

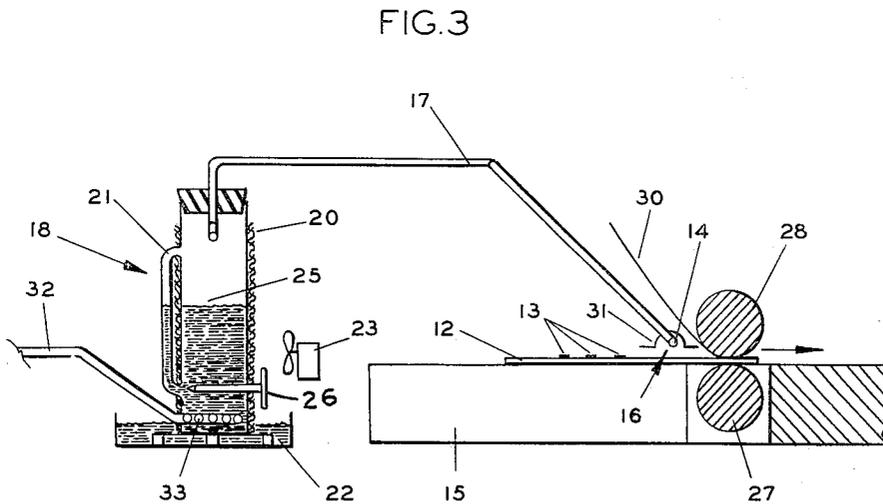
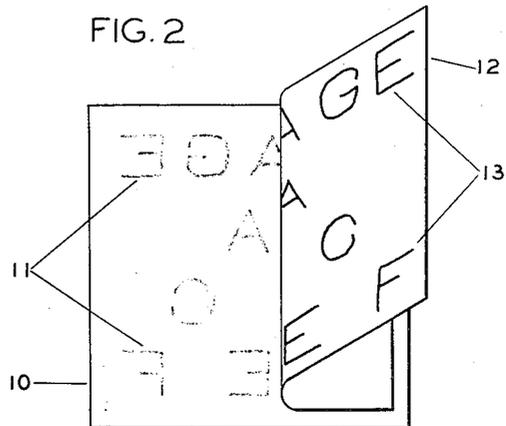
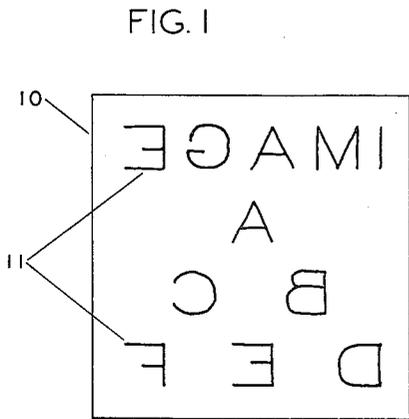
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TRANSFER AND FIXING METHOD

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TRANSFER AND FIXING METHOD

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

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 member and a photoconductive insulating coating. The coating is a good insulator in darkness and will retain the electrostatic charge placed thereon. However, an area of the charged surface will be quickly discharged upon exposure to light. When a charged plate is exposed to a pattern of light an electrostatic latent image is produced on the plate surface. The latent image may be developed by cascading particles across the surface of the xerographic plate, particles which will readily adhere to charged areas on the plate surface. Usually, this developed image body of particles is then transferred electrostatically to another surface, and is there fixed through heat fusing. However, this method of transfer and fixing is subject 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 disclose means, methods and apparatus for the production of high quality transfers of developed xerographic images. It is another object of this invention to provide means, methods and apparatus for fixing or fusing the transferred image.

A difficulty which has existed in the art of xerography is that of transferring the developed xerographic image to an electrically conducting surface such as zinc or aluminum. The use of electrostatic transfer to a conducting surface is presently very complicated and deterioration of quality of image may sometimes result. Where other known techniques are used the quality of the transferred image again may be substantially poorer than the originally developed xerographic image. It is therefore another object of this invention to provide means, methods and apparatus for transferring a developed xerographic image to a conducting surface without loss of quality.

