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METHOD AND APPARATUS FOR TRANSFERRING IMAGES
FROM XEROGRAPHIC TO METALLIC PLATES
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Fig. 1

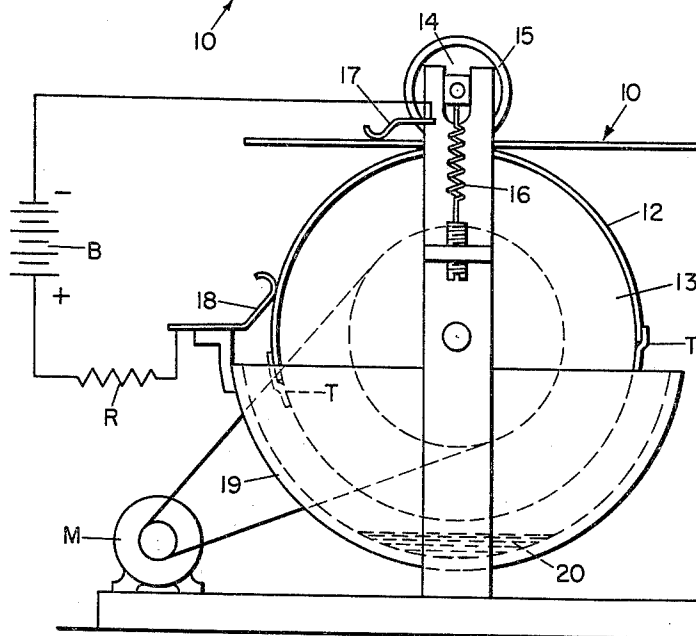
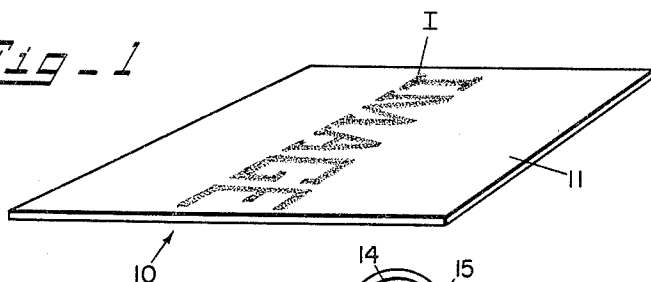


Fig. 2

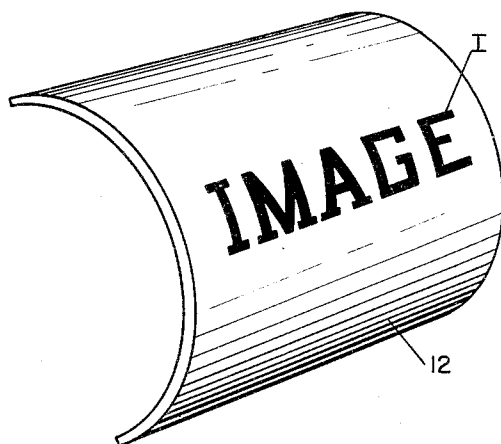


Fig. 3

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METHOD AND APPARATUS FOR TRANSFERRING IMAGES FROM XEROGRAPHIC TO METALLIC PLATES

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This invention relates to the production of high quality permanent images through xerography and, more particularly, to methods and apparatus for the transfer and fixing of developed xerographic images onto metallic plates.

In the art of xerography it is usual to place an electrostatic charge upon the surface of a xerographic plate which is composed of a conductive backing and a photoconductive insulating coating, for example, of selenium. The coating is a good insulator in darkness and will retain any electrostatic charge placed thereon. However, any area of the charged surface will be quickly discharged upon its exposure to light. When the charged plate is exposed to a pattern of light an electrostatic latent image is produced on the coating. This latent image may then be developed by cascading powder particles across the surface of the coating of the xerographic plate. These particles readily adhere to the charged areas on the plate surface and render the latent image visible.

Usually this developed image of powder particles is then transferred electrostatically to another surface and is fixed on the latter, for example, by heat fusing. However, this method of transfer and fixing is subject on occasion to certain limitations and is not always the method of choice, particularly for high quality photographic reproduction. It is, therefore, an object of this invention to provide method and apparatus for the production of high quality transfers of xerographic images and additionally to provide method and apparatus for fixing and fusing the transferred image.

