

June 27, 1961

C. F. CARLSON
METHOD AND APPARATUS FOR TRANSFERRING
AND FIXING XEROGRAPHIC IMAGES
Filed Dec. 29, 1955

2,990,278

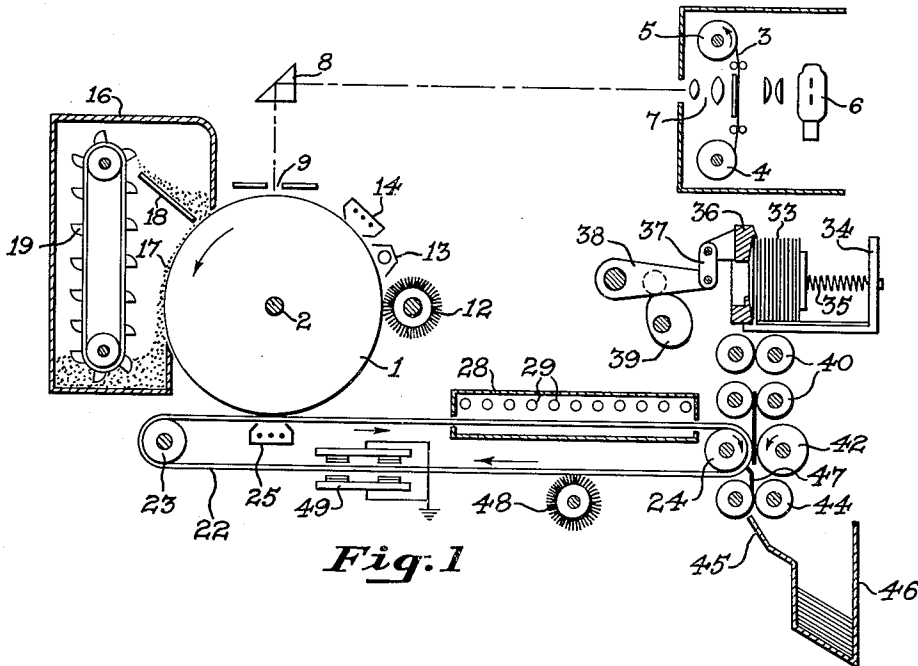


Fig. 1

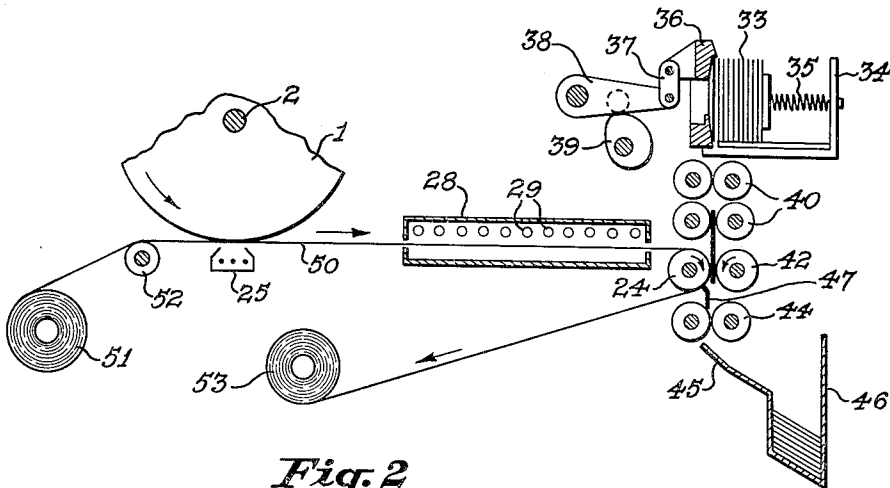


Fig. 2

INVENTOR.
CHESTER F. CARLSON

BY *Frazer & Skindler*

ATTORNEY

1

2,990,278

METHOD AND APPARATUS FOR TRANSFERRING AND FIXING XEROGRAPHIC IMAGES

Chester F. Carlson, Pittsford, N.Y., assignor, by mesne assignments, to Haloid Xerox Inc., Rochester, N.Y., a corporation of New York

Filed Dec. 29, 1955, Ser. No. 556,326

18 Claims. (Cl. 96—1)

This invention relates to the field of xerography and, particularly, to an improved method of and apparatus for transferring and fixing a xerographic powder image on a support.

More specifically, the invention relates to an improved method and apparatus for transferring and fixing xerographic powder images on support surfaces of a type which may be injured by the use of conventional xerographic image fixing techniques, or in applications in which conventional fixing techniques cannot conveniently be employed. For example, the conventional heat fusing or vapor solvent fixing techniques that are widely employed in xerographic installations cannot always be employed in applications in which there is a critical requirement to maintain a predetermined moisture content or the dimensional stability of the support material.

