May 18, 1965 E. C. GIAIMO, JR Re. 25,779

ELECTROSTATIC PRINTING

Original Filed June 30, 1953 2 Sheets-Sheet 1

Fig. 5.

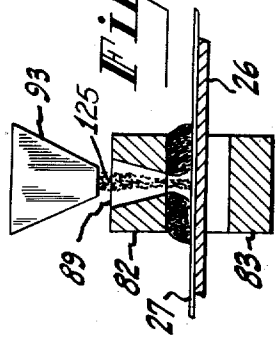


Fig. 1.

Fig. 4.

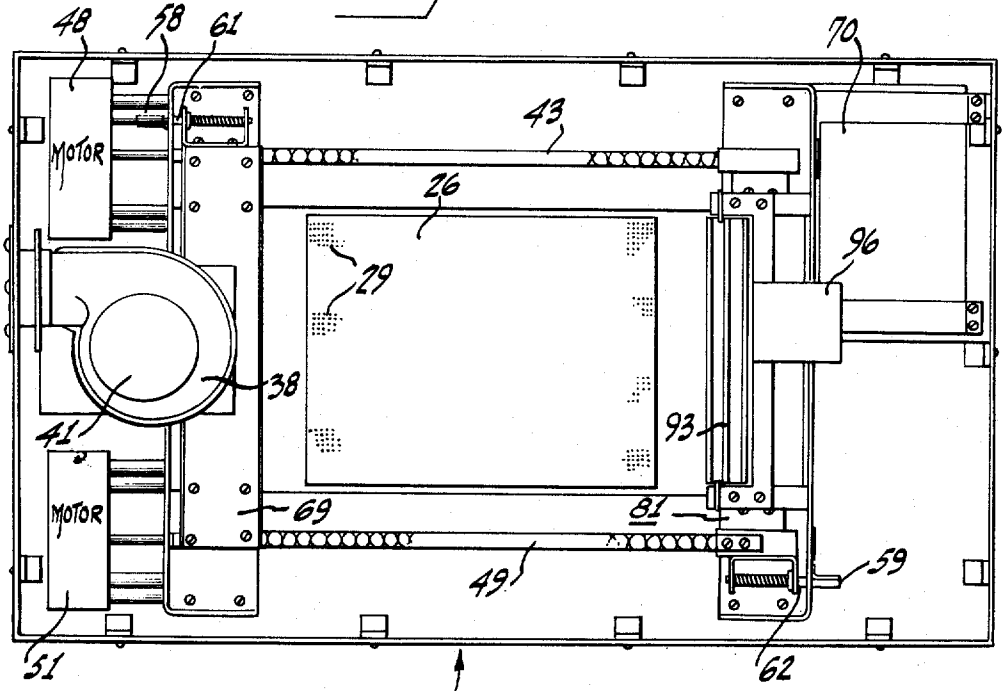
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ELECTROSTATIC PRINTING

Original Filed June 30, 1953 2 Sheets-Sheet 2

Fig. 2.



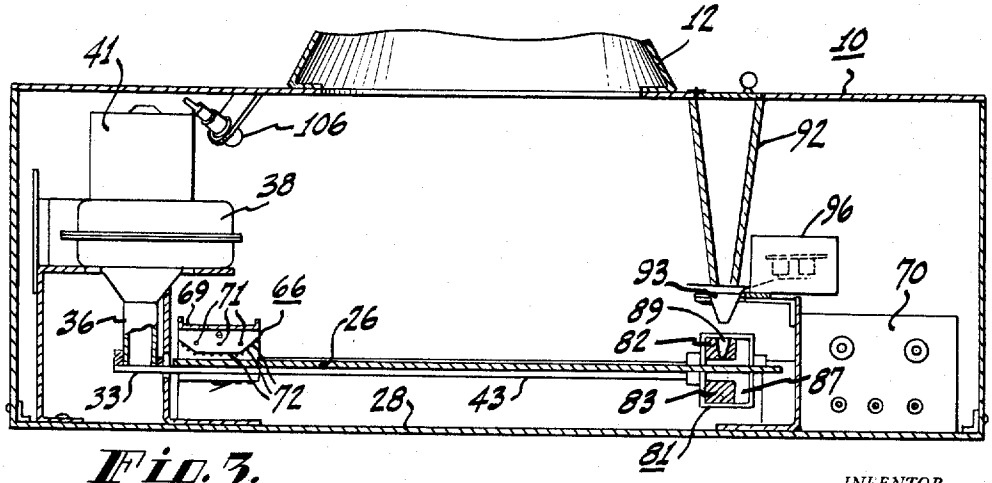


Fig. 3.

