Feb. 16, 1965 B. KAMINSTEIN 3,169,457

ELECTROPHOTOGRAPHIC PRINTER

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FIG. 1

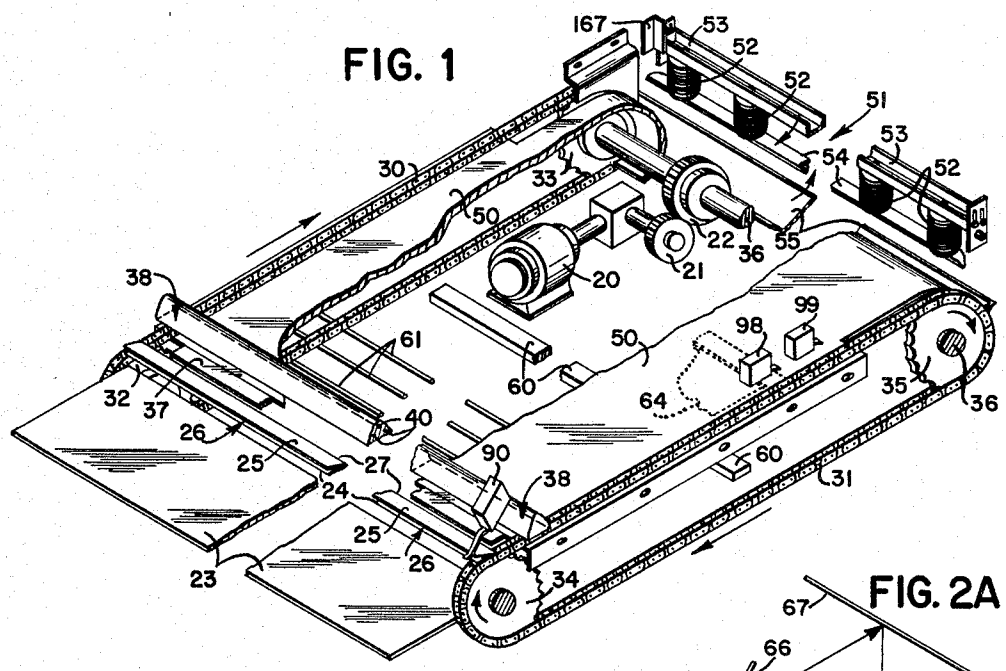


FIG. 2A

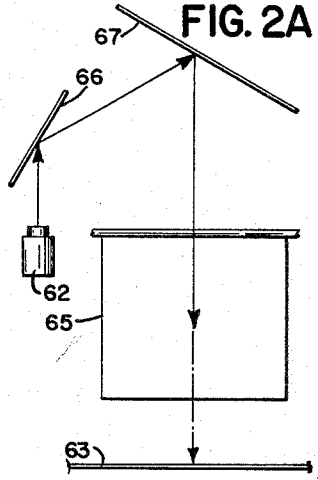


FIG. 2B

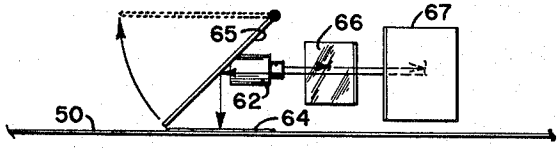


FIG. 11

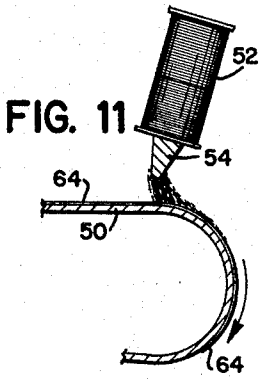
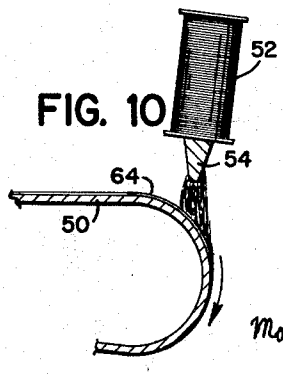


FIG. 10



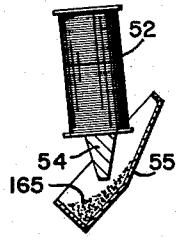


FIG. 9

INVENTOR
BERNARD KAMINSTEIN
BY Pennie, Edmonds,
Morton, Barrows and Taylor
ATTORNEYS

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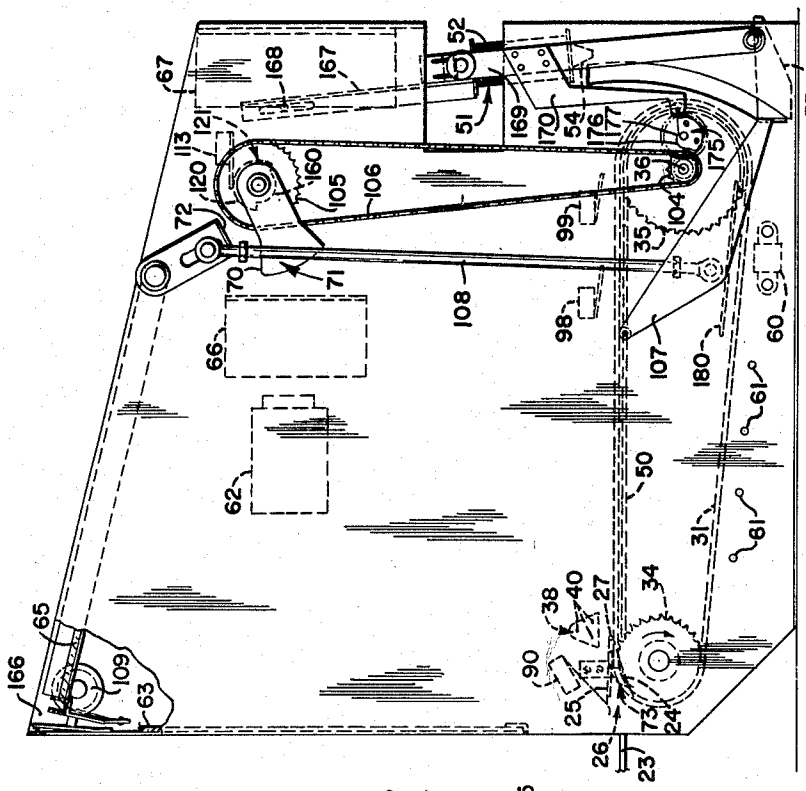


