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[54]	HIGH-SPEED COPIER	
	1 Claim, 2 Drawing Figs.	
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[50]	Field of Search	355/3, 8, 11, 17

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ABSTRACT: A latent image formed in a photoconductor surface carried on a conductive base is transferred to a sheet of untreated paper by placing said sheet in contact with said surface and imposing a high-voltage potential between the sheet and base. A charge image is thus formed in the sheet of paper corresponding to the latent image in the photoconductor surface, and this charge image is thereafter developed. These lenses are rotatably mounted such that the lenses rotate successively into the optical path for transmitting the image being scanned to the photoconductive surface.

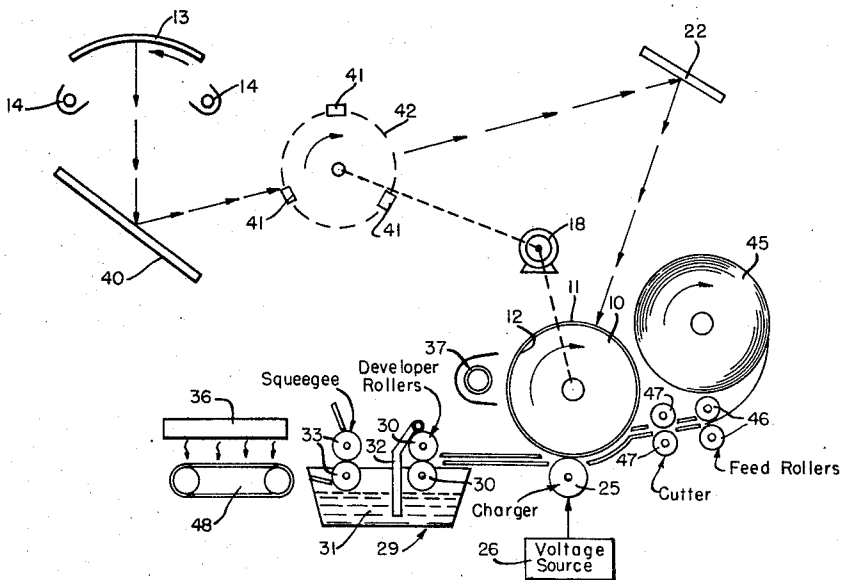
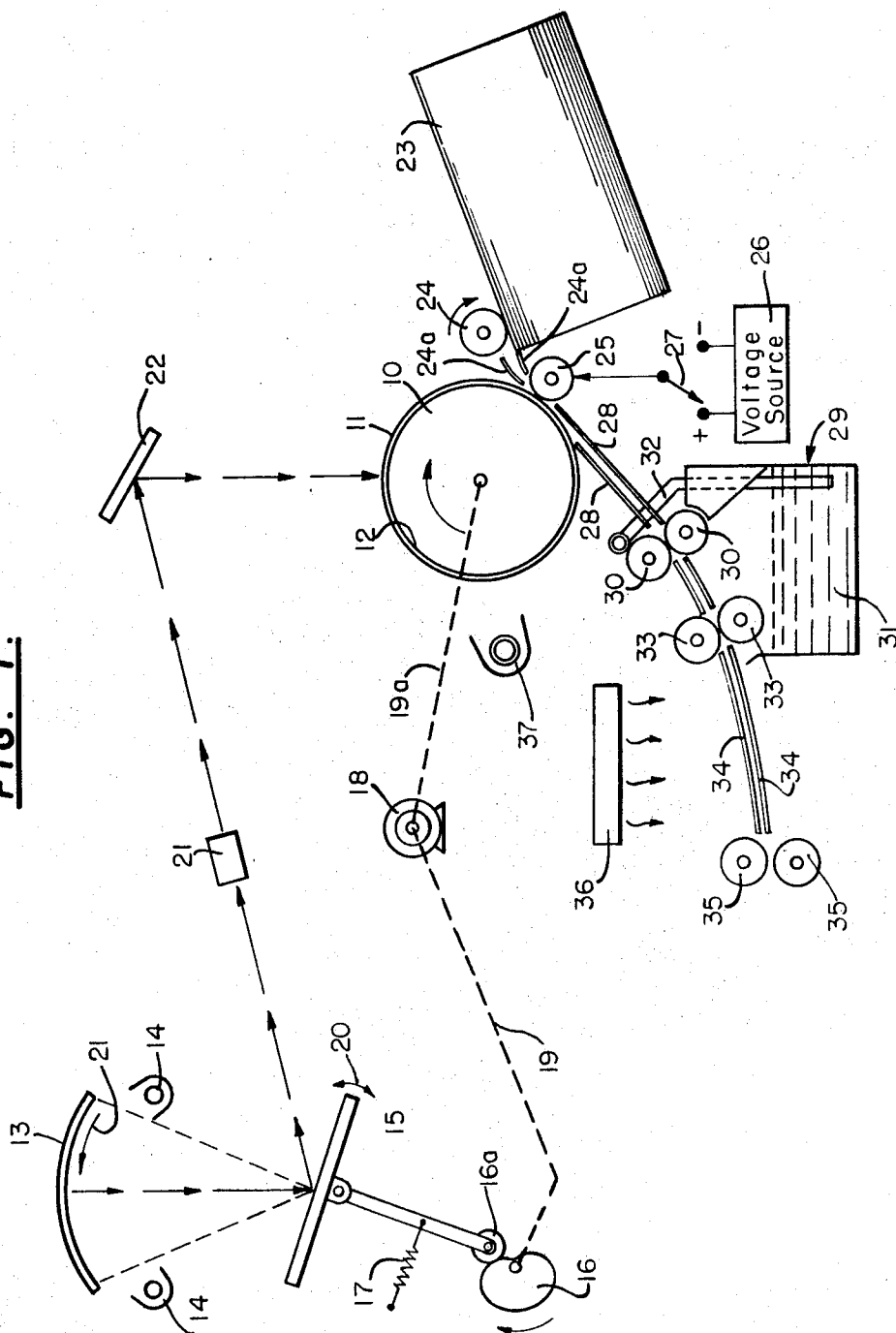