A further object of this invention is that of improving the quality of transfer obtainable when transferring a developed xerographic image to a substantially rigid surface such as for example a zinc lithographic plate, thereby facilitating the use of xerography in new fields.

In transferring a developed xerographic image to some surfaces, such as a conducting or a rigid surface or the like, difficult problems of fusing or fixing the image permanently to the surfaces are encountered, and it is therefore still another object of this invention to provide novel means, methods and apparatus for permanently fusing a xerographic image to a surface.

Additional objects of the invention, will in part, be obvious and will, in part, become apparent from the following specification and drawings in which:

FIG. 1 is a plan view of a xerographic powder image on a surface;

FIG. 2 is a flow step showing the transfer of a xerographic powder image to an intermediate transfer material; and

FIG. 3 is a side view in cross section showing transfer apparatus according to one embodiment of the invention.

Referring to the drawings, in FIG. 1 a developed xerographic image 11 is shown on surface 10 which may be

a xerographic plate or any other surface on which a developed xerographic image has been placed. The developed xerographic image 11 shown in FIG. 1 is mirror reverse reading. Conventional xerography will produce a mirror reverse reading image, or if prisms and optical systems are used, a direct reading image. For purposes of describing this invention reference will be made to image 11 shown in the figures as reverse reading, but it is to be remembered that a direct reading developed xerographic image can be produced if desired and it is intended that the description which follows also includes a direct reading image.

FIG. 2 shows the transfer of the developed xerographic image 11 from surface 10 to sheet 12. The transferred image on sheet 12 is designated generally as 13. As can be seen in FIG. 2 the mirror reverse image 11 becomes a direct reading image 13 on transfer to another base and it can be said that a transfer from one surface to another throughout this invention results in a change of the direction of reading of the image.

The transfer to sheet 12 may be brought about in a number of ways such as through the use of electrostatics, or other process known to those in the art, or the like. One preferred method of transfer is disclosed in the now abandoned application Serial No. 397,917, filed December 14, 1953 by Andrus and bearing the name "Pressure Transfer of Xerographic Images" and continued in U.S. Patent 2,843,499 which issued on July 15, 1958 bearing the same name and inventor and includes transfer of an image body by pressure transfer to a softened dye transfer paper or the like. Sheet 12 should be any surface capable of accepting the image such as any sheet or web, or the like, or such surfaces as are disclosed in said pending application. This includes, but is in no way limited, to papers, films, gelatin coated surfaces, coated surfaces in general, plastics, cloths, and other forms of sheet material.

FIG. 3 represents one embodiment of a transfer apparatus, and although this invention is described in terms of this apparatus, it is to be understood that any other apparatus capable of achieving the same end results is intended to be included. As is shown in this drawing, sheet 12 is placed with image 13 exposed on transfer table 15 and is moved under vapor applicator 16 and into rollers 27 and 28 mounted in and above transfer table 15. Transfer surface 30, such as a sheet or web to which xerographic image 13 is transferred, is brought into contact with sheet 12 and image 13 as sheet 12 and transfer surface 30 feed through rollers 27 and 28 together. Vapor applicator 16 is composed of a shield 31 and an outlet tube 14. Outlet tube 14 extends across the width of transfer table 15, as does shield 31, and is provided with many uniformly cut and uniformly spaced outlets facing the direction of transfer table 15. Outlet tube 14 is connected to vaporizing tower 18 through connecting tube 17 which is composed of a single tube length extending from vaporizing tower 18 and a joint at which the single tube splits into 2 tube lengths each of these lengths extending to and terminating at an opposite extremity of outlet tube 14. Vaporizing tower 18 stands in water pan 22 and is surrounded by cloth covering 20. A thermometer 26 is positioned and disposed to indicate the temperature of the liquid 25 within vaporizing tower 18 while liquid level indicator 21 shows the amount of liquid 25 present. Air pressure is supplied to vaporizing tower 18 by conduit 32 and through bubbler manifold 33. Cooling fan 23 is positioned near vaporizing tower 18.

