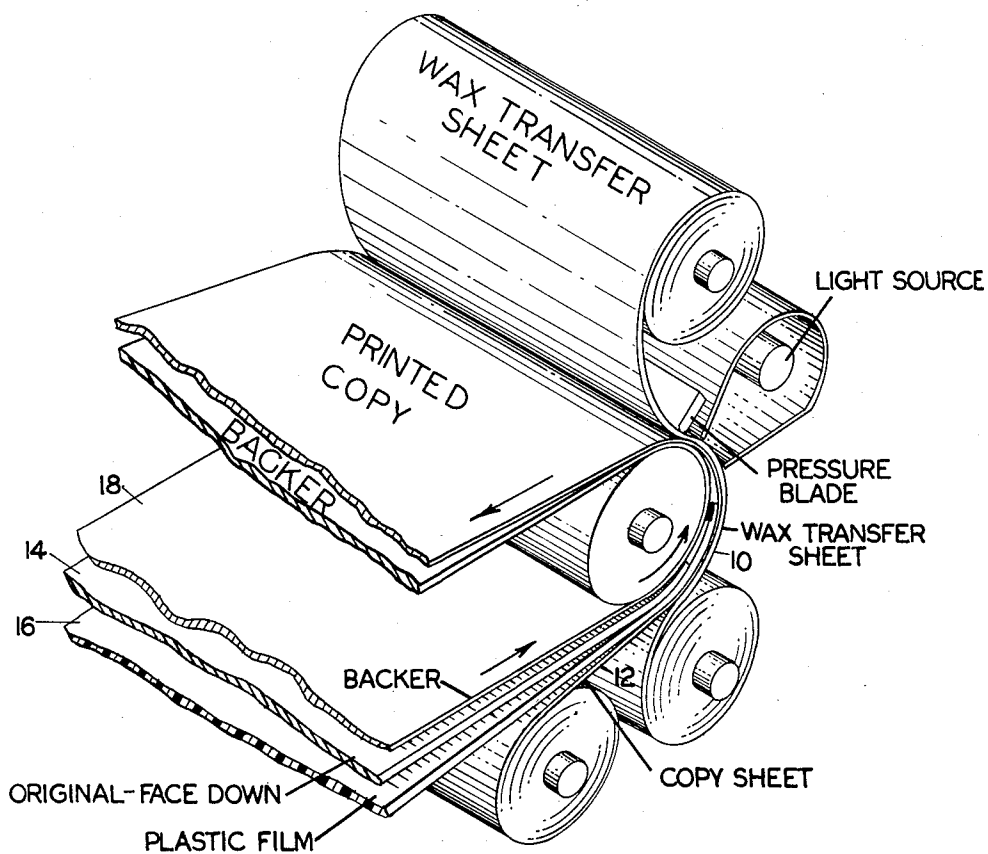


Feb. 18, 1964

R. B. RUSSELL
THERMOTRANSFER COPY PROCESS WHEREIN A HEAT SINK
IS POSITIONED WITHIN THE COMPOSITE
Filed June 21, 1960

3,121,791



INVENTOR.
Robert B. Russell
BY *Porter, Cliftlick + Russell*

ATTORNEYS

1

3,121,791 THERMOTRANSFER COPY PROCESS WHEREIN A HEAT SINK IS POSITIONED WITHIN THE COMPOSITE

Robert B. Russell, 248 Park St., Newton, Mass.

Filed June 21, 1960, Ser. No. 37,669

2 Claims. (Cl. 250—65)

This invention relates to thermographic copying and more particularly to improvements which enhance definition and eliminate background when employed with the thermographic printing process described in my prior and copending application Serial No. 821,943, filed June 22, 1959 now Patent No. 3,048,695.

A brief discussion of certain background facts will best lead to an understanding of the invention. While making copies by the machine and process of my above said copending application, I have noticed various curious things for which there has hitherto been no apparent explanation. For instance, a crease in the original results in a transfer of wax from the transfer sheet to the copy sheet along the line of the crease. Several authorities have attributed this effect to the scattering of the incident radiation by the walls of the crease and/or to small amounts of dirt collected in the crease. However, various facts show that these explanations are not actually complete. Thus the same form of unwanted wax transfer occurs at the end or sides of the original where the wax melts and transfers markedly along the line of the edge of the sheet. No scattering of light or dirt is present along these edges to explain such increased heat. Again, while printing raised letters as for instance letters printed by engraving, the melting and transfer of the wax extends radically to each side of the letter body and far beyond the probable extent of heat emanating directly from the black portion of the letter.