FIG. 4

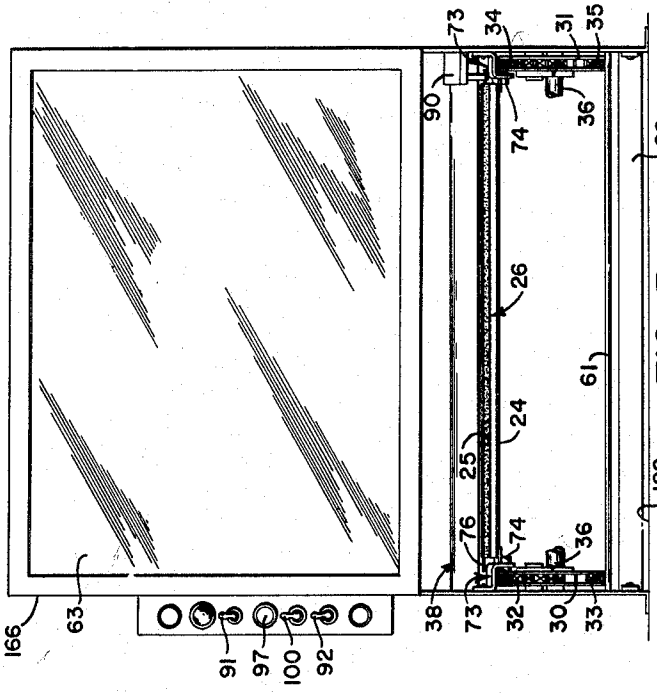


FIG. 3

INVENTOR
BERNARD KAMINSTEIN
BY Pennie, Edmonds, Morton, Barrows & Taylor
ATTORNEYS