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ELECTROSTATIC PRINTING

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14 Claims. (Cl. 95—1.7)

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This invention relates to a page printer of the electrostatic type, and, more particularly, to an electrostatic printer having a developer powder applicator brush whose bristles are formed of ferromagnetic powder suspended from a magnet pole.

In many libraries and record keeping institutions it has become a common practice to photograph and reduce voluminous records to convenient microfilm size. These small rolls of film may be easily stored in comparison to the space consuming volumes they replace. Utilizing these films to extract information is made rather difficult under the present viewing arrangements. A common method of viewing is to project the film frames upon a ground glass plate. The disadvantage of this method is that the viewer must continuously position himself at the projector in order to see what is on each frame. There is also no permanent record available for any notations that may be made. Only one frame can be seen at a time and unless there are several projectors available, one frame cannot be simultaneously compared with another.

A method of overcoming this difficulty would be to photograph or to prepare an enlarged photograph of the material on the frame. The photographic process is relatively expensive. A dark room, wet chemicals, and special apparatus for developing and drying film are required. Printing by the electrostatic method would overcome most of these difficulties. There is a need for an electrostatic printer of simple inexpensive construction which will conveniently produce permanent prints from film rolls similar to 35 mm. microfilm.

Progress has been hindered by several shortcomings in existing electrostatic printers. One of these was lack of a simple developing powder applicator which would apply a uniform coating of developing powder across all parts of the charged and light exposed sheet. This problem has been solved by forming a powder retaining brush of bristles formed of ferromagnetic powder bunched together by, and suspended from, a magnet. This brush applicator is disclosed in the copending application for Letters Patent of the United States of Harold G. Greig, Serial No. 344,123, filed March 23, 1953, now U.S. Patent 2,874,063, issued February 17, 1959.

An object of this invention is to provide an electrostatic printer which will conveniently and rapidly print the information contained on a frame of film.

A further object of this invention is to provide an electrostatic printer which will furnish a permanent record of the information on microfilm rolls in convenient form and which can be operated by inexperienced, unskilled personnel.

Another object of this invention is to provide an improved developing powder brush applicator for an electrostatic printer which has magnetically held bristles of ferromagnetic powder which are relatively stiff, evenly distributed over the entire brushing surface and to which developing powder can be conveniently supplied.

A still further object of this invention is to provide

an improved developing powder applicator of the type described which has an even distribution of powder or toner throughout the entire length of the brush.

A still further object of this invention is to provide an electrostatic printer of the type described which is inexpensive to manufacture, simple to operate and reliable in operation.

A still further object of this invention is to provide an improved developing powder applicator of the magnetically suspended ferromagnetic powder type which has even distribution of bristles over the entire length of the brush and will permit an even supply of developer or toner to be added during normal operation of the brush.

An electrostatic printer, according to the present invention, with an improved developer powder applicator brush is constructed in the following manner. A light excluding enclosure is provided so that ambient room light will not interfere with printing. At the top of this enclosure is provided a light projector. A film guide is installed across the aperture of this projector so that the light can be directed through a frame of film adjusted within the guide. As the light travels through the film and into the enclosure, it passes through a lens system which enlarges the image. The enlarged image is projected upon a flat plate or platen within the enclosure. When the proper image is focused, the projector light is turned off while a sheet of photoconductive paper **27** is placed on the platen and the enclosure is sealed. Any suitable photoconductive paper may be employed.

A corona charger is moved across the face of the paper leaving a residual charge over the surface of the paper. The projector light is then turned on which exposes the paper to the image on the frame of film. The paper releases the charge where its surface is struck by light. A latent charge image of the frame of film is left on the surface of the paper. The developer powder applicator brush is then moved across the surface of the paper. The applicator has magnet pole pieces above and below the plane of the sheet of paper joined at their ends by permanent magnets. A ferromagnetic powder is suspended from the upper pole piece forming bristles in contact with the upper surface of the paper. Composition of this type of ferromagnetic carrier powder as well as the developer powder is set forth in the above mentioned application for Letters Patent of the United States of Harold G. Greig, Serial No. 344,123, filed March 23, 1953. In one form of this brush a slot is cut through the upper pole piece substantially across the entire length of the brush. This slot continues down through the bristles which are mutually repulsive. A slot substantially across the entire length of the brush is, therefore, provided into which the developer powder can be conveniently added.

This brush is swept across the entire exposed face of the sheet. The electroscopic powder is drawn off to the charged areas of the paper. An enlarged duplicate of the image on the film slide will therefore be formed on the sheet. When heat is applied this powder or toner which is pigmented will be fused permanently onto the paper and a permanent image or picture is formed.