To place the transfer apparatus in operation air pressure is applied through conduit 32 and through bubbler manifold 33 to vaporizing tower 18. This pressure drives vapors of liquid 25 through tube 17 to vapor applicator 16 where vapors escape through the openings in outlet tube 14 and saturate the area below shield 31.

Although vaporizing tower 18 is always connected to outer areas through the openings of outlet tube 14, substantially no loss of vapors will result when the transfer apparatus is not in operation. The vapors themselves are generally heavier than air and if pressure is not supplied through conduit 32, the vapors will not escape upward out of vaporizing tower 18 and out of the openings of outlet tube 14. Of course a valve or pet-cock may be inserted in tube 17 to further assure that vapors do not escape.

Sheet 12 carrying powder image 13 moves into rollers 27 and 28 after passing beneath the saturated area below shield 31. The vapors of liquid 25, vapors which act as a solvent for the image material making up image 13, contact image 13 as those areas on surface 12 carrying image material move beneath vapor applicator 16 and are absorbed into the image material and dissolved therein. After removal from rollers 27 and 28, transfer surface 30 is separated from sheet 12 and the vapors absorbed by the image material are allowed to evaporate. The image will appear on transfer surface 30 and will be permanently fused to this surface.

Liquid 25 should be a volatile liquid, the vapors of which act as a solvent for the materials making up image 13. The particular liquid used will depend on the particular image material and 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; oxygenated solvents such as ethanol, acetone, ethyl acetate and other alcohols, ketones, esters and the like.

Although it is not intended to limit in any way this invention, and although other explanations are possible, it is now believed that the vapors of liquid 25 act on image 13 thereby causing it to become a more liquified tacky or adhesive body. If allowed to stand the image would fuse into a solid permanent image body and permanently affix itself to sheet 12 on which it rests. However, when subjected to even pressures by rollers 27 and 28, while in contact with transfer surface 30, tacky image 13 adheres to and thus fuses and permanently affixes itself to that surface presented to it which will hold the tacky image adhesively with more tenacity than the other surface. For example, if sheet 12 is one to which a tacky image will not readily adhere, the even pressure applied by rollers 27 and 28 will cause transfer surface 30 as well as sheet 12 to be pressed against image 13 with equal force, and when separation of sheet 12 from transfer surface 30 is accomplished, image body 13 will have transferred to transfer surface 30 and will permanently affix and fuse thereon.

To facilitate the transfer of image 13 from sheet 12 to transfer surface 30 the relative abilities of the surfaces to hold the image in its tacky state must be taken into account. For example, if both sheet 12 and transfer surface 30 tend to hold the image with equal holding force, the image material will divide between the surfaces when sheet 12 and transfer surface 30 are separated. Another factor which must be considered is the cohesive force of the image body itself as it relates to the adhesive tendencies of the surfaces presented to it, for example, if the adhesive properties of sheet 12 with respect to the image are greater than the cohesive forces of the exposed tacky image, a portion of the image body will affix itself to sheet 12 and remain there after separation. To avoid such happenings and to bring about complete transfer of image 13 to transfer surface 30, it is desirable that image 13 after exposure to image soluble vapors be incompatible with the surface on which it rests, or sheet 12, and that it associate readily with the surface against which it is pressed, or transfer surface 30. By "incompatible" it is meant that the image material in its tacky state and as it

solidifies does not adhere substantially to the surface toward which it is incompatible. This incompatibility may be an inherent property of the image material with respect to the image-bearing surface or it may be accomplished by treatment such as, for example, moistening the surface with water.