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FIG. 7

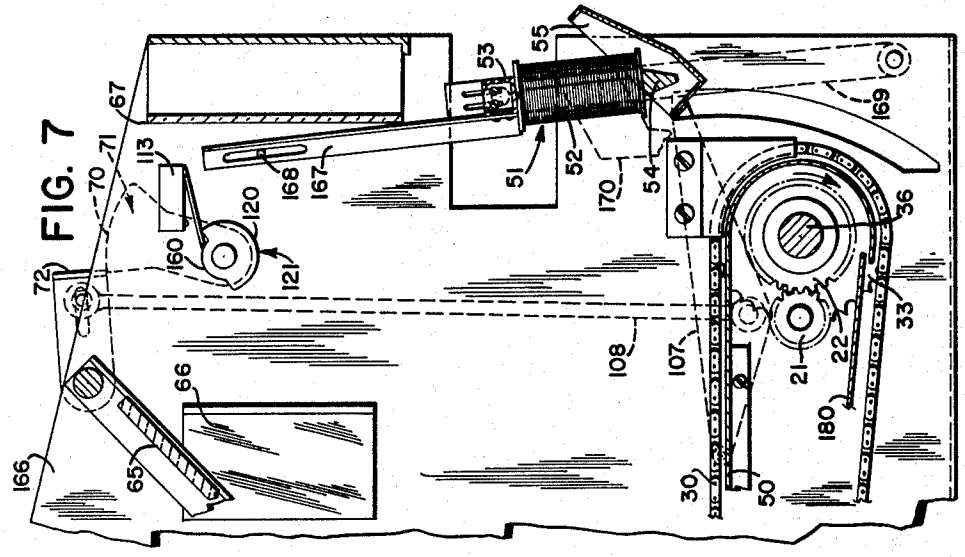


FIG. 8

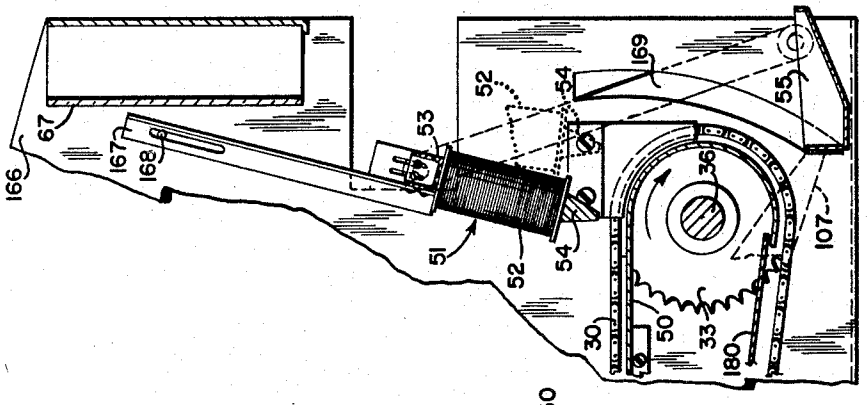


FIG. 5

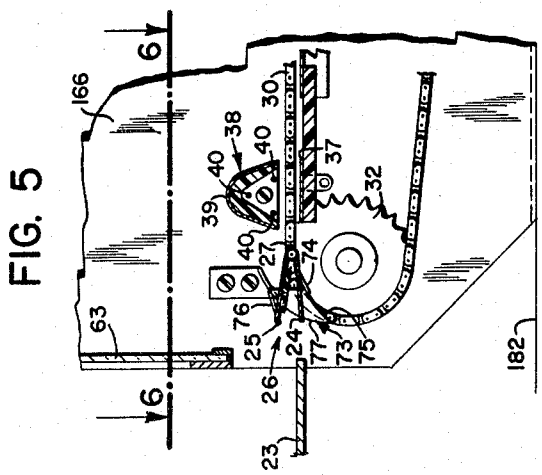
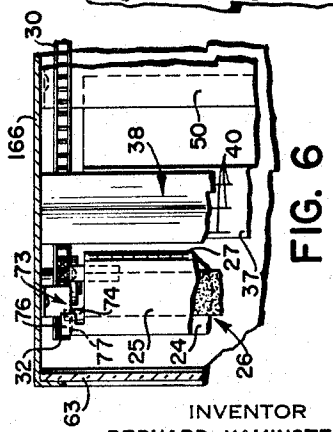


FIG. 6



INVENTOR
BERNARD KAMINSTEIN
BY Pennie, Edmonds,
Morton, Barrows and Taylor
ATTORNEYS

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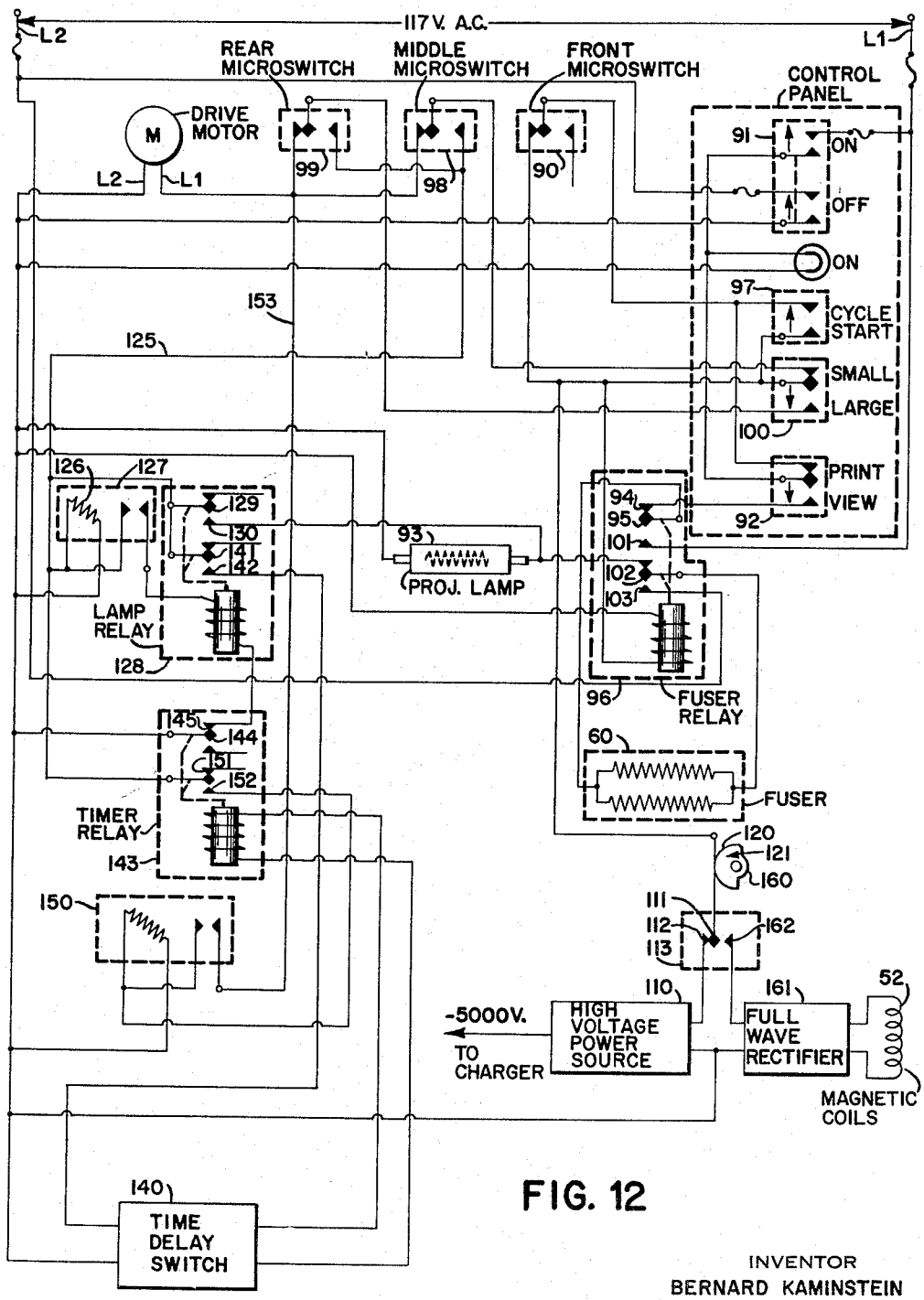


FIG. 12

INVENTOR
BERNARD KAMINSTEIN
BY Pennie, Edmonds, Morton, Barrows and Taylor
ATTORNEYS

United States Patent Office 3,169,457 Patented Feb. 16, 1965

3,169,457 ELECTROPHOTOGRAPHIC PRINTER

Bernard Kaminstein, Paramus, N.J., assignor to Kamstat Corporation, Garden City, N.Y., a corporation of New York

Filed Feb. 13, 1962, Ser. No. 173,100
11 Claims. (Cl. 95—1.7)

This invention relates to electrostatic printing, and more particularly to improved apparatus and methods for making enlarged prints from microfilm images by an electrophotographic process.