Heretofore the transfer of a developed xerographic image to a conductive metallic plate such as a lithographic plate, for example, of zinc, has involved procedures as embodied, for example, in the Copley Patent No. 2,637,651 granted May 5, 1953. In effecting such transfer heretofore, the developed xerographic image has first been transferred from the xerographic plate to a non-conductive sheet, such as a piece of paper. Thereafter the image transferred to the sheet of paper has in turn been transferred to the conductive lithographic plate. This two-stage transfer procedure can in some instances be replaced by a single-stage transfer by the practice of the instant invention.

An object, therefore, of the present invention is to provide method and apparatus for direct single-stage transfer of a developed xerographic image to a conductive metallic surface, such as a zinc, aluminum or other metallic plate, without loss of quality, or dimensional changes. The transfer when practicing the instant invention is effected from one dimensionally stable surface to another.

In the transfer of a developed xerographic image directly to a conductive surface problems of fusing or fixing the transferred image permanently to the conductive surface are encountered. It is, therefore, still another object of this invention to provide novel methods and apparatus for permanently fusing the transferred image to the conductive surface. In a preferred embodiment the fusion is effected by vapor fixation with vapors of a suitable volatile solvent for the xerographic image material.

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Further objects and features of the invention will become apparent from the following specification and the accompanying drawing wherein:

FIG. 1 is a plan view of a xerographic powder image on a photoconductive insulative coating of a xerographic plate;

FIG. 2 is a diagrammatic view of transfer apparatus illustrative of a manner of transferring the powder image of FIG. 1 directly to a conductive metallic plate and of permanently fusing the transferred xerographic image thereto;

FIG. 3 is an elevation showing a lithographic plate to which an image has been transferred and fused;

Normally the transfer of a developed xerographic powder image from the xerographic plate to a piece of paper or other non-conductive medium is accomplished by placing the latter in contact with the coating of the xerographic plate bearing the powder image and then applying a charge to the paper. This results in transfer of the powder image from the coating to the paper by electrostatic attraction. Thereafter the transferred powder image may be fixed to the paper sheet or else in turn it may be transferred to a conductive sheet or plate.

The transfer to a paper sheet involves no difficult problems. If an attempt, however, is made to substitute a conductive sheet, for example, of zinc or other metal for the paper sheet, the transfer has not heretofore been found to be satisfactory principally because of the conductivity of the zinc or metallic plate. This conductivity makes it impossible to isolate an electric charge at any one localized area of the metal plate. If, therefore, for example, one point or area in the xerographic plate coating is a little too thin or if there happen to be pin holes or other similar defects in the coating, or if for any other reason electric charges can pass freely from the metal plate surface to the conductive backing member of the xerographic plate, then any charge applied to the zinc surface in its entirety sparks through to the xerographic backing member.

This problem is not material where the transfer plate is paper and non-conductive because any local discharges from the charged paper to the backing of the photoconductive coating is kept localized. Accordingly, in transfer to paper localized break-down points do not seriously affect the quality of the transferred image.

On the other hand, where the transfer plate is conductive a single point of electric break-down would result in failure of transfer over the entire area of the conductive transfer plate in contact with the xerographic plate. In addition, each point of local break-down results in permanent destruction of the photoconductive coating in an area surrounding the point of break-down.

It is to be noted also that a zinc or other metallic plate superposed upon the photoconductive selenium layer or coating of a xerographic plate in combination with the conductive backing member of the latter provides a comparatively high capacity condenser. Thus, if electric charge leaks through the photoconductive selenium layer or coating at any point a great deal of such charge can leak through because the entire condenser is discharged.

A basic principle utilized in the instant invention to avoid such problem is the maintenance merely of tangent line contact between the metallic lithographic plate and the xerographic plate during transfer of the developed powder image on the latter to the conductive metallic plate. This line contact is in substitution for area contact and this reduces the capacity of the condenser to a minimum. This reduction in capacity reduces the leakage charge available and also reduces the severity of electrical breakdowns when they occur.

In brief, the desired result is accomplished by apply-

ing the zinc or other conductive metallic plate to the surface of a drum and by feeding the drum-borne conductive plate to the xerographic plate surface which is positioned merely in tangent line contact under controlled pressure with the drum-borne plate. During such feeding the conductive plate and the xerographic backing plate are maintained with an electrical potential difference between them to cause transfer of the powder image from the xerographic plate to the conductive plate. Simultaneously or thereafter the image transferred to the conductive metal or zinc plate is fused thereto, and in the present embodiment of the invention such fusing may be achieved by any suitable means such as by vapor of a volatile solvent, heat, or the like.

