducting material, for example copper. Within the cylinder 103 is located a heating device 104, the heat radiating from the cylinder 103 being absorbed thereby and transmitted to the carrier web 87. The arrangement is such that the web runs with its layer-free side above the cylinder 103. The charged layer faces outwardly and the preparation of the copies can be observed through a window 105 provided with red glass, for example. In dependence on this observation, it is possible to control for example the speed of advance of the web 87, the inclination of the sloping web portion between the roller 97 and the drum 67, the vibrator frequency and/or the rate of the powder distribution.

Above the fusing device 64, a set of louvers 109 are provided which allow the developed heat to escape from the housing. Correspondingly, a set of louvers 110 are provided in the vicinity of the illuminating device 55. If required, it is possible to provide outlet openings in the side walls of the housing for additional ventilation.

The cylinder 103 is supported in the side walls of the housing on three rollers 106, 107, 108. This facilitates the current supply for the non-rotating central heating device 104 arranged in the cylinder 103. The web 87 runs from the fusing device 64 into the chamber 120 containing the storage roller 60.

The side walls of the housing are made removable. One housing side forms at the same time a supporting plate for the drive mechanism and the switching panel for the electrically operated parts. The other side wall of the housing may be provided, if required, with closable openings through which the various chambers of the device are accessible.

The layer-carrying web 87 drawn from supply roller 59 is formed into a generally horizontal, elongated loop extending generally parallel to the light channel defined by the exposure chamber 54. In operation, the xerographic layer on this web is first charged and illuminated as it successively passes the charging device 61, 91 and the light gate 92, 93 on the lower run of the loop. After passing around the deflecting roller 97, this layer is dusted by developing powder from hopper 66 which falls onto the strongly sloping portion on the upper run of the loop between roller 97 and drum 67. The vibratory action of this drum causes the powder to be evenly distributed over the web surface and to form thereon a visible image corresponding to the pattern of charges produced on the photoconductive layer by the beam 86, the loose excess powder sliding off the sloping web portion into the collector 68 and thence into the overflow container 69. The electrostatically attracted powder particles remaining on the web 87 are fused onto the xerographic layer by the heating device 103, 104 to form a permanent replica of the image projected from the master copy.

What I claim is:

1. An electrophotographic copying device for the con-

tinuous production of copies on a flexible carrier having an electrically chargeable photoconductive surface, comprising a dispenser for said carrier, a light-tight enclosure, guide means positioned in said enclosure for receiving the carrier from said dispenser and leading it through said enclosure along a looped path, having a lower run and an upper run following said lower run, with its photoconductive surface facing downward on said lower run and upward on said upper run, electrode means positioned in said enclosure adjacent said lower run for producing an electric charge on said photoconductive surface, said enclosure having an aperture underneath said lower run beyond said electrode means, optical means for directing light rays, reflected by a master copy to be reproduced, through said aperture onto the charged photoconductive surface of the carrier, hopper means positioned in said enclosure above said upper run 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 enclosure adjacent said upper run and beyond said hopper means for fusing said powder onto said surface and forming a permanent copy of said master image on said carrier, take-up means for the developed carrier positioned beyond said guide means, and mechanism in said enclosure for vibrating said carrier on its passage through said sloping portion in a manner effecting an even distribution of the developing powder thereon, said mechanism including a vibrator roller supporting said carrier at the junction of said upper run with said sloping portion and means for rotating said vibrator roller about a fixed horizontal axis in the sense of advance of said carrier but at an increased speed relative thereto, said vibrator roller being provided with peripherally spaced surface portions differing in their spacing from said axis whereby said carrier is oscillated and excess developing powder is shaken off at said sloping portion.

2. A device according to claim 1 wherein said vibrator roller is of polygonal cross-section.

3. A device according to claim 1 wherein said guide means includes a pair of supporting rollers for the carrier, said supporting rollers flanking said aperture and forming a gate for said light rays.

4. A device according to claim 3, further comprising drive means operatively connected with one of said supporting rollers and a pressure roller co-acting with the last-mentioned supporting roller for engaging the carrier therebetween.

