Jan. 23, 1968 J. G. A. LEIN ETAL 3,364,857

DUPLICATING

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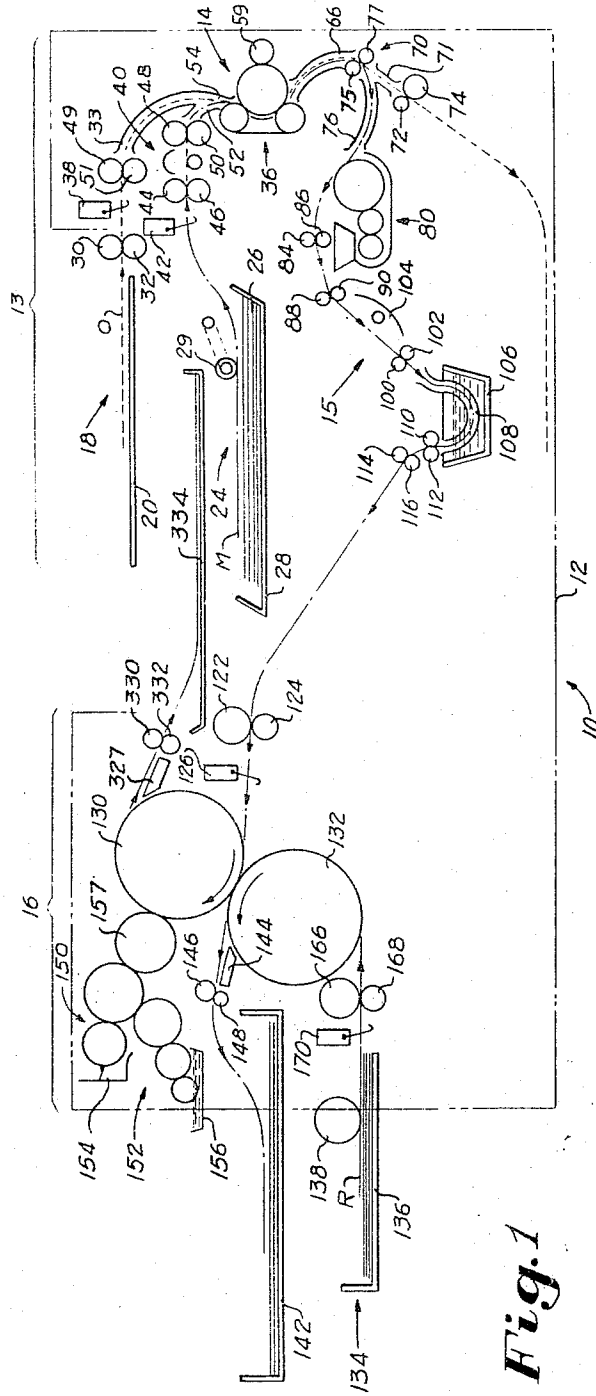


Fig. 1

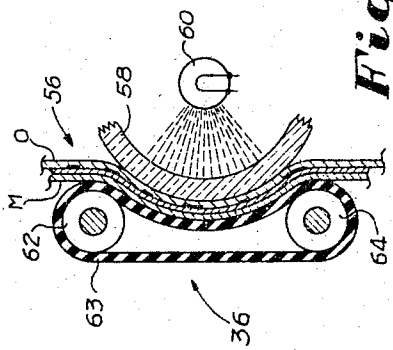


Fig. 2

INVENTORS.
JUERGEN G.A.LEIN
JOSEPH A.VERDERBER
BY Russell L. Post
ATTORNEY.

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DUPLICATING

Juergen G. A. Lein, Cleveland, and Joseph A. Verderber, Lyndhurst, Ohio, assignors to Addressograph Multigraph Corporation, Cleveland, Ohio, a corporation of Delaware

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ABSTRACT OF THE DISCLOSURE

An electrostatic sheet is charged, exposed, imaged with raw fusible resin based toner and then fused only to a partial degree in order to provide a useful ink receptive image for a limited number of printed copies, but requiring less space for a fusing structure and lower level requirements.