In the preferred embodiment of this invention, image 11 on surface 10 is transferred to a sheet material carrying a moist and swollen hydrophilic layer and preferably a gelatin coating. This material carrying a gelatin coating is in this invention sheet 12 which is then pressed against surface 10 bringing about a transfer of image 11 to sheet 12 whereon image 13 is found. In this invention sheet 12 while still damp is injected into the transfer apparatus and therein subjected to exposure to vapors and pressing between rollers 27 and 28 against transfer surface 30. Image 13, when exposed to vapors, becomes a sticky, tacky image body which is immiscible with the damp gelatin layer and while within and on, it remains a separate body which will readily adhere to a surface presented to it. When this sticky, tacky, adhesive form of image contacts transfer surface 30, while between rollers 27 and 28, it adheres with more tenacity to transfer surface 30 than to surface 12. In this embodiment, therefore, incompatibility has been accomplished by means of immiscibility. When separation is accomplished substantially all of the image material is transferred to transfer surface 30 on which it solidifies.

Transfer surface 30 should be any surface to which the image will readily adhere. This includes, but is in no way limited to papers, web or sheet materials, coated surfaces, metallic materials, plastics and the like. In producing lithographic plates according to this invention, fine results have been obtained using grained and ungrained zinc surfaces, grained and ungrained aluminum surfaces, bimetallic lithographic plates, steel, and the like including various other lithographic plate materials and metals used in template making.

The image may be composed of any material which will fuse to a solid and permanent image body when exposed to solvent vapors. 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 2,659,670. One such preferred image material of this kind is available from The Haloid Company, Rochester, N.Y. under the name XeroX Toner. When this image material is used it is preferred that trichloroethylene be employed as liquid 25.

In order to consistently achieve good transfers the vapor temperature as it relates to the image material temperature must be controlled. It has been found that when too little solvent is absorbed by the image, the powder will not transfer to the transfer surface, while when too much solvent is absorbed by the image material, the image becomes too fluid and spreads as it is squeezed between the rollers.

If the temperature of the image material as it relates to the temperature of the vapors is too low, the vapor condenses readily on the image particles, causing the image to absorb too much solvent, thereby making the image too fluid to transfer properly. On the other hand if the temperature of the image material in respect to the temperature of the vapors is too high, then sufficient solvent is not absorbed and the image will not transfer. It is preferred that condensation be avoided as an aid to absorption of the proper amount of solvent in the image materials and as a means of promoting efficient transfers.

When condensation occurs, not only will the image body become too fluid, but droplets of liquid 25 will form on the matrix on which, or in which, the image body rests. These droplets will appear both unevenly in amount and without uniformity of position. They have no beneficial effect to the process of transfer but can act detrimentally, as for example by spreading unevenly portions of the image or making portions of the image

too fluid to transfer, or by somehow reacting with the matrix itself or the like. This is another reason condensation should be avoided.

It has been found that condensation of vapors striking the image particles and the matrix is prevented when liquid 25 is at a temperature of from 10 to 20° F. cooler than the temperature of the image material and the matrix which generally means 10 to 20° F. cooler than room temperature and preferably 15° F. cooler.

One very convenient means of temperature control is accomplished by standing vaporizing tower 18 in water pan 22 so that cooling cloth 20 absorbs water and becomes saturated. Fan 23, which is manually controlled, is allowed to blow toward cooling cloth 20 until the temperature as read on thermometer 26 of liquid 25 is within the desired range. Fan 23 is turned off and on as desired, thereby keeping the temperature of liquid 25 in the preferred range while the transfer apparatus is in use. Thermostatic means, of course, could be devised to operate the fan automatically, and also other ways of controlling the vapor temperature are possible and are intended to be encompassed within the scope of this invention.

It has also been found that the concentration of vapor in the vapor air mixture has a decided effect on transfer. Using trichloroethylene as the vapor, a suitable range appears to be a concentration of between 15 to 50 percent of vapor in air, and optimum results have been attained using a concentration of 25 percent vapor by weight in air.