Other objects and advantages of the present invention will become apparent to those skilled in the art from a reading of the following specification in conjunction with the accompanying drawings in which:

FIGURE 1 is a view in elevation of the printer showing the loading door of the enclosure closed;

FIGURE 2 is a plan view in section taken on the line **2—2** of FIGURE 1 as viewed in the direction of the arrows;

FIGURE 3 is an elevation in section of FIGURE 2 taken in the direction of the arrow A;

FIGURE 4 is a view in perspective of the magnetic structure for providing the magnetic brush effect; and

FIGURE 5 is a section of the magnetic structure of FIG. 4 illustrating the manner in which the developer powder is fed into the slot by means of which it is distributed throughout the entire length of the magnetic structure.

Referring to the drawing in more detail, reference character **10** indicates the base portion of a substantially light tight housing in which electrostatic printing is conveniently carried out in accordance with the invention. The base portion **10** of the housing is surmounted by a light hood **12** which provides a support for a film reel mechanism comprising film spools **14** and **16** and a film guide **18**. A lamp housing **21** is supported above the film guide **18** so as to project light through a selected frame of the film carried by the spools **14** and **16**. Reference character **23** designates a lens or lens system employed for imaging copy such as film on a flat platen member **26** which is disposed to receive photoconductive paper which may be of any suitable type, as mentioned heretofore. The platen **26** is suitably supported above the base plate member **28** and is perforated as indicated by reference character **29**. An enclosed air box **33** lies beneath the platen **26** and is connected by a suitable conduit or air duct **36** to a suction blower **38** driven by a suitable motor **41**.

A grooved drive shaft or double lead screw **43** is suitably supported in bearings within the base portion **10** of the housing and lies above the base plate member **28**. Rotation is imparted to the lead screw **43** by a suitable means such as a motor **48**. A similar double lead screw **49** is rotatably supported within the base portion **10** of the housing and is driven by suitable mechanical connections from a motor **51**. Lead screws similar to those just described are disclosed in "Radio Facsimile" RCA Institutes Technical Press, volume I, page 31. The motors **48** and **51** are suitably connected through control switches such as push buttons **53** and **54** respectively. The motor supports, may, if desired, have limit switches **58** and **59** included in control circuit therewith. The limit switches are operated in well known manner by limit switch operators **61** and **62**.

As stated above, the platen **26** is disposed to receive a record receiving member in the nature of a paper sheet having a photoconductive surface. In accordance with the operational procedure to be outlined hereinafter, means are provided for charging the record receiving sheet. In the illustrative example, a charging device **66** spans the platen and rests upon the lead screws **43** and **49** with slidable engagement. It is suitably connected as by a blade (not shown) engaged with the continuous return groove of the lead screw **43** so that as the motor **48** rotates the charging device **66** will traverse the platen **26** and return to its rest position when the push button **53** is pressed. The latter may be arranged to bridge the limit switch **58**. The charging device is provided with a conductive shielding top **69** and end members of insulating material to which are secured a wire grid **71** and a second wire grid **72**. The grid **71** is or may be connected to the negative pole of a 6,000 volt D.C. source **70** and the grid **72** may be connected to a 1,000 to 2,000 volt negative D.C. top on the high voltage source **70**. To adjust the charging voltage where the composition of the photoconductive paper varies, control knob **73** is provided.

Reference character **81** designates generally a magnetic structure which comprises a top pole piece **82** and a bottom pole piece **83** as shown somewhat diagrammatically on FIGS. 4 and 5 of the drawing. The pole pieces **82** and **83** are joined at their ends by T-shaped permanent magnets **86** and **87**. The magnets **86** and **87** are so poled that the pole pieces **82** and **83** are of opposite polarity. The magnetic structure **81** is supported for slide engagement upon the lead screw **43** and also rests

at its opposite end upon the lead screw **49**. A knife blade (not shown), for example, engages with the continuous return groove of the lead screw **49** so that magnetic structure will be propelled over the platen **26** as the motor **51** rotates. The limit switch **59** provides for only one complete excursion of the magnetic structure **81**. It is preferred that the motors **48** and **51** be wired in any manner well known in the art so that only one motor is operable at a time.

The pole piece **82** is slotted as indicated by reference character **89** and developer powder **125** may be supplied to the magnetic structure **81** through an elongated chute **92** which lies above an elongated funnel **93**. A vibrator **96** agitates the funnel **93**. Powder drops from the funnel **93** into the slot **89**. It will be understood that it is within the scope of the present invention to have the funnel **93** deposit the powder upon the record receiving member on the platen **26** just slightly in advance of the magnetic structure **81**.