The conventional electrostatic printing process involves the steps of converting a light image to a corresponding electrosatic charge image on a sensitized insulating material such as paper, and then converting the charge image back to a visible image by the application of an electroscopic toner material thereto. The toner powder, which is electrostatically held to the electrical charge image, is then permanently fixed to the paper by the application of heat. Although various types of chemical dielectric coatings may be used as photo-sensitive, photo-conductive materials, a mixture of zinc-oxide in a resin binder has been most commonly used. The paper surface so coated is uniformly electrically charged such as by corona discharge means and the charged surface is then optically exposed to the light image to be printed. Since the zinc-oxide coating is photo-conductive, the electrostatic charge is dissipated in those areas exposed to light while remaining substantially unaltered in those areas that are unexposed. The latent electrostatic negative charge image is then developed by dusting it with an oppositely charged electroscopic toner powder.

One method which has been proposed for applying such a toner powder comprises mixing finely divided suitable toner powder with a powdered magnetic material such as iron and forming a magnetic brush from the combination. The toner powder is caused to adhere to the magnetic particles due to the friction-produced triboelectric charging effect. The toner powder is generally selected in the triboelectric series with respect to iron so as to assume a positive charge. When brought in contact with the latent negative charge image, the positively charged powder toner is caused to transfer from the magnetic particles in the brush and adhere to the paper. The toned electrostatic image is then permanently fixed by heat fusion.

Several known methods and techniques for producing such prints directly on paper are generally described in an article entitled "Electrofax" Direct Electrophotographic Printing on Paper, written by C. J. Young and H. G. Greig, printed in R.C.A. Review, volume XV, pages 469–484, December 1954.

Although the method of charging the toner powder by a friction produced triboelectric effect is attractive because of its extreme simplicity, it has had a recognized disadvantage in that the produced charge is not always uniform throughout the magnetic brush. Where the toner is applied manually, this disadvantage is of little consequence because the brush can be repeatedly applied to the print until the charge image is fully developed as determined by inspection. In automatic printing apparatus, however, the aforementioned non-uniformity of powder charge can present a serious problem in that the developed print will exhibit local variations in image contrast.

A further problem presented in the design of automatic printers which apply toner with magnetic brushes is that of maintaining uniform print contrast across the entire length of the print. The contrast deficiency obtains from the gradual depletion of toner on the brush surface maintained in contact with the electrostatic image as the brush advances across the charged surface.

It is a principal object of this invention to provide an automatic microfilm printer, including a simple electromagnetic brush mechanism, which is capable of producing high quality prints having excellent contrast uniformity.

A further object of this invention is to provide an improved electromagnetic brush assembly which produces a long soft-bristled brush capable of transferring a maximum amount of toner powder to the electrical charge image and a minimum of iron particles thereto with the resultant production of clean high-contrast prints.

Another object of the invention is to provide an improved corona-discharge type electrostatic charger apparatus which features improved electrical charging efficiency.

In accordance with the present invention, an automatic film projection printer is provided which includes as an integral system, a microfilm projector, a projection screen for viewing a full print-size image of the microfilm image to be printed, a base-supported dielectric easel including an electrostatic charger and ground plate disposed adjacent the input end thereof, and an electromagnetic brush assembly and toner supply trough pivotally supported adjacent the output end thereof. Paper drive means including a paper clamp are provided for advancing the sensitized paper through the various printing stages in the machine and automatic time-controlled circuits are incorporated to control the paper drive, the projector exposure, positioning of the optical projection mirror, electrical energization and deenergization of the electromagnet and toner fuser, and positioning of the toner supply bin with respect to the electromagnet.

In accordance with one featured aspect of the invention, the brush electromagnet is energized with pulsating D.-C. current or with D.-C. current having a high percentage of A.-C. ripple current superimposed thereon. During the brush pickup portion of the operating cycle, the toner supply trough is moved upwardly in a tilted position adjacent to the long magnetized pole piece so that a relatively long and wide pile-up of toner coated magnetic particles is picked up to form a long soft-bristled brush. The supply trough is then lowered to an initial rest position and the brush is swung forward so as to come in contact with the electrically charged paper. The initial contact between the brush and paper is effected at the downwardly curved end portion of the transport easel thus exposing a long sidewall surface of the magnetic brush to the charge image on the paper. As the paper is progressively advanced under the brush, the brush is gradually moved and tilted further forward in a direction opposite to that of the paper motion so that new sidewall surface material of the brush is exposed to the charge image on the paper. This added forward tilt motion of the brush serves to effectively compensate for toner depletion and assures uniform development of image contrast from top to bottom of the print.

In accordance with a further aspect of the invention, the electromagnet is energized with electrical current having a large A.-C. component. The resultant variation in magnetic field strength causes a portion of the toner coated particles near the brush surface to be momentarily released on the paper surface and retrieved at diffeernt areas of the brush. This rapid fluctuating action tends to expose a larger percentage of the surface particles on the brush and thereby enhances brush to print transfer of the toner to effect improved image contrast. The resultant circulation effect is also believed to reduce local variations in contrast caused by non-uniformity in the electrical charges carried by the toner particles.