Such conditions occur, for example, in the formation of xerographic images on perforated record cards of the type used in punched card tabulating systems. In addition, when xerographic powder images are to be formed on metal layers such as grained zinc or aluminum lithographic plates or electroplated metal layers on plastic insulators which are used as intermediates in printed circuit manufacture, it is found that the metal layers are not only frequently damaged by heat fusion of the xerographic powder image but are also not well adapted to the electrostatic transfer of the xerographic powder image thereto because of their conductivity or rigidity or both. In order to apply xerographic powder images to surfaces of the type mentioned, it has been found that the powder image may be transferred to smooth-surfaced intermediate support material, tackified while in contact with the intermediate support and, while the powder image is in tackified condition, pressed against the final support surface so that the tackified image is forced into the interstices thereof and forms a firm bond therewith, whereby the powder image remains adhered to the final support surface when it is separated from the intermediate support material. In the process of xerography, for example, as disclosed in Carlson Patent 2,297,691, issued October 6, 1952, a xerographic plate comprising a photoconductive insulating material on a conductive backing is given a uniform electric charge over its surface and is then exposed to the subject matter to be reproduced, usually by conventional projection techniques. This exposure discharges the plate areas in accordance with the light intensity which reaches them, and thereby creates an electrostatic latent image on or in the plate coating. Development of the image is effected with a finely-divided material such as an electroscopic powder which is brought into contact with the photoconductive insulating material and is held thereon electrostatically in a pattern corresponding to the electrostatic latent image. Thereafter, the developed xerographic image is transferred to a support material to which it may be fixed by any suitable means.

The developing material employed may be of any convenient type suitable to the requirements of a particular application. For example, in line copy applications, the developing material may be of the type disclosed in Walkup Patent 2,618,551, issued November 18, 1952, wherein a pigmented powdered resin is combined with coated glass bead carriers and is thereby triboelectrically charged to a polarity opposite to that of the electrostatic

2

latent image to be developed. Subsequently, the combined material is cascaded over the latent image whereby the resin particles are caused to adhere electrostatically to the charged portions of the image. Various other pigmented resins, usually having a polystyrene base, are available to suit specific applications. Materials of the type disclosed in Copley Patent No. 2,659,570, issued November 17, 1953, may also be employed.

Regardless of the type of development, the developing material particles are held to the support entirely by electrostatic attraction at this stage of the process, and, thus, are subject to being smudged during handling. Therefore, whenever an electrostatic image is developed to form a xerographic powder image, and such powder image is then transferred to another support material, it is generally required that the powder image subsequently be fixed to the ultimate support material on which it is formed. The type of fixing technique that is employed depends on the requirements of any given installation. For example, the pigmented resins used for line copy and/or half-tone work are commonly fixed by heat fusing, whereby the powder particles of the image are sufficiently tackified to flow into the interstices of the support material and form a firm bond therewith. Upon cooling of the image, the bonded pigment forms a permanent record of the copy to be reproduced.

The term "tackified," and the several variant forms thereof used throughout the specification, is employed to define the condition of the powder particles that form the copy pattern when treated in a manner such that the individual powder particles soften and coalesce, and in which state they become sticky and readily adhere to other surfaces. Although this condition necessarily requires a flowing-together of the powder particles to effect a thorough fusion thereof, it is to be understood that the extent of such flowing is not sufficient to extend beyond the boundary of the pattern in which the particles are formed.

The technique of heat fixing xerographic images has been found to be highly suitable for many types of applications and is in wide commercial use. However, under certain conditions, the application of heat may adversely affect the dimensional stability or other physical characteristics of the support on which the xerographic image is to be formed.

A typical example of such a situation arises in the field of record controlled machines wherein coded perforations representing alphabetic and/or numeric characters are punched in record cards or in tape and serve to control various operations of a wide variety of machines, such as accounting machines, tabulating machines, computers, etc. In this field of endeavor it has been found highly desirable to form visible xerographic images on the record cards to supplement or duplicate the perforated data indications and thereby amplify or facilitate the use of such records in their regular applications. However, it has also been found that the conventional xerographic image heat fixing technique mentioned above cannot conveniently be employed under all conditions without occasionally affecting the dimensional stability and/or moisture content of a record card. For example, the application of excessive heat to fix the image can, under certain conditions, result in differential expansion or contraction of portions of the card to an extent to make it unfit for use in its normally intended operation. Obviously, any change in the physical characteristics of the record cards that would affect their operability during card sensing, card feeding, or card sorting operations cannot be tolerated.

Heretofore, various techniques have been proposed whereby a xerographic powder image is fixed in a manner

to form a permanent image on a support such as a perforated record card or similar device without affecting the dimensional stability and/or moisture content thereof, and whereby the normal utilization characteristics of the support remain unimpaired. Although such xerographic powder image fixing techniques are well suited for use in many applications, it has been found that further improvements may be made in the formation of permanent visible images by xerographic techniques whereby the dimensional stability and utilization characteristics of support material may be preserved and, at the same time, may be applied to form xerographic images on support materials of types which, heretofore, were not considered to be conveniently or practically adapted to use in xerographic systems.