5. An electrophotographic copying device for the continuous production of copies on a flexible carrier having an electrically chargeable photoconductive surface, comprising a housing; walls in said housing dividing the same into a plurality of chambers including an elongated projection chamber, an exposure chamber, a developing chamber and a heating chamber, said walls having an aperture for the passage of light from said projection chamber to said exposure chamber, said walls further having slots for admitting said carrier to said exposure, developing and heating chambers; feed means in said housing for successively advancing said carrier in an elongated loop through said exposure, developing and heating chambers; mounting means in said projection chamber adapted to receive a master copy to be reproduced, illuminating means for said master copy and optical means in said projection chamber for directing light rays reflected by the master copy onto the photoconductive surface of the carrier in said exposure chamber by way of said aperture, said optical means including an objective of large focal length and a reflector in the path of the light rays between said objective and said surface; electrode means positioned in said exposure chamber for producing an electric charge on said photoconductive surface prior to the impingement of said light rays thereon; hopper means positioned in said developing chamber for depositing an adhering powder on said photoconductive surface; and fusion means positioned in said heating chamber for thermally fixing said powder on said photoconductive surface; said projection chamber extending alongside said loop and forming an elongated light path generally parallel to said loop between said mounting means and said reflector, said feed means including a pair of supporting rollers for the carrier, said supporting rollers flanking said aperture and forming a gate for said light rays, drive means operatively connected with the more downstream one of said supporting rollers and a pressure roller coacting with the last-mentioned supporting roller for engaging the carrier therebetween and keeping it taut between said supporting rollers.

6. A device according to claim 5 wherein said chambers further include a dispensing chamber ahead of said exposure chamber and a receiving chamber beyond said heating chamber, said feed means comprising a carrier-supply roller in said dispensing chamber and a take-up roller in said receiving chamber.

7. A device according to claim 5 wherein said walls form a conductive enclosure around said exposure chamber, said enclosure being grounded, said electrode means including at least one conductor and dielectric supporting means for said conductor in said enclosure.

8. A device according to claim 5 wherein said optical means further includes at least one ray-controlling light baffle extending across said light path.

9. An electrophotographic copying device for the continuous production of copies on a flexible carrier having an electrically chargeable photoconductive surface, comprising a dispenser for said carrier, a light-tight enclosure, guide means positioned in said enclosure for receiving the carrier from said dispenser and leading it through said enclosure along a looped path, having generally horizontal upper and lower runs and a distinctly sloping connecting portion between said runs, with its photoconductive surface facing the outside of the loop, electrode means positioned in said enclosure adjacent one of said runs for producing an electric charge on said photoconductive surface, said enclosure having an aperture adjacent said one of said runs beyond said electrode means, optical means for directing light rays from a master copy, which is to be reproduced, through said aperture onto the charged photoconductive surface of the carrier, hopper means positioned in said enclosure above the upper run for depositing a developing powder onto the illuminated photoconductive carrier surface in the region of said sloping portion, thereby converting the latent image on said surface into a visible replica of said master copy, heating means positioned in said enclosure adjacent said upper run and beyond said hopper means for fusing said powder onto said surface and forming a permanent copy of said master image on said carrier, take-up means for the developed carrier positioned beyond said guide means, and mechanism in said enclosure for vibrating said carrier on its passage through said sloping portion in a manner effecting an even distribution of the developing powder thereon, said mechanism including a vibrator roller supporting said carrier at the junction of said upper run with said sloping portion and means for rotating said vibrator roller about a fixed horizontal axis in the sense of advance of said carrier but at an increased speed relative thereto, said vibrator roller being provided with peripherally spaced surface portions differing in their spacing from said axis whereby said carrier is oscillated and excess developing powder is shaken off at said sloping portion.

10. A device according to claim 9 wherein said vibrator roller is of polygonal cross-section.

11. A device according to claim 9 wherein said guide means includes a vertically displaceable deflecting roller positioned in said enclosure at the junction of said upper and lower runs for varying the inclination of said sloping portion.

12. An electrophotographic copying device for the continuous production of copies on a flexible carrier having an electrically chargeable photoconductive surface, com-

promising a housing; walls in said housing dividing the same into a plurality of chambers including a projection chamber, an exposure chamber, a developing chamber and a heating chamber, said walls having an aperture for the passage of light from said projection chamber to said exposure chamber, said walls further having slots for admitting said carrier to said exposure, developing and heating chambers; feed means in said housing for successively advancing said carrier through said exposure, developing and heating chambers, said feed means including a pair of supporting rollers for the carrier, said supporting rollers flanking said aperture and forming a gate for said light rays, drive means operatively connected with the more downstream one of said supporting rollers and a pressure roller co-acting with the last-mentioned supporting roller for engaging the carrier therebetween and keeping it taut between said supporting rollers; mounting means in said projection chamber adapted to receive a master copy to be reproduced, illuminating means for said master copy and optical means in said projection chamber for directing light rays reflected by the master copy onto the photoconductive surface of the carrier in said exposure chamber by way of said aperture; electrode means positioned in said exposure chamber for producing an electric charge on said

photoconductive surface prior to the impingement of said light rays thereon; hopper means positioned in said developing chamber for depositing an adhering powder on said photoconductive surface; and fusion means positioned in said heating chamber for thermally fixing said powder on said photoconductive surface.

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