

May 14, 1957

G. W. F. SIMMONS ET AL

2,791,949

XEROGRAPHIC COPYING DEVICE

Filed Feb. 1, 1956

2 Sheets-Sheet 1

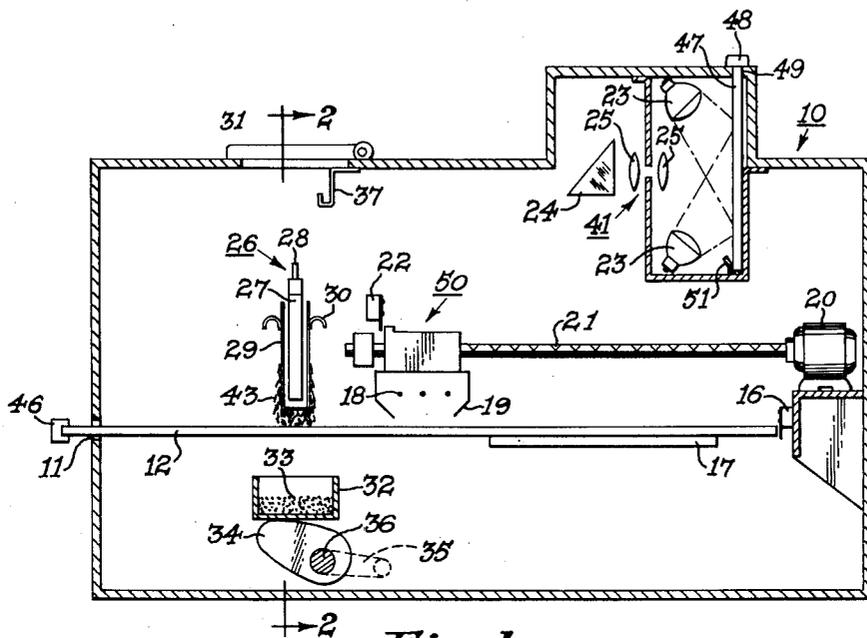


Fig. 1

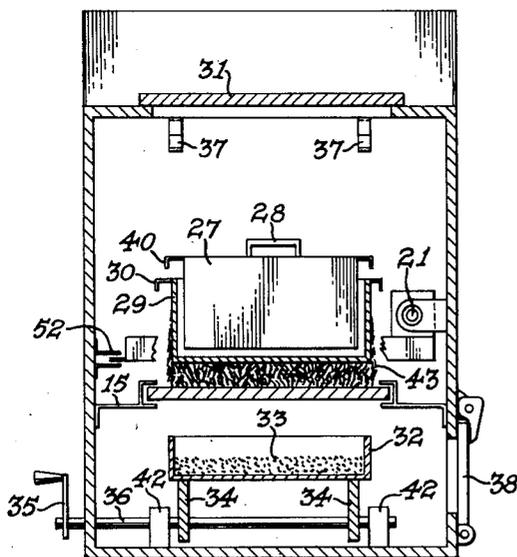


Fig. 2

INVENTORS
WARREN E. SAUL
GEORGE W. F. SIMMONS
BY
Frank H. Schindler
ATTORNEY

May 14, 1957

G. W. F. SIMMONS ET AL

2,791,949

XEROGRAPHIC COPYING DEVICE

Filed Feb. 1, 1956

2 Sheets-Sheet 2

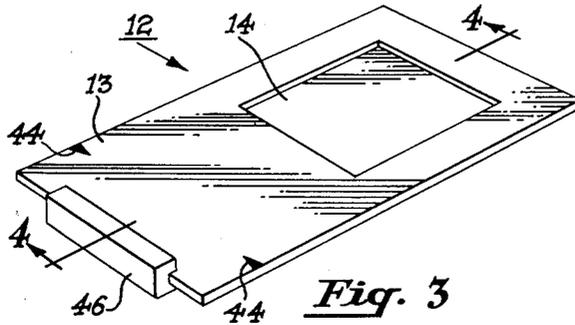


Fig. 3

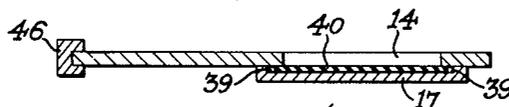


Fig. 4

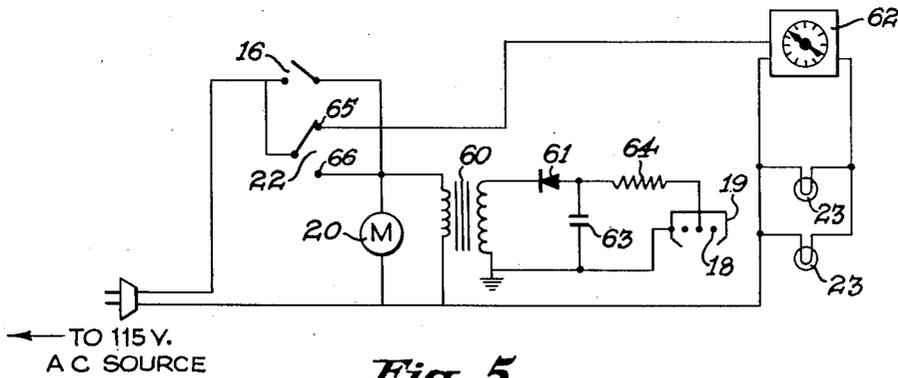


Fig. 5

INVENTORS
WARREN E. SAUL
GEORGE W. F. SIMMONS
BY
Frank A. Steinhilber
ATTORNEY

1

2

2,791,949

XEROGRAPHIC COPYING DEVICE

George W. F. Simmons, Henrietta, and Warren E. Saul, Rochester, N. Y., assignors to The Haloid Company, Rochester, N. Y., a corporation of New York

Application February 1, 1956, Serial No. 562,845

4 Claims. (Cl. 95—1.7)

Our invention relates to xerography and more particularly to improved means for applying electroscopic developer material onto a surface bearing an electrostatic image.

In xerography it is usual to form an electrostatic latent image on a surface. One method of doing this is to charge a photoconductive insulating surface and then dissipate the charge selectively by exposure to a pattern of activating radiation as set forth, for example, in U. S. 2,297,691 to Chester F. Carlson. Other means of forming electrostatic latent images are set forth in U. S. 2,647,464 to James P. Ebert. Whether formed by these means or any other, the resulting electrostatic charge pattern is conventionally utilized by the deposition of an electroscopic material thereon through electrostatic attraction whereby there is formed a visible image of electroscopic particles corresponding to the electrostatic latent image. Alternatively, the electrostatic charge pattern may be transferred to an insulating film and the electroscopic particles deposited thereon to form the visible image. In any case this visible image, in turn, may be transferred to a second surface to form a xerographic print or may be fixed directly to the photoconductive surface.