The principal object of the present invention is to provide an improved method for transferring and heat fixing a xerographic powder image on a support without affecting the dimensional stability or utilization characteristics of such support. A further object is to provide an improved method for transferring and heat fixing a xerographic image on a support without the requirement for specialized support material. A further object is to provide an improved method and apparatus for transferring and heat fixing xerographic powder images on perforated record cards, metal sheets, electroplated metal layers, and similar types of support material. A further object of the invention is to provide an improved apparatus and method for transferring and heat fixing xerographic powder images in a rapid, economical and efficient manner.

These and other objects are attained, in accordance with the method of the invention, in conjunction with a xerographic process wherein an electrostatically charged xerographic plate is exposed to a projected image to form an electrostatic latent image on the plate corresponding to the projected image and the plate is developed with oppositely charged particles of tackifiable developing material that are attracted to the latent image to form a xerographic powder image corresponding to the projected image, transferring the xerographic powder image to a smooth-surfaced intermediate support material, heat tackifying the powder image while in contact with the intermediate support material, superposing a final support material on the tackified powder image, pressing the final support material into surface contact with the intermediate support material, and separating the final support material from the intermediate support material, whereby, during the separating step, the tackified image material adheres to the surface of the final support material and is fixed thereon as it cools and hardens.

Typical arrangements for carrying out the method of the invention are shown in the accompanying drawings, in which:

FIG. 1 is a schematic sectional view of a conventional type of xerographic processing machine adapted to perform the method of the invention and employing a smooth-surfaced continuous belt as the intermediate support surface; and

FIG. 2 is a schematic sectional view of apparatus similar to that shown in FIG. 1 but employing an expendable smooth-surface paper web as the intermediate support material.

In the various embodiments of xerographic processes currently in general commercial use, the basic process is essentially the same as that disclosed in the above mentioned Carlson patent, but differs in some respects in the several materials and techniques employed, depending upon the type of copy to be reproduced. For example, in the reproduction of line copy, the xerographic plate currently in commercial use normally has a photoconductive layer of amorphous selenium deposited on a metal backing plate, usually of aluminum, although it also may be made of brass or other materials. Such

a plate is usually charged by moving it relatively to a fine wire assembly held at high potential, so that corona current is emitted, whereby a uniform electrostatic charge is applied to the photoconductive surface of the plate.

In the dark, this surface can accept and hold an electrostatic charge but when it is exposed to light or other form of radiation, the charge decays in an amount that is substantially proportional to the radiation. Thus, after charging and exposing to the subject matter to be reproduced, a charge pattern remains on the plate surface in the form of an electrostatic latent image of the subject. In most systems, the electrostatic image is a mirror image or reverse reading reproduction of the original subject matter. This electrostatic image is then developed by dusting it with a finely divided powder that has been given an electrostatic charge of opposite sign to the charge comprising the electrostatic latent image on the xerographic plate.

After development, the reverse reading powder image is usually transferred to a sheet of support material, by means of electrostatic transfer techniques, to form a direct reading powder particle image on the support material. This is accomplished by placing the sheet of support material over the powder particle image on the xerographic plate, and by applying corona discharge uniformly to the exposed surface of the support material to charge it to a polarity opposite to that of the charge on the particles forming the powder image. This causes the powder particles to adhere electrostatically to the support material so that, when the support material is separated from the plate, substantially all of the pigmented resin particles remain on the support material. Thereafter, in most applications, the xerographic powder image is fixed on the support material either by heat fusing or by exposing the powder image to an atmosphere of solvent for the particular type of resin employed.

In the practice of the method of the present invention, an electrostatic latent image of the subject matter to be reproduced is formed on a xerographic plate, as in general commercial practice. However, in order to obtain a direct reading image on the final support material, it is preferred at this point that the electrostatic latent image be formed in direct reading position on the xerographic plate instead of in reverse reading position, as in usual practice. This may be accomplished conveniently by placing an optical image reversing device, such as a prism, in the light path between the subject matter and the xerographic plate, or by turning the film over in the projector.

The electrostatic image on the xerographic plate is then developed, in usual manner, preferably by cascading with oppositely charged particles of pigmented powdered resin, whereby the powder particles are electrostatically attracted to the latent image to form a direct reading powder image of the subject matter on the xerographic plate. This powder image is then electrostatically transferred to an intermediate support material which is preferably of such composition that it does not readily or effectively form a mechanical bond with the powdered developing material, either in its dry or tackified state, but readily permits the powder material to be bonded thereto electrostatically. Preferably, such intermediate support material comprises a relatively heat insensitive plastic sheet such as Teflon or Kel-F, each of which is a fluorinated vinyl carbon material of such physical characteristics that it is substantially adhesive to dry or tackified xerographic developing materials. Other materials that have relatively little affinity for developing material, such as silicone treated kraft paper or closely woven glass fiber cloth, may also be employed, if desired. Although materials having a low bond strength for tackified and/or hardened powder images are considered more practicable for use with the method of the invention, it should be noted that materials having a higher bond strength for powder image material, such as paper, may

5

also be employed in the form of an expendable web, as described below.