As a further feature, the electromagnetic brush assembly is operatively arranged to be electrically deen-

ergized (after a development operation) when it is physically disposed at a distance of approximately six inches above the toner storage trough. The entire magnetic brush is thus dropped into the trough in a manner such as to produce thorough agitation and mixing of the finely divided magnetic and toner particles. The agitation produces considerable friction between all of the particles comprising the brush and produces a highly desired uniformity in the triboelectric charging of the toner powder. This uniformity of charging adds to the uniformity of print contrast.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings in which:

FIG. 1 is a fragmentary perspective view of a printer built in accordance with the invention;

FIGS. 2A and 2B are simplified plan and elevation views of the projector and mirror optics of the microfilm printer provided by the invention;

FIG. 3 is a front plan view of the microfilm printer provided by the invention as viewed from the operating position;

FIG. 4 is a side elevation view of the printer shown in FIG. 3;

FIG. 5 is a fragmentary side elevation view of the forward portion of the printer shown in FIGS. 3 and 4;

FIG. 6 is a fragmentary plan view of FIG. 5 as indicated;

FIG. 7 is a fragmentary elevation view of the rear portion of the printer shown in FIG. 4 with the toner supply trough in the brush pick-up position;

FIG. 8 is a fragmentary elevation view of the rear portion of the printer shown in FIG. 4 illustrating the magnetic brush positions during the application of toner to the print;

FIG. 9 is a fragmentary elevation view illustrating the relative positions of the electromagnet, the tilted toner trough and the supply of toner therein;

FIG. 10 is a fragmentary elevation view illustrating the initial contact position of the magnetic brush with respect to the curved end portion of the dielectric easel and the advancing print paper thereon;

FIG. 11 is a fragmentary elevation view illustrating the second contact position of the magnetic brush with respect to the curved end portion of the dielectric easel and the advancing print paper thereon; and

FIG. 12 is a schematic electrical diagram of the power drive control circuit for the automatic microfilm printer provided by the invention.

Referring to FIG. 1, there is shown in simplified form, for explanatory purposes, a perspective view of the printer provided by the invention with the housing, the optical projector, mechanical linkages and electrical control equipment removed. As shown the printer includes electric motor **20** which provides drive power for the entire printer through a gear reduction system including gears **21** and **22**. Sensitized printing paper or web material is supplied and delivered to the printer via table surface **23**. The forward or leading edge of the print material is placed between the jaws **24** and **25** of spring loaded paper clamp **26**. The clamp jaws, which are hinged along the rear edge **27** and normally maintained in a closed clamping position, are opened by a special cam to release each finished print at the terminal portion of the printing cycle. This special cam, which will be described later in conjunction with FIG. 5, also releases the jaws to the clamping position after the clamp is driven in the forward direction a very short distance from the position shown. The respective opposite ends of clamp **26** are secured to drive chains **30** and **31** which are supported on and driven by sprocket gears **32**, **33** and **34**, **35** via drive shaft **36**. In operation the clamped print paper is advanced across an electrically conductive ground plate **37** which is advantageously chrome plated to reduce the electrically charged paper friction to a minimum.

Electrical charging of the sensitized coated (photoconductive) paper is effected by a corona-discharge type charger **38** comprising an outer shield member **39** and three fine-wire members **40** supported on high-voltage insulators within shield **39** and extending the full width of the support easel **50** as shown. The wire members **40** are electrically connected to the negative terminal of a high-voltage supply (e.g., 5000 volts) the positive or ground terminal of which is returned to ground plate **37**.

The photosensitive dielectric surface of the print material is electrostatically charged by corona discharge which effects ionization of the air around the spaced wires **40**. Improved ionization efficiency is achieved by disposing the wires **40** in a triangular spaced relationship as illustrated in FIGS. 1 and 5.

As the paper surface is uniformly charged by passage between the ground plate **37** and the exposed underside of the charger element **38**, it is advanced forward onto the surface of a dielectric easel **50** which may be made of aluminum, the upper surface of which is anodized. The motor drive is momentarily halted after the charged paper has advanced to approximately mid-position on the easel. It is then optically exposed to a projected enlarged light image of the microfilm photographic image to be printed. Following the short-term exposure, the projector is turned off and the paper carrying a latent electrostatic image is advanced along the surface of the easel to the far end thereof where the electrostatic image is developed to a visible image by the application of an electroscopic toner powder.

In accordance with the invention an electromagnet **51** comprising bar pole piece **54** and electrically energizable coils **52** supported on frame member **53** is provided to pick up the electroscopic toner brush material from storage trough **55** to form a long-bristled magnetic brush. The cooperative operating relationship of the electromagnet and the trough will be described in greater detail below. It is sufficient to say at this point that the magnetic brush suspended from the bar pole piece **54** is brought into contact with the charged paper surface near the upper curved end portion of the easel, and development is effected by transfer of the toner powder from the magnetic particles on the brush to the charge image on the paper. The transferred toner powder, which is caused to adhere to the print by electrostatic forces, is then permanently fixed by passing the print over an electrical heater element **60** which provides sufficient heat to fuse the powder to the paper. The fixed print is advanced over support rods **61**, delivered and released by the clamp to an operator or receiving station at the front of the printer. The printing cycle having thus been completed the machine is ready for a repeat operation.

Having described the general mode of operation of the electrophotographic printer provided by the invention, the various operating features will now be described in greater detail with particular reference to the remaining figures in the drawings.

A conventional microfilm slide or strip film projector **62**, as illustrated in FIGS. 2A, 2B and 4, is provided to project an enlarged optical image on either the forward operator's viewing screen **63** or in the alternative on the charged sensitized surface of the print paper **64** supported on the surface of easel **50**. When the operator desires to view the enlarged microfilm image on screen **63**, the pivotally supported mirror **65** is retained in its up position at the top of the projector (see FIG. 4) and the image is directed to the front screen via front-surfaced mirrors **66** and **67**. During the paper-exposure interval of the operating cycle, mirror **65** is driven downwardly by surface **70** of mirror cam **71** coming in contact with the surface of cam follower **72**. With the mirror in the down position, as illustrated in FIG. 2B, the enlarged projected image is reflected onto the surface of print paper **64** via mirrors **66**, **67** and **65** as shown.