The usual process of applying the developer to the latent electrostatic image is set forth in U. S. 2,618,552 to E. N. Wise and involves the use of a finely-divided colored material called a toner deposited on a slightly more coarsely divided material called a carrier. This two-component developer is cascaded across the electrostatic image areas. The toner and carrier being rubbed against each other while cascading impart an electrostatic charge to each other by triboelectric charging. To produce a positive of the electrostatic image a toner and carrier are selected such that the toner will be charged to a polarity opposite to that of the electrostatic image, the carrier being charged to the same polarity as the electrostatic image. When a carrier particle, bearing on its surface oppositely charged particles of toner, crosses an area on the image surface having an electrostatic charge, the charge on the image surface exerts a greater attraction for the toner than the carrier and retains the toner in the charged area and separates it from the carrier particle. The carrier particles being oppositely charged and having greater momentum are not retained by the charged areas of the plate. When a toned carrier particle passes over a non-charged area of the plate, the electrostatic attraction of the carrier particles for the toner particles is sufficient to retain the toner on the carrier preventing deposition in such areas as the carrier particles' momentum carries both toner and carrier past. By this mechanism, the image is developed, i. e. made visible.

It has recently been discovered that when a developer mix comprising a toner and a ferro-magnetic carrier material is contacted with a magnet so that streamers are formed (called "bristles") which constitute a brush-like mass and the brush then passed over the surface bearing the electrostatic latent image whereby the brush contacts the image-bearing surface, the developer is both tribo-

electrically charged and deposits on the electrostatic latent image in a manner similar to that wherein the toner and carrier mix is cascaded across the image-bearing surface.