This invention relates generally to the production of multiple copies from an ordinary graphic original and more particularly relates to a method and means for duplicating copies of an original by integrating photoimaging techniques with the lithographic technique to automatically and rapidly produce high quality reproductions.

Duplicating processes and equipment heretofore known, among them lithographic duplicating, afford the capability of automatically turning out high quality copies once an imaged master of the graphic original has been provided. The output of such processes is, however, limited by the amount of time required to prepare masters for use on the equipment. Photographic techniques provide a simplified way of imparting an image to a flexible material that could be made to function as a lithographic master. One form of photographic procedure which is found especially suitable in practicing the invention is the photoelectrostatic technique which involves the application of a uniform electrostatic charge in the dark to the surface of a photoelectrostatic member comprising a photoconductive layer applied to a suitable support and selectively discharging the surface by exposure to a pattern of light and shadow in accordance with the graphic subject matter on the original to be copied. Exposure to the pattern of light and shadow results in a latent electrostatic image on the surface. Typical photoelectrostatic members employ a photoconductive material, usually zinc oxide particles, dispersed in an insulating resin binder applied to a conductive support such as paper. The resulting latent electrostatic image can be developed directly on the photoconductive surface by applying an electroscopic resin powder which adheres to the portions of the exposed surface corresponding to the image on the original. In the circumstance that the electroscopic powder is positive working, it will adhere to the charged latent image areas, and in the case of reversal powders they will be attracted to the light exposed areas. The powder image is then fixed by heat, solvent vapor, pressure or such chemical treatment as to permanently bond the image to the photoconductive surface.

The imaged photoconductive members can be converted into lithographic masters by chemically treating in a known manner the background or non-image areas, i.e., those areas not protected by the powder image, to render the zinc oxide resin binder layer hydrophilic.

Present techniques are somewhat inefficient since the operating parameters of the individual processes or techniques determine the maximum efficiency of the overall output. In particular where electrostatic photocopying is employed, the imaging technique calls for the complete fixing of the image in accordance with the demands of

photocopying systems having for their objective a finished photocopy.

As compared with the recognized photoelectrostatic means and methods for preparing copies, an integrated procedure has certain special merit. While a pure photoelectrostatic process has a limited range of recognition as to such variables as color, contrast, and the like for producing acceptable copies, it has been found that a photoelectrostatic copy which is marginal or unacceptable for direct use, can be converted to a master capable of duplicating fully acceptable and usable copies, since only a minutia of ink receptive deposition on the master will act as a sufficient base for a clearly interpretable printed image.

Accordingly, one object of the present invention is to provide a new and improved method and apparatus for duplicating.

Another object is to provide a method of duplicating which is simple, efficient, and capable of turning out reproductions of consistently high quality.

A further object is to provide a duplicating process that integrates the photoelectrostatic imaging techniques with the high quality printing capabilities of lithographic techniques through an activation step which permits rapid, efficient automatic operation.

In achieving the foregoing objects, one embodiment of the invention for making a faithful copy of an original which is inscribed with graphic subject matter, utilizes the photoelectrostatic imaging technique. This invention, in one aspect at least, involves the discovery that this technique is characterized by relative low cost photoelectrostatic members whose photoconductive properties permit them to be easily sensitized to light so that they are photographically responsive to patterns of light and shadow, and which are further readily and speedily convertible to lithographic printing plates without operator intervention.

In one form of the instant invention the exposure of the charged photoconductive member is accomplished by contact printing at an exposure station, that is, by exposing the charged light sensitive surface through the graphic original. It will be appreciated, however, that an optical system can also be used to equal advantage to project a light pattern onto the charged sheet, in which case the master could have graphic subject matter inscribed on both sides.

A feed-in station for receiving the graphic original and a supply source of photoconductive masters including feeding means therefor, are arranged in a generally horizontal array juxtaposed and feeding into the imaging segment of the apparatus.