The air pressure supplied through conduit 32 is dependent on a number of factors such as for example the desired saturation of the vapors in air beneath shield 32, the rate of flow required to maintain saturation, the geometry of the tubes 17 and 14 and the openings of outlet tube 14 and the like. The preferred air pressure supplied should produce air flow through vaporizing tower 18 at a rate of about 20 to 40 liters per minute.

For best results the image material should be exposed for a closely controlled time to the vapors. Sheet 12 moves under vapor applicator 16 as it is drawn through rollers 27 and 28. Preferably these rollers are driven by a motor (not shown) at a rate causing sheet 12 to move under vapor applicator 16 so that it takes the desired amount of time for image material to enter and pass under and leave the area directly under vapor applicator 16. Using trichloroethylene vapors on known xerographic developers requires an exposure of from 1 to 3 seconds, and preferably for 2 seconds, and exposure generally will vary depending on the vapors used, the image material, the concentration and the like.

Rollers 27 and 28 may be rubber rollers or the like. The amount of pressure they exert will depend on many factors, such as for example the image material, the transfer surface, sheet 12, the room temperature and the like. Generally a force of from 2 to 10 pounds per linear inch has been found to produce good transfers where normal xerographic developers are exposed to trichloroethylene vapors within the other preferred limitations of this invention.

Following the movement of transfer surface 30 and sheet 12 through rollers 27 and 28, sheet 12 is separated out of contact with transfer surface 30 leaving a transferred image on transfer surface 30. A time delay of a few seconds and preferably from 4 to 8 seconds is desirable before the transferred image is used for example as the image to be inked on a lithographic plate. This time delay will allow absorbed vapors to evaporate thereby solidifying the image. Generally the fused image will need no further treatment; however, for some applications of the transferred image it may be desirable to further assure permanence through exposure to heat. It is pointed out that usually any time delay necessary for the image to solidify and to permanently fuse will be less than the time it takes to attach transfer surface 30 to other equipment for further utilization and so generally

it will not be necessary to make provisions for the time lapse required for evaporation.

In carrying out transfers according to this invention high quality images with good resolution are obtainable.

The final image is a fused permanent image which is permanently affixed to transfer surface 30, whether this surface be conductive or not, and whether it be rigid or not.

Although this invention has been described in terms of specific embodiments, it is intended to broadly cover this invention within the scope and spirit of the appended claims.

What is claimed is:

1. A method of transferring a tackifiable developed xerographic powder image, the steps comprising exposing said image resting on a support base to vapors of a solvent for the image material, said support base being incompatible with said image material when said image material is in a tacky state, pressing said support base carrying said image after exposure to said vapors and while in a tacky state against a transfer surface of a transfer member with said tacky image between said support base and said transfer surface, said transfer surface comprising a material to which said tacky image adheres tenaciously causing adhesion of the developed and tacky image to said surface while said support base and transfer surface are pressed together, separating said support base from said transfer surface with said image adhering to said transfer surface, and solidifying said exposed image by evaporating said vapors from the image material.

2. A method of forming a fused transferred permanent xerographic image on a surface comprising transferring a developed xerographic image of tackifiable electroscopic powder particles on a xerographic plate to a support base carrying a water impregnated hydrophilic layer by pressing said image against said hydrophilic layer, exposing said transferred powder image on said support base to vapors of a solvent for said electroscopic powder particles to render said powder image tacky, said vapors being held at a cooler temperature than said powder particles, pressing said support base carrying the tacky xerographic image against a transfer surface of a transfer member with said tacky image between said transfer member and said support base between rollers, said tacky image holding with greater tenacity to said transfer surface than to said hydrophilic layer, separating said support base from said transfer surface with said image on said transfer surface, and solidifying said image into a fused transferred permanent xerographic image body on said transfer surface by allowing said solvent vapors to evaporate from said image body.