5 An object of the present invention is to provide a novel means for applying electroscopic developer powder to an electrostatic image-bearing member.

Another object of this invention is to provide suitable means as set forth, wherein the developer mix is applied by a magnetically maintained brush.

10 A further object is to provide developing means as set forth, wherein electrostatic images may be easily and semi-automatically developed in relatively compact and easily operated apparatus.

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

Fig. 1 is a side elevation, partly schematic, illustrating apparatus according to the instant invention;

20 Fig. 2 is a section along the line 2—2 of the apparatus of Fig. 1;

Fig. 3 is a plan view illustrating means for holding the electrostatic image-bearing member;

25 Fig. 4 is a section along the line 4—4 of the member of Fig. 3; and

Fig. 5 is a diagram of the electric circuit for the apparatus of Figs. 1 and 2.

30 The apparatus to be described, embodying the invention in illustrative form, in general comprises a light-tight container, means for inserting therein a member bearing a layer of a photoconductive insulating material, means for sequentially and consecutively charging the photoconductive insulating material and exposing it to a pattern of light and shadow to be reproduced and means 35 for contacting the photoconductive insulating material with a magnetic brush.

The apparatus may be operated with a developer comprising a toner powder and a carrier material. The carrier material consists of magnetically attractable powders such as magnetic ferrites as described in U. S. patents to J. L. Snoeck Nos. 2,452,529, 2,452,530 and 2,452,531, all dated October 26, 1948, iron carbonyl, alcoholized iron etc. while any of the large number of toner materials known to those skilled in the art such as those described 40 in U. S. 2,618,551 to L. E. Walkup, U. S. 2,618,552 to E. N. Wise and U. S. patent application Serial No. 327,452, filed December 22, 1952, by R. B. Landrigan, now U. S. Patent No. 2,753,308, are suitable for mixing with the magnetic carrier to form a developer to be employed 45 in the present invention.

If alcoholized iron is used as the magnetic carrier, it is possible to develop a reversed image or a direct image by selecting a toner above or below iron in the triboelectric series. As examples, powdered shellac or rosin, each pigmented with a suitable material such as carbon black, when used with alcoholized iron give a direct image with a negative charged surface and a reversed image with a positively charged surface. Similarly, Vinsol resin (an extract from long leaf yellow pine stumps composed principally of an oxidized form of abietic acid and manufactured by Hercules Powder Company, Wilmington, Delaware) colored with a suitable dye such as nigrosine gives a direct image with a positively charged surface and a reversed image with a negatively charged 50 surface. Alternatively, the toner may be kept the same and the magnetic carrier varied to obtain a direct or reversed reproduction of the electrostatic image. Thus, using a polystyrene resin with a suitable pigment as carbon black for the toner one can obtain a direct image of a negatively charged surface when using PMC Z270, a powdered iron produced by the Haloid Company, Rochester, New York, as the magnetic carrier and a re-

versed reproduction of the negatively charged image when using Carbonyl L, a powdered iron made by the reduction of an iron carbonyl by Antara Chemicals Division of General Aniline and Film Corporation, New York, New York, as the magnetic carrier.

Referring now to the drawings in more detail there is shown in Figs. 1 and 2 suitable apparatus for xerographically reproducing an image pattern of light and shadow according to the instant invention. The apparatus comprises a light-tight container or box 10 having an entrance slot 11 to accommodate member 12 bearing a layer of a photoconductive insulating material. Guide and support means 15 support member 12 in spaced parallel relation to charging means 50. Desirably the charging means 50 is a corona charging unit as described in more detail in U. S. patent application Serial No. 194,688, filed November 8, 1950, by J. J. Rheinfrank, now abandoned. In general, the corona charging unit comprises, as shown, corona generating wires 18 protected by shield 19. Alternatively the charging means may comprise a semi-conductive roller connected to a source of high voltage, a frictional charging brush as described in U. S. Patent 2,357,809 to C. F. Carlson, etc. Suitable means as a motor 20 moves the charging means 50 relative to the photoconductive insulating material while suitable means as a reversing screw 21 returns charging means 50 to its original position. A first switching means 16 engages member 12 and energizes the circuits for charging means 50 and motor 20. A second switching means 22 is energized upon the charging means 50 returning to its original position and energizes exposure means 23 and de-energizes the circuits for charging means 50 and motor 20.