The imaging segment comprises a charging means disposed in the path of the photoelectrostatic master which renders the photoconductive surface thereof sensitive to light, the contact exposure station, and a separating station where the original is separated from the master, and a developing station where the latent electrostatic image created by virtue of the light exposure through the original is developed by the application of an electroscopic resinous powder.

Means are provided for activating the photoconductive master to a lithographic master by passing said master through an activating zone which softens the resinous powder causing it to adhere to the surface of the master and then applying an aqueous solution to the imaged surface to chemically react that portion of the surface unprotected by the powder image portions. The activating zone is designed so that the master is rapidly processed rendering it effective as a lithographic master without having to perfect it as in the circumstance of preparing the usual photocopy. The activating zone is a significant

step in the duplicating process of this invention making possible the rapid, concurrent preparation of successive masters as they become available from the imaging device to the lithographic printing means. In other words, the activating zone provides the link between the imaging means and the lithographic printing means whereby the duplicating process may be integrated into one compact unit.

The activated master as it emerges from the activating zone is guided by a grid work forming a guide way to a position with its lead edge ready to be inserted into the lithographic printing means by suitable master insertion means. The necessary ink and moisture applicator rollers are brought into contact with the master for a predetermined number of revolutions inking up the master prior to the energization of the receiving sheet feeding means. At the conclusion of the pre-inking cycle the receiving sheet feeding means is actuated, beginning the printing cycle.

Many other objects and advantages of the present invention will become apparent from considering the following detailed description in conjunction with the drawings in which:

FIG. 1 is a longitudinal cross-section of apparatus in accordance with the invention, shown in diagrammatic form; and

FIG. 2 is an enlarged detail of the exposure arrangement.

Referring to the drawing, there is illustrated a duplicating apparatus indicated generally at **10**, including a housing indicated diagrammatically at **12**, and arranged in accordance with the principles characterizing the procedure of the present invention.

The apparatus is shown generally in FIG. 1 and embodies basically a master making segment **13** which includes a master imaging portion **14** and an activating portion **15**. As a master prepared in the master making segment **13** is completed, it is conducted through the activating portion **15** to a lithographic printing segment **16** where copies are produced by a lithographic printing technique.

The master making segment **13** includes an original feed-in station indicated generally at **18** provided near the upper portion of the housing **12** and including a generally horizontal platform **20** so positioned that an original O is directed into the imaging segment of the apparatus **14**. To provide means for supplying a photoelectrostatic master M to the imaging segment of the machine **10** there is a magazine assembly indicated generally as **24** containing a stack **26** of individual masters M in a generally horizontally disposed hopper **28**. A master starting roller **29** is arranged for cooperation with the next master to be fed and feeds it forward in response to the proper signal. The masters preferably are photoelectrostatic members comprising a substrate such as paper having coated thereon a photoconductive insulating layer such as zinc oxide particles dispersed in an insulating resin binder. While the feed-in platform **20** and the hopper **28** are preferably in a horizontal position for convenient handling of the original, it will be understood that other positions are also feasible.

The machine **10** is placed in operation by the feeding of the original O, face down, into the nip of a pair of rotating feed rolls **30, 32** operated by a magnetic clutch **39** (not shown) and disposed at an entry way to a paper guideway **33** leading to an exposure station indicated generally at **36**. A switch **38**, designated an "original ready" switch, is provided at a point just after rollers **30, 32** sensing the approach of the original O and serves to control the operation of the machine by signaling the entry of the original O. As a master M is advanced, it is led into the charging station **40**. As the forward edge of the master M supplied by the assembly **24** approaches the charging station **40**, a master detecting switch **42** is operated by the lead edge of the master to place the charging station **40** into operation so that the face of the master is provided with a uniform electrostatic charge. This operation of switch **42** by the master may also be used to energize the illumination source for imaging, and to control the forwarding of the original in timed relation with the master.