FIG. 1.



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HIGH-SPEED COPIER

BACKGROUND OF THE INVENTION

The present invention relates to copiers of the electrostatic type, and is more particularly concerned with an improved method and apparatus for achieving copies of any desired subject material more rapidly than has been possible heretofore.

Electrostatic processes and apparatus are, in themselves, well known and ordinarily make use of the photoconductive properties of various known materials such as ZnO, CdS, CdSe, ZnS, ZnSe, Se, S, Anthracene, P.V. Carbazole, or combinations thereof. Such materials, as well as other known materials which may be employed in the practice of the present invention, have a conductivity which can be caused to vary as a function of incident light. Characteristically, the materials exhibit relatively high resistivity (or low conductivity) in the dark, and lesser resistivity (or higher conductivity) when exposed to light, with the actual resistivity or conductivity of incremental portions of a photoconductor surface being dependent upon the different intensities of light which may fall upon different portions of such a surface.

In copying systems suggested heretofore, a drum coated with such a known photoconductor is initially given a uniform electrostatic charge, whereafter the charged drum is exposed to the image of a document projected onto the drum through an appropriate lens system. This exposure to light causes the charge to be dissipated in various areas of the drum by causing the charge to flow to a conductive support (e.g., of aluminum) carrying the photoconductive material, and then to ground. The electrostatic charge remains, however, in the image areas so as to produce, in effect, a latent image taking the form of a pattern of electrostatic charges on the drum surface. This charge image is then ordinarily developed directly on the drum surface by the application of toner material to said drum surface. The image so developed is thereafter transferred to a sheet of copy paper by using an oppositely charged corona to attract the toned image and by interposing a sheet of copy paper between the image and the corona, to accept the image. The resultant visible image on the sheet of copy paper may then be fixed by application of heat thereto.

The known method and apparatus described above suffers from the major disadvantage that the drum surface must be charged as part of the copying process. This not only reduces the speed at which copies may be made, but also imposes rather strict requirements on the character of the photoconductor surface. In addition, the requirement that toner be caused to adhere to the drum surface and thereafter be transferred to a separate sheet of charged paper tends to slow up the copying process and, in addition, gives rise to problems of maintenance and periodic cleaning of the equipment.