While the xerographic powder image is electrostatically adhered to the intermediate support material, it is tackified by the application of heat to a degree that it becomes sufficiently sticky readily to adhere to other surfaces. While in this condition, the final support material, e.g., a perforable record card, is superposed on the tackified image and then is uniformly pressed into intimate surface contact with the intermediate support material. In the preferred embodiment of the invention, it is desirable that the intermediate support material have a lower bond strength for tackified and hardened powder images than that of the final support surface for the image material, although, as described below, this condition is not essential to the successful practice of the invention. In any event, the surface of the final support material should be such that the application of pressure causes the tackified powder material to flow into the interstices of the final support material and physically bond therewith, whereas relatively no bonding occurs between the tackified powder material and the surface of the intermediate support material.

Thereafter, the final support material with the tackified powder image adhered thereto is separated from the intermediate support material by any suitable means. As described below, separation is preferably effected in timed relation to the hardening of the tackified powder image, in accordance with the type of intermediate support material employed, whereby the image forms a permanent bond with the surface of the final support material and provides a direct reading reproduction of the subject matter thereon.

Thus, there is provided an improved method whereby xerographic images may be transferred and fixed on final support surfaces of types which heretofore were considered impractical or inconvenient to receive images of this type. The transfer can be performed with extreme rapidity so that there is very little heat transfer between the intermediate support surface and the final support surface whereby even heat-sensitive materials may be used for final support surfaces without danger of damage thereto. In the event relatively rigid material, such as a grained zinc or aluminum lithographic plates or electroplated plastic material, is employed as the final support material, the flexibility of the intermediate support material allows it to conform closely to the final support surface in order to provide a complete transfer of the xerographic image. If necessary, pneumatic pressure pads or similar devices may be employed in the final transfer step to obtain close conformity with curved surfaces and even with somewhat irregularly shaped surfaces, as in the ornamentation of metal or china articles, or relatively rough paper or cloth.

With reference to the separation of the final support surface from the intermediate support surface, it is noted above that this should be effected in timed relation to the hardening of the tackified powder image, in accordance with the type of intermediate support material employed. As soon as contact is made between the tackified powder image and the relatively cold final support surface, the final support surface begins to absorb heat from the image and from the intermediate support layer whereby the temperature of the fused toner begins to approach its hardening point. When an adhesive intermediate support material is employed it is generally preferred, though not necessary, to maintain contact until the toner solidifies as this permits the transfer of a maximum of the toner material to the final surface. When the intermediate support surface is not adhesive, e.g., when plain paper is used, it is usually desirable to bring the surfaces together and then separate them rapidly before the tackified toner adjacent to the intermediate sheet is completely hardened, as it is difficult to obtain a clean separation after bonding is completed. The latter method may be employed even though an adhesive

6

intermediate support material is used, although the transfer is not quite as complete. It should be noted that hardening of the toner image begins adjacent to the cool final surface so that, with accurate timing, separation can be effected after some of the toner has hardened against the final surface but before a bond is formed to the still warm intermediate surface. The separation time may be controlled within relatively wide limits, as desired, by suitable selection of toner material components and by variations in the temperature applied to tackify the toner.

A typical apparatus for practicing the method of the invention is disclosed in FIG. 1 which constitutes an adaptation of a xerographic processing machine of the type disclosed in co-pending application S.N. 393,058, filed in the name of Clyde R. Mayo et al. on November 19, 1953, and which is currently in extensive commercial use under the name of XeroX Copyflo No. 1 continuous printer, manufactured by The Haloid Company of Rochester, New York. In this arrangement a xerographic plate having a photoconductive surface and a conductive backing is arranged in the form of a cylindrical drum 1 and is mounted for rotation on a shaft 2 that is rotated at a predetermined speed by suitable motive means (not shown). Subject matter that is to be reproduced is represented by successive frames of a microfilm 3 that is fed from a supply reel 4 to a take-up reel 5 by suitable driving mechanism which effects travel of the film at a rate proportional to the speed of the drum and the degree of magnification of the film image projected onto drum 1. A light projection system 6 is provided to direct light through microfilm 3 and to project images from the film through an optical system 7, which magnifies the image, and a prism 8 that reverses the image and reflects it through a slit onto a portion of the photoconductive surface of xerographic drum 1. Obviously, the prism may be eliminated by turning the film over in the projector and projecting it directly on the drum.