The master M is advanced into the charging station **40** by means of rollers **44, 46** with its photoconductive layer facing up. The charging means comprises a corona charging unit of a well-known type, although it will be understood that other means for applying an electrostatic charge may be employed if desired. A second roller set **48, 50** withdraws the charged master from the charging unit **40** into a master guideway **52**. The lead edge of the original O, which is now being advanced by a pair of rollers **49, 51**, and master M converge at the junction of guideways **33** and **52** which form a throat portion **54** leading to the exposure station **36**. In the throat portion **54** the elements are placed in contiguous superposed position with the graphic subject matter of the original facing toward the charged and now light sensitive surface of member M forming an assemblage **56**, as can be seen in FIG. 2.

Referring now more specifically to FIG. 2, the assemblage **56** is advanced into the exposure station **36** being received between the rotatively mounted transparent cylinder **58**, having axially disposed therein a fixed illumination source **60**, and a continuous, looped conveyor belt **63**, mounted about a pair of rollers **62, 64**, whose axes are parallel to the axis of rotation of the cylinder **58**, the belt **63** being disposed in a manner so as to be partially wrapped around the periphery of a portion of the cylinder **58**. As the assemblage enters between the cylinder **58** and the belt **63**, it is urged into intimate contact with the cylinder **58** so that the belt, assemblage and cylinder move in unison with the aid of a third roller **59** spring urged against the cylinder **58**. The assemblage thus passes the illumination source **60** which directs light onto the original, producing thereby a corresponding pattern of light and shadow on the surface of the master. The amount of the exposure may be governed by any one of several conventional controls, such as, for example, varying the energy input to the illumination source **60** or as by variably shading or blocking off the light source **60**. The time duration of the energization of charging station and the lamp is controlled in any suitable manner, e.g., by a suitable time delay activated by the switch **42** and set to provide sufficient time for the assemblage to clear the charging and exposure areas.

As the assemblage **56** emerges from the exposure station **36**, it is received into the guideway **66** which directs its movement toward the separating station **70**, defined by feed rollers **75** and **77**, at which point the original O is parted from the master M, the former being discharged from the master making segment **13** via a guideway **71** by the operation of a roller set **72, 74**, while the master proceeds along guideway **76** to the developing station **80**. In the developing station the master M has applied to the lower surface thereof which bears the latent image, electroscopic resin powder which adheres to the image portions. In the instant apparatus the well known magnetic brush type developer arrangement is employed, although other means for applying the powder may be employed.

When the master M leaves the developer station, it carries a loosely associated powder image which has been imparted in the imaging segment and thence proceeds to the activating means identified generally as **15**. This image has the appearance of a useful printed page, but is not fixed, and most of the image material would fall away by handling the sheet. A series of feed roller pairs **84, 86; 88, 90**; and **100, 102** convey the master from the developer past a source of heat **104** which serves merely to soften the electroscopic resin powder sufficiently to just adhere to the surface of the master M. Thereafter the master is advanced into a trough arrangement **106**

where it is conducted by a guide member **108** through a treating solution by a series of rolls **110**, **112**, **114** and **116** for the purpose of applying the treating solution to the surface of the master M thereby converting the non-image areas, that is the areas unprotected by the adhering resin powder, to a moisture receptive condition.

At this point it may be noted that one of the important features of the instant process and equipment is the speed of operation which provides a cycle time effective for use as an office machine. It has been discovered that the master does not require a degree of completion or copy quality comparable to that which an electrostatic copy needs to be usable, but can, on the contrary, produce high quality lithographic prints under circumstances which merely fix the powder image in place in a rudimentary manner. It will be appreciated that this has a notable affect upon the processing speed, because now the master can travel past the fusing or fixing point at a high linear speed without requiring temperatures which would either damage the paper or place impractical power supply requirements on the overall machine. As an example, sheets have been processed at the rate of seven inches per second with only ½ second total time in the fixing station.

Full fusing to a fixed image requires time. Space and production requirements often do not allow for the desired time. It is the discovery of this invention which has cut the fusing time requirements and allowed full machine production to proceed. This discovery is that an image which is fused to a degree which is too soft to be useful as a copy, will nevertheless allow conversion of the background to a hydrophilic condition and yet retain enough image to attract ink for satisfactory printing.