Referring now particularly to the drawing and particularly to FIG. 1, the reference character 10 denotes a xerographic plate bearing a photoconductive surface or coating 11. A developed powder image I is shown upon the coating 11. In order to transfer the developed image I from the surface or coating 11 of the xerographic plate 10 to a metallic conductive plate 12, for example, of zinc, the conductive plate 12 is mounted in any desired manner, for example, by masking tape T, on the periphery of a transfer drum 13. If the plate 12 is of zinc, its grain surface is faced outermost. The masking tape T may be replaced by suitable quick acting release clamps (not shown) or by other mechanism. The drum 13 is rotated by any conventional means such as motor M. A smaller diametered pressure drum or roller 14 is supported in adjustable pressure relationship relative to the surface of the drum 13. The roller 14 is preferably of metal and is covered with a layer 15 of rubber or the like.

In order to transfer the powder image I of the xerographic plate 10 to the metal plate 12, the pressure of the roller 14 against the roller 13 is adjusted to a desirable figure by regulation of tension on springs 16 located at opposite ends of the shaft of roller 14, and the xerographic plate 10 with its developed powder image facing the outermost surface of metal plate 12 on the drum 13 is fed between the rollers 13 and 14 while an electrical potential difference, for example, from a battery B, is applied between the metal plate 12 and the xerographic plate 11. When the xerographic image material is negatively charged, as it conventionally is in commercial operation of xerography, the negative terminal of battery B is connected to a contact spring 17 that engages the conductive backing surface of the xerographic element 10. The positive terminal of battery B is connected through a resistor R and a contact spring 18 to the conductive plate 12 on drum 13. The polarities may be reversed, of course, if the image material is positively charged.

Since the conductive plate 12 and the xerographic plate 10 are merely in momentary line contact along any particular portion during image transfer, the break-down difficulties and electric discharges from plate 11 to plate 12 mentioned above have less likelihood of occurring, and, in particular, are much less serious when they do occur because of the many times decreased capacitance of the system. The speed of rotation of the drum 13 is selected for the most effective transfer of the image to the zinc surface 12.

The transfer drum 13 carrying the conductive plate 12 on its surface is partially surrounded or enclosed by a vapor-fusing chamber 19. This vapor-fusing chamber 19 contains liquid trichloroethylene 20 at its bottom. Other vapor-fusing agents compatible with the resin content of the developer powder may be used. Only the trichloroethylene vapors rising from the liquid 20 actually come into contact with the surface of the conductive plate 12. This vapor, which is a solvent for the resin content of the powder of the image transferred to the plate 12, causes the powder to fuse to the plate surface and become permanently fixed thereon. Thereafter the plate is removed from the drum 13 and with its perma-

nently carried image may be used for lithographic reproduction of the image transferred to it. If necessary, its curvature is eliminated by known ways, for example, by the application of vacuum to its back surface.

In practicing the invention as just described, it is found that the effectiveness of the transfer depends both upon the applied pressure, and the electrical potential between the plates. If excessive pressure is applied by the pressure roller 14, the usual result is hollow lines in images transferred to the lithographic plates. If insufficient pressure is applied, incomplete transfer is the result. Transfer forces of the order of $\frac{1}{8}$, $\frac{3}{8}$ and 1 pound per linear inch of pressure roller 14 in contact with the xerographic plate 10 during transfer have been used. The force of $\frac{3}{8}$ pound per linear inch gives the best over-all results. The springs 16 whose tensions may be adjusted serve to adjust the pressure of roller 14.

The value of the electrical potential difference to be applied by battery B between the plates 10 and 12 is governed by the frequency of occurrence of electrical breakdown and that value which gives the best image transfer. In practice it is found that the best over-all results occur when the voltage applied during transfer is of the order of from 250 volts to 335 volts and preferably is about 315 volts D.C. with a protective resistor R of the order of approximately 200,000 ohms between the battery B supplying the electrical potential difference and the transfer plate 12 when the thickness of the coating on the xerographic plate or element 10 is approximately 20 microns thick. It has been found in practice that increase of the resistor value to 40 megohms and of the applied voltage to approximately 405 volts has no beneficial effect.

In the apparatus of FIG. 2 as constructed, the drum 13 is approximately 10 $\frac{3}{8}$ " in diameter and 30 inches long while the pressure roller 14 has a diameter of approximately 3.2 inches covered with a $\frac{1}{16}$ " layer 15 of rubber and is also 30 inches long. The drum 13 is driven by a fractional horsepower motor M at approximately 4.8 r.p.m. Other dimensions and speeds may be used.