Drum 1 travels in a counterclockwise direction and, during the course of its rotation, a given portion of its photoconductive surface is first subjected to the operation of a cleaning brush 12 that removes any adhering developing material, following which the cleaned portion of the photoconductive surface may be illuminated by a fluorescent discharge lamp 13 which insures removal of any electrostatic charges remaining on the surface of the drum and which may have been induced by the cleaning brush or other source. After passing under discharge lamp 13, the drum surface is next subjected to corona discharge from a charging grid 14 which imposes the required electrostatic charge on the drum surface. After charging, the drum surface is next exposed to a light image of the subject matter through slit 9 whereby the photoconductive surface is discharged in accordance with the light intensity which reaches it to form an electrostatic latent image of the subject matter to be reproduced.

After exposure, the drum surface passes through a developing chamber consisting of a housing 16, located adjacent the surface of drum 1 and extending from side to side thereof, forming a closed and substantially sealed chamber wherein development of the electrostatic image takes place. Development is effected by cascading oppositely charged particles of pigmented resin material 17 over the surface of the drum, in transit. The developer particles are projected into contact with the drum by means of a slide 18, and the excess particles fall to the bottom of the developing chamber from which they are elevated by a bucket type conveyor mechanism 19 and returned to the upper end of slide 18 for reuse. Suitable means may be provided to replenish the developing material as it is expended on the drum surface.

In order to provide an intermediate support surface to which the xerographic powder image may be transferred, there is provided an endless belt 22 that is mounted for movement over horizontally arranged rollers 23 and 24 and which contacts the surface of xerographic drum 1

over a portion of its path of travel. As noted above, belt 22 is preferably formed of a smooth-surfaced adhesive plastic, such as Teflon or Kel-F, to which the powder image does not adhere even though tackified. Suitable motive means are provided to move the belt at a linear rate equal to the peripheral speed of the drum so that opposed surfaces of the drum and belt remain in register throughout their period of contact. If desired, any convenient belt tensioning device may be employed to minimize slippage of the belt.

In order to transfer the xerographic powder image from the drum to the belt surface, a corona discharge electrode 25 is mounted beneath belt 22 in the area in which the belt and drum surface are in contact. Electrode 25 is continuously energized from a suitable power source to emit an electrostatic charge opposite to that on the xerographic image particles, whereby the image particles are electrostatically attracted from the surface of the drum and are transferred to the surface of belt 22 and remain electrostatically bonded thereto.

After transfer, the xerographic powder image on the belt passes into a form of tackifying or heat fusing chamber 28, wherein the powder image is tackified. In the arrangement shown, there is disclosed a tackifier 28 of the heat fusing type wherein resistance wires 29 are energized to a degree to emit sufficient radiation to cause the powder particles to soften and coalesce to form a sticky surfaced image of the subject matter to be reproduced, in which condition the powder image emerges from the tackifying chamber and begins to pass over horizontal roller 24.

In order to superpose the final support surface on the tackified powder image the apparatus includes, by way of illustration, a record card feeding apparatus of the type commonly employed in perforated card controlled machines. Briefly, in this device record cards are placed in a card magazine and are passed seriatim to suitable feed rolls whereby they are advanced to be engaged between belt 22, as it passes over roller 24, and a pressure roll that presses them against the tackified powder image on the belt surface to effect image transfer, after which the cards are passed to a receiving magazine. Specifically, the record cards 33, or comparable types of final support surface, are placed in a magazine 34 in which they are urged into contact with a card feeding mechanism by means of a suitable spring 35. The cards are advanced, one at a time, by a picker knife 36 that is guided for reciprocating movement in suitable ways and is actuated, through a link 37 and pivotally mounted crank 38, by a cyclically operated cam 39 to advance the cards in timed relation to the projection of images on xerographic drum 1.

As each card 33 is passed from magazine 34 it is gripped by conventional card feed rolls 40 that engage the edges of the card and move it downwardly to a position in which it is pressed against the surface of continuous belt 22 by a pressure roll 42. Preferably, roll 24 and pressure roll 42 are each provided with a resilient surface whereby the card is pressed into intimate surface contact with the tackified powder image on the surface of continuous belt 22. The pressure applied at this point is such that the tackified powder image is caused to flow into the interstices of the record card surface and bond thereto. As each card emerges from engagement with pressure roll 42 and belt 22 it is gripped by suitable ejector rolls 44 that are continuously rotating and serve to pass the card onto a deflecting chute 45 whereby it is fed into a receiving magazine 46. If required, suitable guide means 47 may be provided to assist in separating the card from belt 22 and guiding it into engagement with ejector rolls 44.