The degree of fusion is not critical. Full fusion is the ultimate, and will serve to print many copies. Anything less will provide an image which will produce a quality print, but will not withstand the rigors of printing for long print runs. Therefore, the degree of required fusion is directly related to the required printing life.

For definition purposes, the term "partial fusion" hereafter will refer to anything less than the ultimate fusing for a particular resin or compound. A fully fused image may be wiped vigorously by the human skin, and part of the image will be carried over to the background, but the image remains legible. A partially fused image will be eroded from the carrying surface by such treatment, and will be obliterated.

The degree of partial fusion will determine the amount of rubbing to remove the image, but will not change the fact that it is removable.

The activated master, in a somewhat moistened condition, next moves to the lithographic printing apparatus identified generally as **16** where it arrives in a ready position with its leading marging between a pair of slightly spaced insertion rolls **122**, **124** which in their customary inoperative condition are maintained out of rolling contact with one another. The leading edge of the master is against a locating stop (not shown) in readiness for an insertion cycle.

The lithographic printing means **16** comprises a master cylinder **130** (FIG. 1 and FIG. 3) and a copy cylinder **132** (FIG. 1 and FIG. 3) each being equipped with clamping means and adapted to retain respectively the master M and receiving sheet R thereon during the printing operation. To provide a copy receiving medium a supply source **134** of receiving sheets R are contained in a tray **136** positioned at the lower left hand portion of the housing **12**, said tray **136** being provided with receiving sheet feed means **138** rendered operative by a receiving sheet solenoid **139** (FIG. 3) for the sheets R. The receiving sheet R is clamped on to the copy cylinder **132** and passes through the area of contact between the cylinders **130** and **132**, receiving thereon the ink image, and is then discharged as a finished copy into a receiving tray **142**. The receiving sheet after having the ink image transferred thereto is positively lifted and guided by the blade member **144** and the roller set **146** and **148** after being unclamped from the surface of the copy cylinder **132**.

A train of ink feed rollers and a train of moisture feed rollers, identified respectively as **150** and **152**, supply ink and moisture from the ink reservoir **154** and moisture supply **156** to the surface of the master cylinder **130**, via a form roller **157**.

While preferred embodiments of the invention have been described and illustrated, it is to be understood that these are capable of variation and modification. Accordingly, the aim in the appended claims is to cover all such variations and modifications as may fall within the true spirit of the invention.

What is claimed is:

1. The method of making multiple reproductions of a graphic subject on receiving sheets from a master having a photoconductive layer thereon comprising the steps of:

electrostatically charging in the dark the photoconductive layer rendering it responsive to light,

exposing the charged layer to a pattern of light and shadow corresponding to the graphic subject producing a latent electrostatic image thereon,

applying electroscopic resin powder to said latent image bearing master forming a powder image thereon,

passing said master through an activating zone wherein said resin powder is caused to adhere to the photoconductive layer as an ink receptive image under lithographic printing procedures to the extent that mild human skin abrasion is capable of uncovering the photoconductive layer over at least portions of the previously toned imaged area, and the background thereafter is made hydrophilic rendering said photoconductive layer differentially receptive to ink and moisture,

applying ink and moisture to said activated member to deposit a transferable ink image corresponding to said graphic subject on the photoconductive layer, and

transferring said ink image to a receiving sheet.

2. The method of making multiple reproductions of a graphic subject on receiving sheets from a master having a photoconductive layer thereon comprising the steps of:

electrostatically charging in the dark the photoconductive layer rendering it responsive to light,

exposing the charged layer to a pattern of light and shadow corresponding to the graphic subject producing a latent electrostatic image thereon,

applying electroscopic resin powder to said latent image bearing master forming a powder image thereon,

passing said master through an activating zone wherein said resin powder is heated to a point below its fusion temperature but above room temperature and thereby softening the said resin powder to a degree which will cause the powder to adhere as an ink receptive image under lithographic printing procedures to the extent that mild human skin abrasion is capable of uncovering the photoconductive layer over at least portions of the previously toned image area, and the background thereafter is made hydrophilic rendering said photoconductive layer differentially receptive to ink and moisture,

applying ink and moisture to said activated member to deposit a transferable ink image corresponding to said graphic subject on the photoconductive layer, and

transferring said ink image to a receiving sheet.