The member 12, bearing the photoconductive insulating material, may comprise a suitable conductive support as brass, aluminum, conductive glass etc., coated with a vitreous layer of sulphur, anthracene, amorphous selenium, alloys of amorphous selenium with various metals such as arsenic, sulphur tellurium etc. or alternatively may comprise a similar conductive backing coated with a finely-divided photoconductive insulating material such as one of the photoconductive insulating materials described above or a photoconductive phosphor as described in U. S. patent application Ser. No. 311,546, filed September 25, 1952, by A. E. Middleton and D. C. Reynolds which finely-divided material is dispersed in a suitable resinous binder as a silicone resin, a vinyl resin, a cellulose ester or ether etc. and coated on the conductive backing. Such xerographic plates, as they are termed, may be used thousands of times before being discarded.

Preferably, however, the photoconductive insulating material used in conjunction with the apparatus of the instant invention comprises a xerographic plate which, by reason of low cost and ease of handling, is specifically adapted for a single use. Such materials are prepared by preparing a mixture of a finely-divided photoconductive phosphor or finely-divided photoconductive insulating material as described in the Middleton and Reynolds application cited above and U. S. Patent 2,663,636 to A. E. Middleton, and coating such materials on a paper backing. A particularly preferred combination is finely-divided zinc oxide dispersed in a silicone resin and coated on a paper backing. Such a material is commercially available from the Haloid Company, Rochester, New York and is termed xerographic paper. When such a material is used for the photoconductive insulating material it is necessary to provide for the problem of mirror reversal. Accordingly, the optical system shown in Fig. 1 which is designed for copying opaque copy as documents and the like includes in addition to lens 25 a prism 24 for affecting mirror reversal so as to obtain a right reading copy of the original to be reproduced.

When the disposable xerographic plate, as xerographic paper, is used, member 12 may consist merely of a flat

conductive plate provided with suitable means as clips for holding the paper in contact with the plate during the various operations and to permit centering under the charging and exposing means. A preferred type of member 12 for use with such disposable plates is shown in more detail in Figs. 3 and 4. As is shown, the conductive plate 13 is provided at one end with a well or depression 14 so placed as to center the paper bearing the photoconductive insulating layer under the charging and exposure means. Grooves 39 secure the paper during development. Suitable means as markings 44 are provided on member 12 to indicate upon withdrawal of the plate when the near end of well 14 first comes under the magnetic brush 26. Desirably, metal plate 17 constituting the bottom of the well 14 is made of soft iron to intensify the flux from the magnetic brush 26 and thus aid in development. Handle 46 permits easy handling of member 12.

Exposure station 41 has a slot 49 wherein may be inserted plate 47. Plate 47 has suitable means as clips for holding a document or other 2-dimensional subject matter to be reproduced while handle 48 also gives a light-tight seal at slot 49. Bracket 51 receives plate 47 and holds it in fixed parallel spacing from lenses 25. Lights 23 are positioned to illuminate plate 47. Prism 24 is positioned to reflect the image from lenses 25 onto the photoconductive insulating material on member 12. Alternatively, instead of the arrangement shown, exposure means 41 may comprise a projector such as is used in a photographic enlarger. In this case only transparent originals may be reproduced. However, mirror reversal may be compensated for merely by proper insertion of the transparent original thus eliminating the necessity for prism 24.

The magnetic brush 26 is positioned so that the bristles 43 of the brush 26 contact the photoconductive insulating material between the charging means 50 and slot 11. The magnetic brush 26 comprises a magnet 27 and support means 52 for supporting the magnet 27 in fixed parallel relation to the member 12. Desirably, although not necessary, magnet 27 is covered by a shield 29 of non-magnetic material. The magnetic developer then does not contact the magnet 27 directly but is held against the exterior wall of the shield 29 by reason of the lines of force of the magnet 27. Projecting lips 30 form the top of non-magnetic shield 29. A handle 28 permits easy handling of the magnet 27. Hooks 37, adapted to receive supports 40, permit supporting the magnet out of contact with the non-magnetic shield 29 thereby facilitating the cleaning of the magnetic brush when desired. A light-tight door 31 gives access to the magnetic brush 26 to permit cleaning and other operations.