Obviously, horizontal pressure roll 22 may be heated, if desired, to insure that the tackified powder image remains in a sufficiently sticky state to permit its adhesion to the record card during the pressure applying step. In

addition, such heating facilitates the removal of the tackified powder image from the surface of belt 22 in the event belt 22 is formed of a material to which the tackified powder image may have any tendency to adhere. In such a case, a cleaning brush 48 may be provided to remove any residual portions of the powder image after the transfer to the final support material. In the event residual electrostatic charge tends to accumulate on web 22, suitable means may be employed to discharge the web during each cycle of operation. For example, a pair of grounded alpha particle emitters 49 may be arranged on either side of web 22 for this purpose. Emitters 49 may conveniently be in the form of metal plates coated with polonium or other radioactive material, as described in Carlson Patent No. 2,701,764, issued February 8, 1955. Alternatively, a pair of A.C. corona discharge wires, supplied from a suitable high voltage source, may also be employed to discharge the web.

In the modification of the invention disclosed in FIG. 2, the apparatus is adapted for use in applications in which it is desired to employ an expendable material as the intermediate support surface. In this figure, all elements are identical to those shown in FIG. 1 and function as described above, except that the continuous belt 22 is replaced by a paper or glassine web 50 that may be fed from a supply roll 51 and over a guide roll 52 and thence into surface contact with xerographic drum 1, as before. After the electrostatic transfer of the powder image and the tackification thereof in tackifying chamber 28, web 50 is passed between pressure rolls 24 and 42, as above, wherein the tackified image is transferred to a record card 33 and the web is then rolled onto a take-up roll 53.

The latter arrangement is particularly applicable to installations in which it is permissible to transfer something less than the entire xerographic powder image to the final support surface. Obviously, in such an arrangement, a certain amount of the powder image will, when tackified, soak into the intermediate support material and will not be transferred to the final support surface during the final transfer step. However, it permits the use of a low-cost intermediate support surface and eliminates the need for cleaning the intermediate support surface after the second transfer step. Inasmuch as most paper stock will withstand temperatures up to 325° F. for quite a long period without turning brown and can even be heated to 400° F. without disintegrating during the fusing of an image, such material can readily be used as the expendable web material in conjunction with present xerographic developing materials which normally can be tackified in the range between 150° F. to 300° F.

Although the method and apparatus of the invention are described, by way of illustration, as applied to the transfer and fixing of fusible xerographic images of line copy to perforated record cards, it is apparent that they are equally applicable for transferring and fixing continuous tone fusible images, and that they may readily be applied for transferring and fixing such types of images to various other types of final support material. For example, by employing a similar type of support surface feeding mechanism xerographic images may readily be applied to relatively rigid support surfaces such as grained zinc or aluminum lithographic plates, or to electroplated plastic sheets such as are employed in the manufacture of printed circuits. In addition, by employing different types of support surface feeding means, the method and apparatus of the invention may readily be applied to transferring xerographic powder images to photographic film for the purpose of film titling, or to plastic film which may subsequently be covered by laminating on a plastic cover sheet, as for forming unalterable identification badges.

Since many changes could be made in the above construction and many apparently widely different applications of the method of the invention could be made with-

out departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. The method which comprises transferring a fusible powder image from a xerographic plate to a heat-insensitive transfer sheet, heating said sheet and the powder image supported thereby to a temperature at which said image becomes adhesive, then pressing the face of said sheet carrying said image against a second surface and removing said transfer sheet to leave an image adhering to said second surface.

2. The method of claim 1 in which said second surface is the surface of a material which is damaged by heating to the adhesive temperature of said powder image, said second surface being initially at a lower temperature than the adhesive temperature.

3. The method which comprises transferring a fusible powder image to a heat-sensitive transfer sheet, heating said transfer sheet and the transferred powder image above the melting point of said powder, placing the face of said transfer sheet carrying the molten powder image against a second surface and then removing said transfer sheet from said second surface while said powder image is still molten, to leave at least part of said molten image on said second surface.

4. The method of applying an image of fusible material to the surface of a heat-sensitive material, which comprises placing fusible powder on a sheet in the form of an image, heating said sheet and said powder to fuse said powder, then pressing said sheet and fused powder against the surface of said heat-sensitive material and removing said sheet to leave an image of fusible material bonded to said heat-sensitive material.

5. The method as claimed in claim 4 in which said sheet is removed before said fused powder image has completely cooled and solidified.

6. The method of claim 4, in which said sheet is formed of adhesive material and is removed after said fused powder image has solidified.

7. The method of applying an image of fusible material to the surface of a heat-sensitive material, which comprises forming an image of fusible powder on a first surface, transferring said powder image to a sheet material, heating said sheet material and said powder image until said image is fused, then pressing the surface of said sheet material carrying said fused powder image against the substantially unheated surface of said heat-sensitive material and separating said surfaces to leave an image on said heat-sensitive material.