As illustrated in FIG. 5, the jaws of paper clamp 26 are opened automatically by cam 73. Finger 74 attached to the lower jaw 24 follows lower cam surface 75 while finger 76 attached to the upper jaw follows upper cam surface 77. The spring loaded jaws (spring not shown) are thus opened and held open at the end of a given printing cycle, the electrical drive power being removed from the motor by closure of microswitch 90 through contact with paper clamp 26.

The printer is electrically energized by closing the power switch 91 (FIGS. 3 and 12) to the "on" position. The microfilm image may be viewed by the operator by throwing switch 92 to "view" position thereby directly energizing the projector lamp 93 through the upper set of normally closed contacts 94, 95 on fuser relay 96 and through the fuser element 60.

The printing cycle is then initiated by placing the edge of a fresh piece of print paper between the open jaws of paper clamp 26, throwing switch 92 to "print" position and momentarily depressing the cycle start switch 97 to the closed position. The 117 volt A.-C. line L1 is thereby connected to the L1 terminal of drive motor "M" through the closed contacts of either the middle microswitch 98 (small print control) or the rear microswitch 99 (large print control) depending upon whether the print size control switch 100 is preset to "small" position (as shown) or in the alternative "large" position.

At the same time the fuser relay 96 is energized and the heater element of fuser 60 is electrically connected between L1 and L2 through the closing of contacts 95, 101 and contacts 102, 103 respectively. The fuser element 60 is de-energized when the front microswitch 90 is switched to the normally open position at the end of a print cycle. With the starting of a new print cycle, the switch contacts of 90 assume a normally closed position (as shown) and the fuser element is energized, as indicated above, along with the high voltage power supply 110. The latter is electrically energized and de-energized through the closing and opening of contacts 111, 112 of mirror microswitch 113 (FIGS. 4, 7 and 12). The contacts 111 and 112 are closed as shown by the large radius surface 120 of small mirror cam 121. Thus the charger wires 40 remain energized by the high voltage supply until the print paper has completely passed under the charger.

As the printing cycle continues, large mirror cam 71, driven by sprocket gears 104, 105 and chain 106, is rotated upwardly against cam follower surface 72 causing the mirror 65 to move to its down position as shown in FIGS. 2B and 7. At the same time the toner supply trough 55, pivotally supported by arm members 107 (not shown), is lifted to an elevated position immediately beneath the electromagnet bar pole 54 by cam follower 72 through connecting rod 108. The forward end of mirror 65 is connected to the end of negator spring element 109 which functions to return the mirror to its normal up-position following the passage of the large radius surface 70 of cam 71 beyond 72.

After the mirror has been moved to its down position and the paper clamp has been advanced forwardly along the top of the easel to a point where it contacts and actuates the arm of the previously preselected microswitch 98 or 99, L1 is disconnected from the drive motor and connected through the back contacts (of the selected microswitch) through lead 125 to the heater element 126 of thermal time-delay relay 127. After a delay of several seconds, the normally open contacts of relay 127 are closed energizing lamp relay 128 which in turn energizes the projector lamp 93 by connecting L1 to the lamp through contacts 129, 130. At the same time, L1 is connected to an adjustable time delay switch 140 through lamp relay contacts 141, 142. Print exposure is controlled by adjusting the time delay of 140 which may be a conventional motor driven switch. Timer relay 143 is electrically energized by the actuation of 140 and lamp relay 128 is de-energized by the opening of contacts 144, 145.

With the extinction of projector lamp 93, the heater element of thermal time-delay relay 150 is energized through contacts 151, 152 of timer relay 143. The thermal time delay relay 150 permits complete cooling of the projector lamp 93 (and hence extinction of the visible light therefrom) prior to the initiation of further movement of the print paper towards completion of print development. The similar delay introduced by time-delay switch 127 assures termination of all machine vibration prior to the energization of the projector lamp thus precluding vibration induced blurring of the enlarged print image. Following a delay of several seconds, the normally open contacts of 150 are closed reconnecting L1 back to the L1 terminal of drive motor "M" through conductor 153.

The exposed print paper, carrying a latent electrical charge image on its upper surface, is thus again placed in motion along the easel surface towards the rear of the machine. At the same time the arm of microswitch 113, that had been maintained in the closed position by the large radius surface 120 of cam 121 (FIGS. 4, 12) is now released to come in contact with the smaller radius surface 160. The full wave rectifier 161 is thereby energized through the contacts 111, 162 in the mirror microswitch and the coils 52 of the electromagnet 51 are supplied with pulsating D.-C. current. The inventor has found that a full-wave rectifier supplying 120 cycles per second half sine-wave current to the coils has provided very satisfactory results.

With the application of current to the magnet coils, the finely divided magnetic particles, carrying toner powder, are picked up along the full length of the bar pole piece 54 which extends across the full width of the print easel 50. In accordance with the teachings of the invention, the toner supply trough 55 is tilted (with respect to its lower rest position) as shown in FIGS. 7 and 9. This tilting action produces two beneficial results, namely; it causes the brush particles 165 to move toward the lower forward edge of the trough (FIG. 9) and assume a long sloping pile-up of the brush material so that a relatively long soft-bristled brush is formed on the pole-bar (see FIG. 10); and the sliding action of the brush material in the trough produces some desired friction between the toner powder and the iron particles thus enhancing the triboelectric charging of the toner powder.