Suitable means may also be provided to permit easy and rapid retoning of the magnetic brush 26. As shown these may comprise a trough 32 containing therein a supply of toner 33. Trough 32 is supported in contact with cams 34 which are in turn connected by means of shaft 36 to arm 35. Shaft 36 is journaled in bearings 42. A light-tight door 38 gives access to trough 32.

An electrical circuit suitable for the apparatus shown in Figs. 1 and 2 is illustrated in Fig. 5. As is shown, electric current from an A. C. source is connected in parallel to switches 16 and 22. Switch 16 is normally open and is connected in parallel to high voltage transformer 60 and to motor means 20. Switch 22 is a double pole single throw switch and is normally in the position shown. In this position it is connected to timing switch 62 which is normally in the off position and is in turn connected to exposure means as lights 23. The high voltage from transformer 60 is rectified by selenium rectifier 61, condenser 63 and resistor 64 and the rectified output supplied to corona wires 18. Shield 19 may be connected to ground as shown, or alternatively may be connected to an intermediate potential i. e., intermediate between the high voltage supplied to corona wires 18 and ground.

The method of operation of the device is as follows: an original sheet to be copied is placed on plate 47 which then is inserted in slot 49 so that the printed side to be reproduced faces towards lens 25. A sheet of xerographic paper 40, of the correct size, is then placed in well 14 and secured by grooves 39 with the photoconductive insulating material facing away from plate 17. The member 12 is then inserted in slot 11 along guide and support means 15 and into contact with switch 16. There being no electrical charge on the surface of the xerographic 10 at the moment of insertion, the contact with bristles 43 of brush 26 at the time of insertion of member 12 produces no deposition of toner on the surface of the photoconductive insulating material 40. Switch 16, on being contacted by member 12, is closed thereby energizing 15 motor 20 and high voltage transformer 60 placing a corona generating potential on corona wires 18. Motor 20 causes the corona to move along reversing screw 21 and then back to its original position. On the corona unit leaving its initial position switch 22 changes from first pole 65, as shown in Fig. 5 to second pole 66. Switch 16 is equipped with a spring so that member 12 must be inserted with a reasonable pressure to cause closure of switch 16. Immediately on releasing this pressure switch 16 returns to the open position. In the meantime, however, switch 22 has been moved from pole 65 to pole 66. Hence, although, switch 16 was immediately opened again, switch 22 now supplies the current to motor means 20 and high voltage transformer 60. Breaking the contact at pole 65 also allows the timing switch 62 to reset itself. On charging means 50 returning to its original position, it once again moves switch 22 from pole 66 to pole 65. This opens the circuit to both the high voltage transformer 60 and the motor 20 turning off these units while at the same time supplying current to timing switch 62 which has now reset itself. This energizes lights 23 which illuminate the copy on plate 47 until the timing motor turns off switch 62. The light from the copy is focused by lens 25 onto prism 24 where it is reflected onto the photoconductive layer of the xerographic paper producing thereon a right reading reproduction of the original to be copied. When the lights 23 go off by action of switch 62, the operator then withdraws member 12 until marks 44 are visible from slot 11. At this point, the near side of well 14, and hence of the xerographic paper 40, will be in contact with the 45 bristles 43 of the magnetic brush 26. Soft iron plate 17 will act to intensify the line of flux thereby elongating the bristles 43 of the brush 26 and assuring a more intimate and thorough contact between the bristles 43 of the brush 26 and the top surface of the xerographic paper 40. The 50 entire surface of the xerographic paper 40 is moved in contact with the bristles 43 by passing the member 12 back and forth a few times under the brush 26 without allowing light to strike it to thereby assure complete and uniform development of the image. Member 12 is then withdrawn 55 and the developed image permanently affixed to the xerographic 40 by fusing as by subjection to a moderate temperature for a short period of time or by contact with the vapors of a suitable solvent for a short period of time as shown by U. S. patent application Ser. No. 299,673, filed July 18, 1952, by C. F. Carlson, now U. S. Patent No. 2,776,907.