8. The method as claimed in claim 7, in which said sheet material is separated from said heat-sensitive material prior to completion of the cooling and solidifying of said fused powder image.

9. The method as claimed in claim 7, in which said sheet material has low bond strength for said fused and solidified powder and said sheet material is separated from said heat-sensitive material after said fused powder image has become solidified by cooling.

10. In the process of xerography wherein an electrostatically charged xerographic plate is exposed to projected image to form an electrostatic latent image on the plate corresponding to the projected image and the plate is developed with oppositely charged particles of heat fusible developing material that are attracted to the latent image to form a xerographic powder image corresponding to the projected image, the method of transferring and fixing the powder image to a final support material comprising the steps of transferring the powder image to a smooth-surfaced intermediate support material, heat fusing the powder image in contact with the intermediate support material, superposing the final support material on the fused powder image, pressing the final support material into sur-

face contact with the intermediate support material, and separating the final support material from the intermediate support material.

11. An apparatus for transferring and fixing a xerographic powder image to a support surface comprising, in combination, a cylindrical xerographic plate mounted for rotation about a horizontal axis, means for applying electrostatic charge to the surface of the plate, means for exposing the surface of the plate to a light image of subject matter to be reproduced to form an electrostatic latent image of the subject on the plate, means for developing the latent image with electrostatically attractable powder to form a xerographic powder image of the subject on the plate, a web of smooth-surface insulating material, a portion of said web being in surface contact with a portion of said xerographic plate, means for transferring a xerographic powder image from the surface of the plate to the surface of the web, means for heat fusing a xerographic powder image supported by the web, means for superposing and pressing a support material on a fused powder image on the web surface, and means for separating the support material from the web surface.

12. An apparatus for transferring and fixing a xerographic powder image to a support surface comprising, in combination, a cylindrical xerographic plate mounted for rotation about a horizontal axis, means for applying electrostatic charge to the surface of the plate, means for exposing the surface of the plate to a light image of subject matter to be reproduced to form an electrostatic latent image of the subject on the plate, means for developing the latent image with electrostatically attractable powder to form a xerographic powder image of the subject on the plate, an endless belt of smooth-surfaced insulating material, a portion of said belt being in surface contact with a portion of said xerographic plate, means for electrostatically transferring a xerographic powder image from the surface of the plate to the surface of the belt, heat fusing means for tackifying a xerographic powder image supported by the belt, means for superposing and pressing a support material on a tackified powder image on the belt surface, and means for separating the support material from the belt surface.

13. An apparatus for transferring and fixing a xerographic powder image to a support surface comprising, in combination, a cylindrical xerographic plate mounted for rotation about a horizontal axis, means for applying electrostatic charge to the surface of the plate, means for exposing the surface of the plate to a light image of subject matter to be reproduced to form an electrostatic latent image of the subject on the plate, means for developing the latent image with electrostatically attractable powder to form a xerographic powder image of the subject on the plate, an endless belt of smooth-surfaced insulating material, a portion of said belt being in surface contact with a portion of said xerographic plate, means for electrostatically transferring a xerographic powder image from the surface of the plate to the surface of the belt, heat fusing means for tackifying a xerographic powder image supported by the belt, means for advancing support material into superposing relationship with tackified powder images on said belt, means for pressing support material into surface contact with tackified powder images on the belt surface, and means for separating the support material from the belt surface.

14. An apparatus for transferring and fixing a xerographic powder image to a support surface comprising, in combination, a cylindrical xerographic plate mounted for rotation about a horizontal axis, means for applying electrostatic charge to the surface of the plate, means for exposing the surface of the plate to a light image of subject matter to be reproduced to form an electrostatic latent image of the subject on the plate, means for developing the latent image with electrostatically attractable powder to form a xerographic powder image of the subject on the plate, an endless belt of smooth-surface in-

insulating material, a portion of said belt being in surface contact with a portion of said xerographic plate, means for electrostatically transferring a xerographic powder image from the surface of the plate to the surface of the belt, heat fusing means for tackifying a xerographic powder image supported by the belt, means for advancing support material into superposing relationship with tackified powder images on said belt, means for pressing support material into surface contact with tackified powder images on the belt surface, and means for separating the support material from the belt surface in timed relation to the operation of the pressure applying means.

15. An apparatus for transferring and fixing a xerographic powder image to a support surface of the perforable record card type comprising, in combination, a cylindrical xerographic plate mounted for rotation about a horizontal axis, means for applying electrostatic charge to the surface of the plate, means for exposing the surface of the plate to a light image of subject matter to be reproduced to form an electrostatic latent image of the subject on the plate, means for developing the latent image with electrostatically attractable powder to form a xerographic powder image of the subject on the plate, an endless belt of smooth-surfaced insulating material, a portion of said belt being in surface contact with a portion of said xerographic plate, means for electrostatically transferring a xerographic powder image from the surface of the plate to the surface of the belt, heat fusing means for tackifying a xerographic powder image supported by the belt, card feeding means for advancing record cards into superposing relationship with tackified powder images on said belt, means for pressing record cards into surface contact with tackified powder images on the belt surface, and means for separating record cards from the belt surface.