The image I on the surface of the xerographic plate or element 10 may be composed of any material which will fuse to a solid and permanent image body upon transfer and exposure to solvent vapors or other suitable fusing means. This includes, but is in no way limited to known xerographic developers such as pigmented resins including rosin modified phenol formaldehyde resins such as are disclosed in Copley U.S. Patent No. 2,659,670 issued November 17, 1953. One such preferred image material of this kind is available from The Haloid Company, Rochester, N.Y. under the name of XeroX Toner. When such material is used, the preferred solvent liquid 20 from which solvent vapors are emanated for vapor fusion in chamber 19 is trichloroethylene. The particular liquid used, however, will depend upon the particular image material. Generally it can be said that suitable solvents include, but are in no way limited to, chloroform, carbon tetrachloride, trichloroethylene, and other chlorinated solvents, the various Freons (believed to be fluorinated lower alkanes), aromatic and aliphatic hydrocarbons such as benzene, toluene, gasoline and gasoline fractions; and oxygenated solvents such as ethanol, acetone, ethyl acetate and other alcohols, ketones, esters and the like.

Before receiving the xerographic image, the lithographic plate 12 on drum 13 passes through the trichloroethylene vapor in the fusing chamber 19. This in no way affects the image transferred to the plate because any vapor that may have condensed on the plate evaporates before transfer occurs. After transfer, the image is passed with plate 12 through the fusing chamber 19 in contact with the trichloroethylene vapors emanating from liquid 20 which fuses the image onto the plate 12.

Although not intended as a limitation, it is believed that the vapors of liquid 20 act on image I on plate 12

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thereby causing it to become a more liquefied, tacky or adhesive body which upon evaporation of the vapor fuses into a solid permanent image body I permanently affixed to the plate 12. The fusion time after transfer is approximately ten seconds. Exposure to vapor for periods much longer than this causes smearing and loss of image resolution.

After vapor fusion and fixation are completed the conductive plates 12 are stripped from the drum 13 and are ready for use. The plates resulting with their transferred images may be used literally for thousands of impressions without deterioration of the transferred xerographic image.

Where vapor fusing as described herein is possible, it constitutes a simple way of fixing the transferred image and avoids problems that heat fixing might involve. Such problems might include a required fusion heat near or above the annealing point of the lithographic plate for fixing of the image to the plate which would of course not be practicable; more expensive arrangements for applying the fixing heat; and possible warpage and dimensional changes due to heat on the transferred image. Vapor fusion eliminates these problems entirely.

After the image has been transferred and fixed to the plate 12, the latter may be removed from the drum 13 and flattened by any conventional method, for example, by application of vacuum to the back of the plate.

While the plate 12 is described herein as a lithographic plate, it is contemplated that image transfer to any conductive plate may be effected and that thereafter the transferred image may be cut from the conductive plate to provide a template.

It is obvious that the xerographic plate may be curved and mounted on the drum 13 instead of the plate 12 and that the latter may be flat and moved in contact with the xerographic plate in the manner in which the latter is presently moved relative to the plate 12.

While specific embodiments of method and apparatus have been described and shown, variations within the scope of the claims are possible and are contemplated. There is no intention, therefore, of limitation to the exact details shown and described.

What is claimed is:

1. The method of transferring a powder image from a photoconductive surface of a xerographic plate directly to the surface of a conductive plate comprising the steps of forming one of said plates in an arc of substantially uniform radius, contacting the convex surface of the curved plate in a rolling motion against the surface of the other plate with the powder image therebetween, whereby the respective plate surfaces are progressively brought into line contact and, simultaneously with said rolling motion, applying an electrical potential between the xerographic plate and the conductive plate.

2. The method of transferring a powder image from a photoconductive surface of a xerographic plate directly to the surface of a conductive plate comprising the steps of forming one of said plates in an arc of substantially uniform radius, contacting the convex surface of the curved plate in a rolling motion against the surface of the other plate with the powder image therebetween, whereby the respective plate surfaces are progressively brought into line contact and, simultaneously with said rolling motion, applying an electrical potential between the xerographic plate and the conductive plate, applying substantially uniform pressure to maintain the plates in surface contact along their moving line of contact, and fixing the image transferred to the conductive plate.