In operation of the apparatus described above as embodying the invention, a microfilm having frames to be copied is first placed upon the reels **14** and **16**. When the proper frame has been adjusted in the film guide **18** the image is visible on the platen **26** when the door **100** of the enclosure **10** is slid open. The image of the film frame can be properly focused on the platen surface by adjustment of the lens system **23** through the lens access door **102**. The projector light source in the housing **21** can then be turned off. A pilot light **106** is provided to illuminate the platen **26** when the door **100** is slid open which causes the cam **107** to actuate the switch **110**. A pilot lamp switch is indicated at **110**. A sheet of photoconductive paper **27** can then be inserted to rest on the platen **26** within the enclosure. The door **100** is then closed shutting off the pilot light **106** and sealing the entire enclosure from outside light.

The charge button **53** is pressed. This actuates the lead screw motor **48** which causes the corona charger **66** as shown in FIGURE 3 to move completely across the surface of the paper and back again to its original position. Pilot light **111** connected across motor **48** indicates when lighted that the charger is in motion. When the corona device **66** passes over the face of the paper, it leaves a residual charge over its entire exposed face.

When pilot light **111** is extinguished, the exposure button **54** is then pressed. Pilot light **112** remains lighted only during exposure time. Time of exposure will vary up to 15 seconds depending on the composition of the paper. Control knob **105** is provided to adjust the exposure time. As the light strikes the surface of the paper it will liberate the charge where the light has contacted. Those areas shaded by the dark portions of the film will not lose their charge. A charge pattern will therefore be impressed upon the paper which will correspond to the light and dark portions of the film.

To make this latent charge image visible, the button **55** is then pressed which will operate the motor **51** turning the shaft **49** which carries the developer applicator brush supported on the magnetic structure **81** across the complete face of the paper and back again. A pilot light **113** indicates that the brush is in motion when lighted. The lines of flux which pass through the sheet of paper from pole pieces **82** to the pole piece **83** cause the ferromagnetic powder located on top of the paper to bunch together in brush-like bristles. Within these bristles, the electroscopic developer powder is sprinkled. The triboelectric quality of the bristles causes the electroscopic powder to cling intimately to the brush. As the brush travels over the charged latent image, the electroscopic powder will be attracted to the higher potential latent image.

The powder **125** which clings to the charged portions of the sheet is pigmented. When heat is applied in a heater (not shown) which may be situated in the base of the enclosure but separate from the light excluding enclosure as at **50**, the powder **125** will fuse to the paper.

A permanent image or enlarged duplicate of the frame of film is therefore fused to the paper. This heater can also be included in a completely separate enclosure.

As stated above, FIGURE 4 shows the slot **89** in the top of the pole piece of the developer which provides a means for conveniently supplying powder to the ferromagnetic brush bristles. It is shown in FIGURE 5 how the bristles mutually repel each other to form a continuation throughout the bristles of the brush of the slot in the pole piece. As this slot is cut along substantially the entire length of the brush, powder can be supplied evenly throughout the entire length of the brush. The developer powder is evenly distributed insuring consistent pigment density in the finished print.

It will be understood by those skilled in the art that timer devices (not shown) may be employed to cyclically time the operations, described above, which can be made to occur in a definite sequence.

What is claimed is:

1. Electrostatic printing apparatus comprising means for supporting a member presenting a record receiving surface means for charging said surface, means to cause said charging means to traverse said surface, means for projecting a light image on said surface whereby to produce a latent electrostatic charge image on said surface, a magnetic structure comprising a magnetized polar member extending laterally of said surface, means to produce relative movement between said surface and said magnetized polar member to cause said polar member to traverse said surface, and means to maintain a quantity of developer mix having magnetic properties in contact with said polar member whereby said polar member is provided with brush-like streamers of said mix, said polar member being located with respect to the record receiving surface of said first named member so that said streamers contact said record receiving surface.

2. Electrostatic printing apparatus comprising means for supporting a member presenting a record receiving surface, means for charging said surface, means to cause said charging means to traverse said surface, and means for projecting a light image on said surface whereby to produce a latent electrostatic charge image on said surface, a magnetic structure comprising a magnetized polar member extending laterally of said surface and a second magnetized polar member disposed on the opposite side of said first named member, means to produce relative movement between said surface and said magnetized polar members to cause said polar members to traverse said surface, and means to maintain a quantity of developer mix having magnetic properties in contact with one of said polar members whereby said one polar member is provided with brush-like streamers of said mix, said one polar member being located with respect to the record receiving surface of said first named member so that said streamers contact said record receiving surface.