In an effort to avoid some of these known problems, alternative methods and apparatuses have been suggested making use of photoconductor surfaces. One such alternative method is suggested for example in Robillard U.S. Pat. No. 3,309,198. Robillard suggests, for example, that an image can be formed in a semiconductor, and thereafter transferred to a copy sheet of special composition, comprising a sheet coating consisting of a mixture of semiconductor material and a dry electrolyte, by applying an electric field between the conductive base of the photoconductive layer and the conductive base of the copy sheet. The image transferred to the copy sheet is then caused to become visible by an oxidation process through exposure of the sheet to a catalytic agent and a reversal potential. This technique thus avoids the need of charging the photoconductive image surface, and also avoids the need of applying toner; but is subject to the major disadvantage that it depends entirely upon the use of special copy paper, as well as upon the use of very special developing mechanisms.

The present invention, recognizing the disadvantages of conventional techniques suggested heretofore, as well as of variants thereof such as the Robillard system, is concerned with an improved electrostatic copying process which is far simpler and more rapid, less expensive, and which avoids the problems which have characterized prior art systems.

SUMMARY OF THE INVENTION

The present invention, while similar in certain respects to known electrostatic copying processes, is particularly characterized by a new technique for transferring latent image from a photoconductor surface to a sheet of copy paper. The new technique avoids the need of charging the photoconductor surface, avoids the need of applying toner to a drum surface, and also permits the use of plain untreated paper as a copy medium.

In accordance with the present invention, an original document to be copied is illuminated with light, and an image of said document is projected onto a surface, e.g., a drum surface, having a photoconductor coating carried on a conductive base. In accordance with known principles, a variable resistivity or variable conductivity latent image of the document is thus formed in the semiconductor surface. This conductivity image reposing on the semiconductive surface is then transferred directly to a sheet of plain, untreated paper by causing the paper sheet to engage the photoconductive surface while simultaneously applying a high-voltage potential between the conductive base of said surface and the sheet of paper.

The paper sheet is thereby caused to receive a latent charge image corresponding to the latent variable conductivity image on the drum surface; and this is accomplished without the need to charge the drum surface itself or the copy paper before the two are brought into engagement with one another. The latent charged image on the sheet of paper produced by the technique of the present invention is thereafter developed by application of charged toner of the liquid, powder, or semiliquid type. The nature of the visible image, i.e., positive or negative, depends upon the comparative polarities of the charge on the toner and the charge on the paper sheet; and either type of image may be produced in accordance with the present invention by appropriate choice of the charge in the toner material, or by appropriate selection of the charge polarity on the sheet of paper.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic representation of a copier apparatus constructed in accordance with one embodiment of the present invention; and

FIG. 2 is a diagrammatic representation of another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIG. 1, a copying apparatus constructed in accordance with the present invention may comprise a drum 10 having a photoconductor material 11 formed as a layer on an underlying conductive base 12. In a preferred form of the invention, the photoconductive material 11 is deposited on a separate conductive resilient base 12 formed, e.g., of aluminum foil, and the composite structure is then wrapped around a supporting drum or the like. The materials of which the several parts 10, 11 and 12 may be constructed are in themselves well known, and the present invention makes no change in these respect. A document to be copied is placed upon a transparent screen 13 of curved configuration, and is illuminated by means of lamps 14 associated with appropriate reflectors. The document on screen 13 is scanned by the action of a mirror 15 which is oscillated by a cam 16 against the restraint of a spring 17. Cam 16 may be driven by a motor 18 which also drives drum 10 through appropriate gear trains and the like diagrammatically depicted 19 and 19a.

As cam 16 is caused to rotate in synchronism with rotation of drum 10, cam follower 16a oscillates mirror 15, as indicated by arrow 20, and causes a document resting on screen 13 to be periodically scanned in the direction generally indicated by arrow 21. An image of said document is, during this scanning operation, reflected from the surface of mirror 15 and projected through lens 21 onto a fixed mirror 22 and

thence onto the photoconductor surface 11 and drum 10. As a result, a latent image is produced in surface 11, taking the form of a variable resistivity or a variable conductivity pattern corresponding in intelligence to the information on the original document place upon screen 13.