3. A method of transferring a tackifiable developed xerographic powder image to a substantially rigid surface comprising transferring a developed xerographic image to a support base characterized by the fact that the image body after exposure to solvent vapors is incompatible with said support base while in a tacky condition, exposing said image on said support base to trichloroethylene vapors said vapors being held at a temperature differential of from 10 to 20° F. cooler than said image material, each portion of said image material being exposed to said vapors for a maximum of 3 seconds and for sufficient time to cause said image to become tacky, pressing said tacky image on said support base against the surface of a substantially rigid member using a maximum of 10 pounds of force per linear inch, said tacky image being attracted with greater tenacity to said surface of said rigid member than to the surface of said support base, separating said support base from said substantially rigid member with said image adhering to said surface of said rigid member, and allowing said vapors to evaporate from said image body thereby forming a permanently fused image on said substantially rigid member.

4. A method of transferring a tackifiable developed xerographic powder image to a conductive rigid member

comprising transferring said developed xerographic image to a support base characterized by the fact that the image body after exposure to solvent vapors and while in a tacky condition is immiscible with said support base, exposing said image on said support base to solvent vapors to render said image tacky, pressing said tacky image on said support base against a conductive rigid member using a force of from 2 to 10 pounds per linear inch, said conductive rigid member having characteristics to hold tenaciously said tacky image causing said image to bond to said rigid member while said tacky image is pressed against said rigid member, and separating said support base from said conductive rigid member thereby forming a permanently fused image on said conductive rigid member.

5. In a method of forming a metal base lithographic plate wherein a xerographic plate is charged exposed developed with powder particles and the developed powder image is transferred to a support base the improvement comprising using as the support base a gelatin coated paper which has been wetted and blotted to remove excess water and then pressed against said xerographic plate carrying said developed image to effect a transfer, exposing said gelatin coated paper carrying said image while still in a damp condition to trichloroethylene vapors to render said developed powder image tacky, said vapors being held at a temperature differential of about 15° F. cooler than said image material, said tacky image being immiscible with said support base, pressing said damp gelatin coated paper carrying said tacky image against a metal base lithographic plate immediately after exposure to said vapors with said tacky image between said plate and said support base, said plate having surface characteristics to hold said tacky image tenaciously when compared to the immiscibility of said tacky image with said support base, separating said gelatin coated paper from said lithographic plate causing said tacky image to adhere to said plate, and evaporating said vapors from the image material thereby solidifying and permanently forming said image on said lithographic plate.

6. A method of transferring a developed xerographic image, which image comprises a tackifiable resin powder in image configuration, the steps comprising forming said developed xerographic image on an image-bearing member having a surface incompatible with a solvent-tackified resin image, tackifying said xerographic image by

exposing the image to vapors of a volatile solvent for said image to cause absorption of solvent into the image, pressing said image-bearing surface against an image-receiving member while said image is in a tacky condition with said image between said image-bearing member and said image receiving member, the surface of said image receiving member in contact with said tacky image being characterized by its ability to hold said tacky image tenaciously as compared to the incompatibility between said tacky image and said image-bearing surface to cause said tacky image to adhere to said image receiving member, separating the image-bearing member from the image-receiving member with said image now adhering to said image receiving member and solidifying the image by evaporating the solvent therefrom.

7. A method of transferring a tackifiable developed xerographic powder image to a lithographic plate, which image comprises a resin powder in image configuration which becomes tacky on exposure to trichloroethylene vapors, the steps comprising forming said developed xerographic image on damp gelatin-coated paper, tackifying said xerographic image by exposing the image to a substantially saturated atmosphere of trichloroethylene vapors to cause absorption of said trichloroethylene vapors into the image, pressing said damp gelatin-coated paper carrying said tacky image against the lithographic plate, said plate being characterized by its ability to hold said image tenaciously as compared to the immiscibility of said tacky image with said damp gelatin-coated paper causing said tacky image to adhere to said plate when pressed against said plate between said gelatin-coated paper and said plate, separating the gelatin-coated paper from the lithographic plate with the transfer image adhering to said plate, and solidifying the image.

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