As the drive progresses, cam 71 is caused to rotate beyond surface 72 and the mirror 65 is returned to its normal up-position and trough 55 is returned to its down-position. The energized electromagnet with its formed magnetic brush is permitted to swing forward to a first developing position so that the sidewall of the brush is brought into contact with the leading edge of the print paper 64 as shown in dotted form in FIG. 8 and as further illustrated in FIG. 10. The magnet assembly 51 is pivotally supported from the main frame 166 by upper arm 167 and pin 168 and by lower arm 169 which is pivotally attached at its lower end to the main frame and at its upper end to the magnet support frame 53. Arm 169 also carries a cam follower arm 170 which remains in contact at all times with the irregular surface of cam 175. The magnet assembly is supported in its rearward position as shown in FIG. 4 by the large radius surface of the cam and is permitted to move forward to the first and second developer positions illustrated in FIGS. 10 and 11 respectively by the corresponding lesser radius cam surfaces 176 and 177.

As illustrated in FIG. 10, the long-bristled magnetic brush is first brought into surface contact with the latent electrostatic charge image on the print paper adjacent the curved end surface of the easel. In this position, the electroscopic toner is gently applied to the paper surface and a large sidewall surface of the brush is exposed to

the charge pattern (across the entire width of the print) so as to effect optimum transfer of toner powder.

As indicated above, the magnetic brush is gradually allowed to swing to the forward position, shown in FIG. 11, as the print paper advances around the curved end portion of the easel in the direction shown. This advance is controlled by the continuous and gradual change of radius of the surface on cam 175. The resulting gradual progressive forward tilting of the long-bristled magnetic brush produces the highly desirable effect of continuously exposing new surfaces of the magnetic brush to new surface of the print as the print is advanced through the toner development stage. In accordance with this featured aspect of the invention, print development is rapidly effected with a relatively simple one piece electromagnet and high uniform image contrast is achieved across the entire print.

After the rear edge of the paper print has passed under the magnetic brush, the large radius cam surface of cam 175 operatively repositions the electromagnet to its rearward position above the toner trough 55 as shown in FIG. 4.

The developed image is permanently heat fixed by passage of the print above the heater elements in fuser 60. An aluminum heat reflector 180 is disposed immediately above the fuser element and print paper, and an insulating material (e.g., glass fiber) is advantageously disposed above 180 (not shown) to minimize heat transfer to the printing easel above.

The fixed print is passed over support rods 61 and released on the table surface 182 when the paper clamp is opened by the action of cam 73 as described above. Power to drive motor "M" is turned off by the opening of the switch contacts on microswitch 90. In the meantime, electrical power is disconnected from rectifier 161 by the operation of mirror cam 121 and the magnetic brush particles are dropped from the bar pole piece back into the supply trough 55. As described above, this dropping action affords excellent mixing action between the magnetic particles and the toner powder assuring uniform redistribution and charging of the toner powder.

The inventor has found that the electrostatic charger described and illustrated as a part of this invention is particularly efficient. Excellent charging uniformity (without streaking effects) has been achieved with a supply voltage as low as 4800 volts and a spacing between the lower wire members and the paper surface of three-fourths of an inch.

The electrophotographic printer illustrated and described can be constructed to accommodate a wide variety of film formats and print sizes. The embodiment described has been constructed to make high-resolution prints from microfilm slides, the prints having varying sizes up to and including eighteen by twenty-four inches.

Although the electrophotographic printing process has been described in terms of a negative electrical charging process followed by development with a positively charged toner powder, it will be recognized that other known electrical charging and developing techniques may also be employed following the teachings of the invention.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. Electrophotographic printer apparatus of the type for developing an electrophotostatic image on a sheet of photoconductive print material, said apparatus comprising a dielectric easel having an input receiving end and an output delivery end, said easel being mounted on a base support frame and having a generally flat top surface with a curved output end surface for supporting said print material, means mounted adjacent the input end of said easel for placing a uniform electrostatic charge on said photoconductive print material, drive means for advancing said print material past said charging means and over the surface of said easel, projector means for exposing said print material to a light image while the material is supported on said easel after having been electrically charged, means for developing the image charge pattern on said material comprising a supply of developer mixture and an electromagnet pivotally supported adjacent the curved output end of said easel, said electromagnet being adapted when energized to pick up and form a magnetic brush from said supply of developer, and means for moving said magnetic brush into contact with said print material as said print material passes along the curved output end of said easel.

2. Electrophotographic printer apparatus of the type for developing an electrostatic image on a sheet of photoconductive print material, said apparatus comprising a dielectric easel having an input receiving end and an output delivery end, said easel being mounted on a base support frame and having a generally flat top surface with a curved output end surface for supporting said print material, means mounted adjacent the input end of said easel for placing a uniform electrostatic charge on said photoconductive print material, drive means for advancing said print material past said charging means and over the surface of said easel, projector means for exposing said print material to a light image while the material is supported on said easel after having been electrically charged, means for developing the image charge pattern on said material comprising trough means mounted adjacent the output end of said easel for storing a supply of developer mixture, an electromagnet pivotally supported above said trough being adapted when electrically energized to pick up and form a magnetic brush from said supply of developer, means for electrically energizing said electromagnet with a pulsating D.-C. current, and means for moving said magnetic brush into contact with said print material as said print material passes along the curved output end of said easel.

3. Apparatus in accordance with claim 1 wherein said dielectric easel is comprised of anodized aluminum.

4. Apparatus in accordance with claim 1 wherein said electrostatic charging means comprises an electrically conductive ground plate mounted adjacent the input end of said easel with an electrostatic charger element mounted above said plate to permit passage of print material therebetween, said charger element including an upper charger wire and a pair of lower charger wires suspended across the input width of said easel in triangular spaced relationship, and a high voltage supply connected between said ground plate and said wires.