3. The method of making multiple reproductions of a translucent original having graphic subject matter on one side thereof from a master having a photoconductive layer thereon comprising the steps of:

electrostatically charging the master in the dark rendering it responsive to light,

placing said master and said original in contiguous relation with one another forming an assemblage,

directing light onto the original side of the assemblage producing a latent electrostatic image on the master,

separating said master from said original,

applying electroscopic resin powder to said latent image bearing master forming a powder image thereon,

passing said master through an activating zone wherein said resin powder is caused to adhere to the photoconductive layer as an ink receptive image under lithographic printing procedures to the extent that mild human skin abrasion is capable of uncovering the photoconductive layer over at least portions of the previously toned imaged area, and the background thereafter is made hydrophilic rendering said photoconductive layer differentially receptive to ink and moisture,

applying ink and moisture to said activated master depositing a transferable ink image corresponding to said graphic subject on the photoconductive layer, and

transferring said ink image to a receiving sheet.

4. The method of making multiple reproductions of a translucent original having graphic subject matter on one side thereof onto receiving sheets from a master having a photoconductive layer thereon comprising the steps of:

electrostatically charging the master in the dark rendering it responsive to light,

placing said charged master in contiguous relation with the side of the original bearing the graphic subject matter,

directing light onto the other side of the original producing a reverse reading latent image on the master,

separating said master from said original,

applying electroscopic resin powder to said latent image bearing master forming a powder image thereon,

passing said master through an activating zone wherein said resin powder is heated to a temperature below its fusion temperature but above room temperature sufficient to soften the powder to where the resin powder is caused to adhere to the photoconductive layer as an ink receptive image under lithographic printing procedures to the extent that mild human skin abrasion is capable of uncovering the photoconductive layer over at least portions of the previously toned imaged area, and the background thereafter is made hydrophilic rendering said photoconductive layer differentially receptive to ink and moisture,

applying ink and moisture to said activated member depositing a transferable ink image,

transferring said ink image directly to a receiving sheet producing a right reading reproduction.

5. The method of making multiple reproductions of a graphic subject on receiving sheets from a master having a photoconductive layer thereon comprising the steps of:

electrostatically charging in the dark the photoconductive layer rendering it responsive to light,

exposing the charged layer to a pattern of light and shadow corresponding to the graphic subject producing a latent electrostatic image thereon,

applying electroscopic resin powder to said latent image bearing master forming a powder image thereon,

heating said resin powder to a softening point below its fusion temperature but above room temperature so that it adheres to the photoconductive layer as an ink receptive image under lithographic printing procedures to the extent that mild human skin abrasion is capable of uncovering the photoconductive layer over at least portions of the previously toned imaged area, and thereafter making the background hydrophilic, thereby rendering said photoconductive layer differentially receptive to ink and moisture,

applying ink and moisture to said activated member to deposit a transferable ink image corresponding to said graphic subject on the photoconductive layer, and

transferring said ink image to a receiving sheet.

6. The method of making multiple reproductions of a graphic subject on receiving sheets from a master having a photoconductive layer thereon comprising the steps of:

electrostatically charging in the dark the photoconductive layer rendering it responsive to light,

exposing the charged layer to a pattern of light and shadow corresponding to the graphic subject producing a latent electrostatic image thereon,

applying electroscopic resin powder to said latent image bearing master forming a powder image thereon,

passing said master through a heating zone at a speed such that the resin powder reaches a temperature at which said resin powder is heated to a softening point below its fusion temperature but above room temperature so that the resin powder adheres to the photoconductive layer as an ink receptive image under lithographic printing procedures to the extent that mild human skin abrasion is capable of uncovering the photoconductive layer over at least portions of the previously toned imaged area,

applying ink and moisture to said activated member to deposit a transferable ink image corresponding to said graphic subject on the photoconductive layer, and

transferring said ink image to a receiving sheet.

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DAVID KLEIN, *Primary Examiner.*