With the particular arrangement diagrammatically shown in FIG. 1, the drum 10 and cam 16 are so related that drum 10 and cam 16 are so related that drum 10 rotates once for every two oscillations of mirror 15; and, as a result, two images of the original document are impressed on the drum surface sequentially during a single revolution of the drum. In practice, the scanning speed of the oscillating mirror 15 must be synchronized to the speed of the drum 10, i.e., one scan of the original document by mirror 15 must be equal to a single pass of a predetermined image area on drum 10. If the image and object are exactly one to one magnification, then the angular scan of the mirror in linear terms should be equivalent to the linear travel of the surface of the drum. This is easily accomplished by adjusting the ratio of the sprockets or gears and chain that drive the drum 10 and cam 16 from motor 18.

After a variable resistivity image has been impressed, in increments, upon the photosemiconductive surface 10 by the technique described, this image can be transferred to a sheet of conventional copy paper for later development into visible form. More particularly, at a proper time in the cycle achieved by appropriate synchronization mechanisms which are in themselves well known, the top sheet in a stack of paper 23 may be fed by means of a feed roller 24 via guides 24a toward the surface of drum 10. The sheet of paper, so fed, is pressed firmly against the photoconductor surface on drum 10 by means of high-voltage roller 15, or by means of other known types of charging mechanism. Roller 25 is coupled to a voltage source 26 capable of impressing a voltage of ± 750 volts, or some other appropriate voltage, on said roller; and the actual polarity of the voltage impressed on roller 25 relative to grounded conductive base 12 may be selected by means of a switch 17 associated respectively with positive and negative output terminals of source 26. Good contact must be maintained by roller 25 between the paper sheet and the semiconductor layer 11 to achieve maximum sharpness and contrast in the final image; and, in this respect, layer 11 should have a smooth, highly polished outer surface for best results.

As the sheet of paper from stack 23 passes between the drum surface and charger 25, a charge image is produced directly on the sheet of paper corresponding to the variable resistance image previously produced in drum layer 11. It will be noted in this respect that the charge image so formed on the paper sheet does not require the use of special treated paper; and, moreover, the latent image is formed on the paper sheet without requiring that drum 10, or the paper sheet, be charged before the two are brought into contact with one another.

The sheet of paper, with its latent charge image thereon, may then be passed via guides 28 to a developer station, generally designated 29. In this station, charged toner is applied to the charged paper sheet so as to adhere thereto selectively and render the latent image on the sheet visible. Either liquid or powder toner may be employed for this purpose, and the diagrammatic showing in FIG. 1 depicts a liquid-toner installation.

More particularly, the sheet of paper with its latent charge image thereon passes through a pair of developer roller 30 which are in turn supplied with liquid toner from a tank 31 via a feeder tube 32. An appropriate pumping mechanism (not shown) may be employed for this purpose. The charged liquid toner renders the charged image on the paper sheet visible in accordance with known principles, and the sheet of paper so developed then passes through a pair of squeegee rollers 33 which remove excess toner from the sheet. The sheet then passes via further guides 34 toward a pair of output rollers 35 for appropriate collection; and heating means 36 may be provided upstream of output rollers 35 to dry the toner. It should be noted that the liquid-toner feeding arrangement shown in FIG. 1 is such that liquid toner is applied only to the upper one

of the two developer rollers 30; and, as a result, the print is only toned on its upper surface whereby it can be dried relatively quickly.

After the latent charge image has been formed on the paper sheet by the techniques described, the latent resistivity image previously formed in photoconductor layer 11 remains in said layer 11 even though its intensity has diminished to a relatively low value which depends on the material constituting layer 11 and its light-decay characteristics. To assure that this image is not printed again, an infrared lamp 37 is positioned adjacent the surface of drum 10 between charging roller 27 and the portion of drum 10 which is exposed to light from mirror 22. Lamp 37 operates to clear the previously transferred image from layer 11 before a next exposure is made.