16. An apparatus for transferring and fixing a xerographic powder image to a support surface of the perforable record card type comprising, in combination, a cylindrical xerographic plate mounted for rotation about a horizontal axis, means for applying electrostatic charge to the surface of the plate, means for exposing the surface of the plate to a light image of subject matter to be reproduced to form an electrostatic latent image of the subject on the plate, means for developing the latent image with electrostatically attractable powder to form a xerographic powder image of the subject on the plate, an endless belt of smooth-surfaced insulating material, a portion of said belt being in surface contact with a portion of said xerographic plate, means for electrostatically transferring a xerographic powder image from the surface of the plate to the surface of the belt, heat fusing means for tackifying a xerographic powder image supported by the belt, card feeding means for advancing record cards into superposing relationship with tackified powder images on said belt, means for pressing record cards into surface contact with tackified powder images on the belt surface, and means for separating record cards from the belt surface in timed relation to the operation of the pressure applying means.

17. An apparatus for transferring and fixing a xero-

graphic powder image to a support surface comprising, in combination, a cylindrical xerographic plate mounted for rotation about a horizontal axis, means for applying electrostatic charge to the surface of the plate, means for exposing the surface of the plate to a light image of subject matter to be reproduced to form an electrostatic latent image of the subject on the plate, means for developing the latent image with electrostatically attractable powder to form a xerographic powder image of the subject on the plate, a web of insulating material extended between a supply reel and a take-up reel, a portion of said web being in surface contact with a portion of said xerographic plate, means for electrostatically transferring a xerographic powder image from the surface of the plate to the surface of the web, heat fusing means for tackifying a xerographic powder image supported by the web, means for superposing and pressing a support material on a tackified powder image on the web surface, and means for separating the support material from the web surface.

18. An apparatus for transferring and fixing a xerographic powder image to a support surface comprising, in combination, a cylindrical xerographic plate mounted for rotation about a horizontal axis, means for applying electrostatic charge to the surface of the plate, means for exposing the surface of the plate to a light image of subject matter to be reproduced to form an electrostatic latent image of the subject on the plate, means for developing the latent image with electrostatically attractable powder to form a xerographic powder image of the subject on the plate, a web of insulating material extended between a supply reel and a take-up reel, portion of said web being in surface contact with a portion of said xerographic plate, means for transferring a xerographic powder image from the surface of the plate to the surface of the web, heat fusing means for tackifying a xerographic powder image supported by the web, means for advancing support material into superposing relationship with tackified powder images on said web, means for pressing support material into surface contact with tackified powder images on the web surface, and means for separating the support material from the web surface in timed relation to the operation of the pressure applying means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,221,776	Carlson	Nov. 19, 1940
2,297,681	Carlson	Oct. 6, 1942
2,357,809	Carlson	Sept. 12, 1944
2,503,758	Murray	Apr. 11, 1950
2,588,675	Walkup et al.	Mar. 11, 1952
2,600,580	Sabel et al.	June 17, 1952
2,628,929	Persoon et al.	Feb. 17, 1953
2,629,671	Murray	Feb. 24, 1953
2,637,651	Copley	May 5, 1953
2,693,416	Butterfield	Nov. 2, 1954
2,726,166	Greaves	Dec. 6, 1955
2,756,676	Steinhilper	July 31, 1956
2,758,524	Sugarman	Aug. 14, 1956

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,990,278

June 27, 196

Chester F. Carlson

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 66, column 5, lines 64, 69 and 75, column 7 line 2, and column 9, line 40, for "adhesive", each occurrence, read -- abhesive --; column 9, line 20, for "heat-sensitive" read -- heat-insensitive --.

Signed and sealed this 26th day of December 1961.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

DAVID L. LADD

Commissioner of Patents

USCOMM-DC

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,990,278

June 27, 196

Chester F. Carlson

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 66, column 5, lines 64, 69 and 75, column 7 line 2, and column 9, line 40, for "adhesive", each occurrence, read -- abhesive --; column 9, line 20, for "heat-sensitive" read -- heat-insensitive --.

Signed and sealed this 26th day of December 1961.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

DAVID L. LADD

Commissioner of Patents

USCOMM-DC

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,990,278

June 27, 1961

Chester F. Carlson

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 66, column 5, lines 64, 69 and 75, column 7 line 2, and column 9, line 40, for "adhesive", each occurrence, read -- abhesive --; column 9, line 20, for "heat-sensitive" read -- heat-insensitive --.

Signed and sealed this 26th day of December 1961.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

DAVID L. LADD

Commissioner of Patents

USCOMM-DC