3. Electrostatic printing apparatus comprising means for supporting a member presenting a photoconductive latent image receiving surface, a substantially rectangular magnetic structure comprising a polar member disposed on one side of said first named member, a complementary polar member disposed oppositely to said first named polar member on the opposite side of said first named member, and a pair of similarly poled magnets joining said polar members at their ends.

4. The apparatus of claim 3 wherein one of said polar members has a slot therein for receiving electroscopic developer powder.

5. The apparatus of claim 3 including means for feeding electroscopic developer material to said first named polar member.

6. A microfilm printer of the electrostatic type comprising a light source, a film supporting means whereby frames of film can be selectively supported in the path of light emanating from said light source, a lens system whereby the image of said film illuminated by said light source can be projected on a photoconductive surface as an enlarged image, a member having a flat surface for supporting a photoconductive sheet of a character which will accept a residual charge and will liberate the charge selectively from portions which are struck by light and retain said charge where not contacted by said light, electrostatic charging means positioned to impose an electrostatic charge upon a sheet disposed on said flat surface, a pair of pole pieces on opposite sides of said member, said pole pieces being adapted to have ferromagnetic powder suspended therebetween to provide brush means whereby an electroscopic developing powder is triboelectrically retained and placed in intimate brushing contact with the photoconductive charged and light exposed surface of a sheet on said member.

7. The combination set forth in claim 6 wherein said pole piece overlying said flat surface is slotted substantially across its entire length whereby to provide for adding developer powder to said brush means.

8. The combination set forth in claim 6 combined with pressure reducing means below said member having a flat surface whereby a sheet is firmly held to the surface of said member while being brushed with developer powder.

9. The combination set forth in claim 6 including guide means and wherein means are provided to cause said charging means to travel transversely over a sheet on the surface of said member and return to its original position on said guide means, and means whereby said developer powder brushing means travels transversely over said surface and back to its original position on said same guide means.

10. A developer powder applicator for electrostatic printing comprising a support for an electrostatic image bearing sheet, a pair of magnetic pole means producing a first magnetic polarity in a plane above said support and an opposite magnetic polarity in a plane below said support to cause lines of magnetic flux to pass through a sheet on said support, one of said pole means being longitudinally slotted throughout the major portion of its length to provide means for feeding electroscopic developer powder and ferro-magnetic particles to said plane above said support to form brush-like bristles thereof within the region of said magnetic flux and to produce by mutual repulsion a longitudinal division of the brush so formed, and means for moving said pair of magnetic pole means relative to said support to bring said brush like bristles into contact with substantially all areas on said image bearing sheet.

11. A charging and developing apparatus for use in electrostatic printing comprising a light tight housing, means for holding in fixed position therein a sheet treated with photoconductive material at an exposure position wherein the latent image of an object to be copied may be formed, electrostatic charging means, means mounting said charging means for movement across the treated side of said sheet to charge the same, means for exposing said charged sheet and forming a latent image on the charged side thereof, magnet means for forming a brush containing developing material and applying the same to said side of the sheet on which is disposed said latent image, means mounting said magnet means for movement substantially parallel to the sheet between a rest position at said side of the sheet, across the sheet and backwardly to the rest position, said magnet means being arranged to operate subsequent to the operation of said exposing means, and means for imparting movement to said charging means and said magnet means.

12. An apparatus according to claim 11, wherein said movement imparting means for the charging means is arranged to move the same substantially parallel to the treated sheet between a rest position at said side of the

sheet, across the sheet and backwardly to said rest position.

13. A charging and developing apparatus for use in electrostatic printing comprising a light tight housing, means for holding in fixed position therein a sheet treated with photoconductive material at an exposure station wherein the latent image of an object to be copied may be formed, electrostatic charging means, means mounting said charging means for movement across the treated side of said sheet to charge the same, means for exposing said charged sheet and forming a latent image on the charged side thereof, developing means for applying developing material to said side of said sheet on which is disposed said latent image, means mounting said developing means for movement substantially parallel to the sheet between a rest position at said side of the sheet, across the sheet and backwardly to the rest position, said developing means being arranged to operate subsequent to the operation of said exposing means, and means for imparting movement to said charging means and said developing means.

14. An apparatus according to claim 13, wherein said movement imparting means for the charging means is arranged to move the same substantially parallel to the treated sheet between a rest position at said side of the sheet, across the sheet and backwardly to said rest position.

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