3. The method of transferring a powder image from a photoconductive surface of a xerographic plate directly to the surface of a conductive plate comprising the steps of forming one of said plates in an arc of substantially uniform radius, contacting the convex surface of the curved plate in a rolling motion against the surface of the other plate with the powder image therebetween, where-

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by the respective plate surfaces are progressively brought into line contact and, simultaneously with said rolling motion, applying an electrical potential between the xerographic plate and the conductive plate, applying substantially uniform pressure to maintain the plates in surface contact along their moving line of contact, and vapor fusing the transferred image for permanent fixation on the conductive plate.

4. The process of claim 3, wherein the pressure is maintained at between $\frac{1}{2}$ and 1 lb. per linear inch of line contact.

5. The process of claim 3, wherein the electric potential applied between the plates is of the order of 200 volts D.C. to 335 volts D.C. and wherein the conductive plate is positively charged and the xerographic plate is negatively charged.

6. The process of claim 3, wherein vapor fusing is effected by trichloroethylene vapor.

7. The improvement in the process of transferring fusible powder images from a xerographic plate to a conductive lithographic plate comprising the steps of forming one of said plates in an arc of substantially uniform radius, contacting the convex surface of the curved plate in a rolling motion against the surface of the other plate with the powder image therebetween, thereby affecting moving line contact between the image bearing surface of the xerographic plate and the conductive lithographic plate and, simultaneously with such rolling motion, applying an electrical potential between the xerographic plate and the conductive lithographic plate, and fixing the image transferred onto the conductive lithographic plate.

8. An apparatus for transferring a powder image from a xerographic plate to a conductive plate, said apparatus including a cylindrical element for supporting a conductive plate, means to support said cylindrical element for rotational movement, clamp means on said cylindrical element for securing a conductive plate thereon whereby said conductive plate is maintained in the form of an arc of substantially uniform radius, means arranged in operative relation to said cylindrical element for urging a xerographic plate into tangential line contact with a conductive plate supported on said cylindrical element, and means to apply an electric potential between a xerographic plate and a conductive plate when arranged in said apparatus.

9. An apparatus for transferring a powder image from a xerographic plate to a conductive lithographic plate, said apparatus including support means for supporting one of said plates in the form of an arc of substantially uniform radius, journal means to support said means for rotational movement, pressure applying means arranged in operative relation to said support means for urging the other one of said plates into tangential contact with a plate supported on said first mentioned means, means to apply an electric potential between a xerographic plate and a conductive lithographic plate when arranged in said apparatus, and means for fixing the image transferred to said conductive lithographic plate.

10. Apparatus for transferring fusible powder images from a xerographic plate to a conductive lithographic plate including a cylindrical element for supporting one of said plates, means to support the cylindrical element for rotational movement, a vapor fusing chamber partially enclosing said cylindrical element, pressure applying means arranged in operative relation to said cylindrical element for urging said other plate into tangential line contact with said plate supported on said cylindrical element, means to apply an electric potential between a xerographic plate and a conductive lithographic plate when arranged in said apparatus, and means for fixing the image transferred to said conductive lithographic plate.

11. Apparatus for transferring powder images from a xerographic element to a flexible, conductive lithographic plate comprising a rotary drum, a pressure roller in tan-

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gential contact with said drum, means for affixing a lithographic plate in surface contact with said drum, means for rotating said drum, said xerographic element and said lithographic plate moving between said drum and pressure roller in line surface contact, and means for applying an electric potential difference between said plate and said element during their movement in line surface contact to effect electrostatic image transfer.

12. Apparatus for transferring fusible powder images from a xerographic element to a flexible, conductive lithographic plate comprising a rotary drum, a pressure roller in tangential contact with said drum, means for affixing a lithographic plate in surface contact with said drum, means for rotating said drum, said xerographic element and said lithographic plate moving between said drum and pressure roller in line surface contact, means for applying an electric potential difference between said plate and said element during their movement in line surface contact to effect electric image transfer, and means for fixing the image transferred to the lithographic plate.

13. Apparatus for transferring fusible powder images from a xerographic element to a flexible, conductive lithographic plate comprising a rotary drum, a pressure roller in tangential contact with said drum, means for affixing a lithographic plate in surface contact with said drum, means for rotating said drum, said xerographic element and said lithographic plate moving between said drum and pressure roller in line surface contact, and means for applying an electric potential difference between said plate and said element during their movement in line surface contact to effect electric image transfer, a vapor fixing chamber surrounding a portion of the

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periphery of said drum and containing a vaporizable liquid whose vapors permeate the chamber for contact with the lithographic plate to fix images transferred to said plate by vapor fusion.

14. The apparatus of claim 13 including spring means for adjusting the pressure of said pressure roller.

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