If it is desired to replenish the amount of toner in the magnetic brush 26, member 12 is withdrawn from container 10 and handle 35 turned causing shaft 36 to rotate in journals 42. This causes cams 34 to move trough 32 containing a supply of electroscopic developer powder 33 so that powder 33 contacts bristles 43 in a sliding contact. Repeating this operation a few times retones the brush 26.

If it is desired to completely change the developer, as in changing from a developer which gives a positive reproduction of an electrostatic image to one which gives a reversal reproduction, the change may be expeditiously carried out in the apparatus of the instant invention. Door 31

is opened and magnet 27 removed from shield 29 by lifting the magnet 27 by handle 28. The magnetic developer 43 attempts to follow the magnet 27 up the side of shield 29 but is prevented from doing so by projecting collar or lip 30. When the magnet 27 is withdrawn above collar 30 the lines of force become too weak to retain the developer 43 and it falls into trough 32. If desired, magnet 27 may be rested on hooks 37 by supports 40 and the outer part of shield 29 wiped with a cloth. Door 38 is then opened, trough 32 containing the old powder 33 removed and a new trough 32 containing new powder 33 inserted. The magnet 27 is then reinserted in shield 29, doors 31 and 38 closed, and then merely rotating handle 35 reconstitutes brush 26.

We claim:

1. A light-tight housing having first, a copy area, said area comprising means to insert copy into a copy plane, means to illuminate said copy plane and means to project said copy plane onto an exposure plane; second, an entrance slot in said housing; third, guide and support means cooperating with said entrance slot to position a photoconductive insulating member in the exposure plane following movement of the member through said slot and into said guide and support means; fourth, electrostatic 25 charging means; fifth, means to move said charging means relative to said exposure plane; sixth, a development zone, said zone comprising a magnet adapted to carry a developer mix of electrostatically charged magnetic particles and support means for said magnet to position and dispose said magnet whereby said mix contacts all the image areas of a photoconductive insulating member as the member is withdrawn from said light-tight housing; and, seventh, switching means to automatically and sequentially sensitize and expose a photoconductive insulating member in said exposure plane by moving said 35 charging means into charging position, actuating said charging means to supply electrostatic charge to the exposure plane, withdrawing said charging means from said charging position and then projecting the illuminated copy plane, now unobstructed by said charging means, onto said exposure plane for a predetermined time.

2. Apparatus according to claim 1 including developer retoner means positioned and disposed in said light-tight housing to supply additional developer mix to said magnet.

3. Apparatus according to claim 1 including a magnetic flux concentrating means positioned and disposed to concentrate the magnetic fields of force intensely toward a photoconductive insulating member as it is withdrawn along said guide and support means.

4. A light-tight housing having first, a copy area, said area comprising means to insert copy into a copy plane, means to illuminate said copy plane and means to project said copy plane onto an exposure plane; second, an entrance slot in said housing; third, guide and support means cooperating with said slot to position a photoconductive insulating member in the exposure plane following movement of the member through said slot and onto said guide and support means; fourth, electrostatic 55 charging means; fifth, means to move said charging means relative to said exposure plane; sixth, a development zone, said zone comprising a magnet at least the lower portion of which is covered by a shield of non-magnetic material, said magnet being adapted to carry a developer mix of electrostatically charged magnetic particles extending from said non-magnetic shield in accordance with the lines of force emanating from said magnet within said shield, a projecting collar encircling the upper portion of said shield and support means for said shield to position and dispose said shield whereby said mix contacts all the image areas of a photoconductive insulating member as the member is withdrawn from said light-tight housing; and, seventh, switching means to automatically and sequentially sensitize and expose a photoconductive insulating member in said exposure plane by positioning said 75

charging means contiguous to said exposure plane, applying electrostatic charge to the exposure plane from said electrode, withdrawing said charging means from said charging position and then projecting the illuminated copy plane, now unobstructed by said charging means, 5 onto said exposure plane for a predetermined time.

References Cited in the file of this patent

UNITED STATES PATENTS

2,357,809	Carlson -----	Sept. 12, 1944
2,588,675	Walkup et al. -----	Mar. 11, 1952
2,711,481	Phillips -----	June 21, 1955