It will be appreciated that the copier diagrammatically shown in FIG. 1 is capable of relatively high-speed operation inasmuch as drum 10 need not be charged, and since no toner need be applied thereto before copy paper is brought into contact with the drum. Moreover, the arrangement lends itself to the ready making of either positive or negative reproductions under the control of switch 27 which operates to determine the polarity of the charge produced on the paper sheet prior to the toning step.

FIG. 2 shows an alternative embodiment of the invention which makes use of the same principles already described. The mechanism shown in FIG. 2 is in large part similar to that described in reference to FIG. 1; and like numerals have accordingly been used for like parts.

In accordance with the modification of FIG. 2, scanning is accomplished by means of a stationary mirror 40 cooperating with a plurality of lenses 41 attached to an appropriate rotatable mount designated 42 and driven along a circular path by means of motor 18 which also drives drum 10. The curvature of screen 13 is chosen in relation to the path of motion of the several lenses 41 to assure that the distance from each lens to the original is always equal, and the distance between the original and the final image always remains constant. As a given lens 41 enters the scanning field, it projects an image of a document resting on screen 13 from mirror 40 onto mirror 22 and thence onto the surface 11 of drum 10. After a given lens 41 has completed a scanning operation, the next subsequent lens 41 enters the viewing field and projects a further image onto drum surface 11. With the three-lens arrangement shown in FIG. 2, and by appropriate choice of dimensions and gear ratios, three images of the original may be projected in sequence onto drum 10 during a single revolution of said drum. The use of multiple lenses 41 tends to eliminate "dead time" in the scanning cycle; and a three-lens arrangement is particularly desirable since, while one lens is scanning, the image may be projected between the other two lenses to mirror 22 and thence on to drum 10.

In the arrangement of FIG. 2, the paper supply is taken from a continuous roll 45 and passes via feed rollers 46 and a paper cutter mechanism 47 toward charging roller 25. The latent charge image produced on a length of said paper may then be developed by the techniques already described, and then dried as the sheet passes along an output conveyor 48.

While I have thus described preferred embodiments of the present invention, many variations will be suggested to those skilled in the art. The foregoing description is therefore meant to be illustrative only and not limitative of my invention. All such variations and modifications are in accord with the principles described are meant to fall within the scope of the appended claims.

Having thus described my invention, I claim:

1. A copier comprising a conductive member having a layer of photoconductive material thereon; means for supporting a document to be copied; light scanning means for scanning a document carried by said supporting means and for directing light onto said photoconductive layer during said scanning to produce a variable resistivity latent image in said layer, said scanning means including a pair of mirrors, a plurality of lenses mounted in angularly spaced relation to one another about

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a circular path located between said mirrors, light from said documents being directed toward one of said mirrors, being reflected therefrom through one of said lenses to the other of said mirrors, and then being reflected from said other mirror onto the surface of said drum, and means for rotating said lenses in unison about said path at a rate related to the speed of rotation of said drum, whereby light passes between said mirrors along an optical path directed through successive different ones of said lenses and passing between others of said lenses, the relative speeds of rotation of said lenses and drum being such that a completed image of said document is projected onto said drum during the time light from said document passes through a single one of said lenses; electrode means located closely adjacent said layer at a position relatively remote from said conductive member; a supply of insulating copy paper, means operative subsequent to the produc-

6

tion of said variable resistivity image in said layer for feeding an uncharged sheet of insulating copy paper from said supply into the region between said electrode means and said photoconductive layer with the opposing sides of said sheet being in firm contact with said electrode means and said layer respectively; energizing means for applying a direct current potential between said electrode means and conductive member, at a time subsequent to the production of said variable resistivity image in said layer and while said sheet is in said region, to produce a latent electrostatic charge image in said sheet corresponding to the variable resistivity latent image in said layer; means for feeding said image-charged sheet out of said region, a supply of electrostatically charged toner; and means for applying charged toner from said supply to said image charged sheet after it has been fed out of said region.

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