5. Electrophotographic printer apparatus of the type for developing an electrostatic image on a sheet of photoconductive print material, said apparatus comprising a dielectric easel having an input receiving end and an output delivery end, said easel being mounted on a base support frame and having a generally flat top surface with a curved output end surface for supporting said print material, means mounted adjacent the input end of said easel for placing a uniform electrostatic charge on said photo-conductive print material, drive means for advancing said print material past said charging means and over the surface of said easel, projector means for exposing said print material to a light image while the material is supported on said easel after having been electrically charged, means for developing the image charge pattern on said material comprising a supply of developer mixture and an electromagnet pivotally supported adjacent the curved output end of said easel, said electromagnet being adapted when energized to pick up and form a magnetic brush from said supply of developer, means for moving said magnetic brush into contact with said print material as said print material passes along the curved output end of said easel, and means for applying

heat to the powder developed print whereby said print image is permanently fixed.

6. Electrophotographic printer apparatus of the type for developing an electrostatic image on a sheet of photoconductive print material, said apparatus comprising a dielectric easel having an input receiving end and an output delivery end, said easel being mounted on a base support frame and having a generally flat top surface with a curved output end surface for supporting said print material, means mounted adjacent the input end of said easel for placing a uniform electrostatic charge on said photoconductive print material, drive means for advancing said print material past said charging means and over the surface of said easel, projector means for exposing said print material to a light image while the material is supported on said easel after having been electrically charged, means for developing the image charge pattern on said material comprising trough means mounted adjacent the output end of said easel for storing a supply of developer mixture, an electromagnet pivotally supported above said trough being adapted when electrically energized to pick up and form a magnetic brush from said supply of developer, means for electrically energizing said electromagnet with a pulsating D.-C. current, and means for moving said magnetic brush into contact with said print material and for progressively changing the angle of contact between said brush and print material as said print material passes along the curved output end of said easel.

7. Electrophotographic printer apparatus of the type for developing an electrostatic image on a sheet of photoconductive print material, said apparatus comprising a dielectric easel having an input receiving end and an output delivery end, said easel being mounted on a base support frame and having a generally flat top surface with a curved output end surface for supporting said print material, means mounted adjacent the input end of said easel for placing a uniform electrostatic charge on said photoconductive print material, drive means for advancing said print material past said charging means and over the surface of said easel, projector means for exposing said print material to a light image while the material is supported on said easel after having been electrically charged, means for developing the image charge pattern on said material comprising trough means mounted adjacent the output end of said easel for storing a supply of developer mixture, an electromagnet pivotally supported above said trough being adapted when electrically energized to pick up and form a magnetic brush from said supply of developer, means for electrically energizing said electromagnet with a pulsating D.-C. current during a print developing time interval, means for moving said magnetic brush into contact with said print material as said print material passes along the curved output end of said easel, and means for de-energizing said electromagnet following the print developing time interval whereby said brush material is dropped from said magnet into said trough.

8. Electrophotographic printer apparatus of the type for developing an electrostatic image on a sheet of photoconductive print material, said apparatus comprising a dielectric easel having an input receiving end and an output delivery end, said easel being mounted on a base support frame and having a generally flat top surface with a curved output end surface for supporting said print material, means mounted adjacent the input end of said easel for placing a uniform electrostatic charge on said photoconductive print material, drive means for advancing said print material past said charging means and over the surface of said easel, projector means for exposing said print material to a light image while the material is supported on said easel after having been electrically charged, means for developing the image charge pattern on said material comprising trough means mounted adjacent the output end of said easel for storing a supply of developer mixture, an electromagnet pivotally supported above said trough being adapted when electrically energized to pick up and form a magnetic brush from said supply of developer, means for electrically energizing said electromagnet with a pulsating D.-C. current during a print developing time interval, means for moving said magnetic brush into contact with said print material and for progressively changing the angle of contact between said brush and print material as said print material passes along the curved output end of said easel, and means for electrically de-energizing said electromagnet following the print developing time interval whereby said brush material is dropped from said magnet into said trough.

9. Electrophotographic printer apparatus of the type for developing an electrostatic image on a sheet of photoconductive print material, said apparatus comprising a dielectric easel having an input receiving end and an output delivery end, said easel being mounted on a base support frame and having a generally flat top surface with a curved output end surface, means mounted adjacent the input end of said easel for placing a uniform electrostatic charge on said photoconductive print material, drive means for advancing said print material past said charging means and over the surface of said easel, projector means for exposing said print material to a light image while the material is supported on said easel after having been electrically charged, means for developing the image pattern on said material comprising trough means mounted adjacent the output end of said easel for storing a supply of developer mixture, an electromagnet pivotally supported above said trough being adapted when electrically energized to pick up and form a magnetic brush from said supply of developer, means for electrically energizing said electromagnet with a pulsating D.-C. current during a print developing time interval, means for moving said magnetic brush into contact with said print material and for progressively changing the angle of contact between said brush and print material as said print material passes along the curved output end of said easel, means for electrically de-energizing said electromagnet following the print developing time interval whereby said brush material is dropped from said magnet into said trough and means for applying heat to the powder developed print whereby said print image is permanently fixed.

10. Apparatus in accordance with claim 7 wherein said electrostatic charging means comprises an electrically conductive ground plate mounted adjacent the input end of said easel with an electrostatic charger element mounted above said plate to permit passage of print material therebetween, said charger element including an upper charger wire and a pair of lower charger wires suspended across the input width of said easel in triangular spaced relationship, and a high-voltage supply connected between said ground plate and said wires.

11. Apparatus in accordance with claim 8 wherein said electrostatic charging means comprises an electrically conductive ground plate mounted adjacent the input end of said easel with an electrostatic charger element mounted above said plate to permit passage of print material therebetween, said charger element including an upper charger wire and a pair of lower charger wires suspended across the input width of said easel in triangular spaced relationship, and a high-voltage supply connected between said ground plate and said wires.

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