In searching for an explanation of these curiosities, I have found they are due at least to a substantial degree to the insulative power of air. Whenever there is an irregular air gap between the copy and the original, the wax over the air gap appears to melt and transfer at nearly the same rate as it does over the black letters on the original. To test this, I have made copy by my process employing an original that has letters deeply imprinted on its surface but without black ink in the letters. These non-heat absorbing letters produce perfectly legible copy. The apparent explanation is that, as the incident radiation is directed through the wax and copy sheets to the original, each sheet is absorbing heat and its temperature is rapidly rising. The original, however, being the most protected part remains relatively cool compared to the copy. Thus heat commences flowing toward the original. As the letters on the original become hotter than the copy sheet due to the greater absorption of the incident radiation which penetrates to the original, the path of heat from the copy toward the original at those places is blocked. This causes the copy to get hotter and melt the wax selectively over the letters. But in a like manner, if the heat path is blocked by the insulative power of an air gap, a similar result takes place and the wax is caused to melt whether or not a letter is there.

The insulative power of air also affects the problem in another way. Thus when an original of irregular density is employed, the portions of the letters overlying the less dense portions of the original become hotter and cause more pronounced printing in those areas. The reason for this is that the dissipation of heat by conduction into the original is less in those areas. A third way by which it affects the problem has to do with the nature of the surface to which the incident radiation is applied. Thus while a smooth-walled air gap in the original will print as indicated above, a jagged or fibrous air gap prints

2

to a far greater degree. In this case the small, free fibers are less able to lose their heat by conduction into the original.

These discoveries have led to the present invention and have made it possible for me substantially to improve the quality of printing difficult originals with the machine and process of my above said prior application.

Recognizing that air gaps should be eliminated is not of itself an advance in the art. This is because good contact with the letters on the face of the original has always been an object of the prior workers in the field who have uniformly based their processes on the theory that the heat is transferred from the black, infra-red absorbing letters to the copy by conduction alone. Thus smoothness and elimination of air gaps have always been obvious objectives in the prior processes. With my invention, however, I am not so interested in good contact with the letters as I am in eliminating non-uniform air gaps between the copy and the white background areas of the original. In my process, the provision of a good point to point contact between the letters and the copy sheet is actually not necessary for two reasons; first, an air gap over the letters can actually increase the selective melting; and second, in my process, that portion of the return heat which is attributable to radiation is not adversely affected by the air space. On the other hand, in my process, uniform contact is important in the background areas of the original because there must be a uniform flow of heat from the wax and copy sheets toward the original in those areas and without such contact the flow will be localized and unwanted printing will occur in the background areas.

Accordingly, in the practice of my invention herein described, I take pains to provide a smooth wax transfer sheet and a smooth uniformly dense copy sheet. These are in part features of my invention as will become apparent from the detailed description which follows. Smoothing and rendering these sheets uniformly dense alone, however, only produces maximum results when the original is also smooth and uniformly dense. Thus I can produce excellent copy with smooth wax and copy sheets on a finely printed smooth original, but I have difficulty achieving good results when copying newsprint with the same wax and copy sheets. As previously mentioned, an engraved image prints poorly by my process because its letters are raised leaving air gaps adjacent to the bodies of the letters.

This invention, therefore, has additionally as a major object, the elimination of the harmful effects of surface roughness and uneven density in the original.

I do this in a preferred embodiment of my invention herein described by placing a thin film of clear plastic between the original and the copy. The effect of this is to provide a relatively uniform "heat sink" between the copy and the original so that heat flow towards the original from the wax and copy sheets is substantially smoothed out. Of course, air gaps between this film and the original can still render the flow uneven to some extent, but the film serves to reduce their harmful effect. On the other hand, the film absorbs but little of the incident radiation and permits the black letters on the original freely to heat up more than the background. Thereafter since the area of the letters is relatively large compared to the thickness of the film, and since the film is both a good conductor and a good radiation transmitter, the film does not substantially interfere with the process of selectively melting the wax over the letters. The result is greatly to improve the copying quality of non-uniform originals such as newsprint.

Other objects and features will best be understood with reference to the following description and drawing in which:

The single figure is a diagrammatic representation

of the lay-up of sheets employed in one embodiment of my invention.

In the preferred embodiment of my invention herein shown, I employ the general process described in my above said copending application. This involves the use of a thin, wax-coated transfer sheet 10 having a relatively non-infra-red absorbent dye in the wax. This transfer sheet 10 is placed over a copy sheet 12, and the copy sheet is then placed over an original 14 bearing letters or other indicia to be copied. Copying is carried out by directing a brief and intense blast of irradiation through the wax transfer and copy sheets to the surface of the original where the letters are heated to a higher temperature than the background areas by selective absorption of the incident radiation. In my process, the wax transfer sheet also absorbs some of the incident radiation, as do the copy sheets and background areas of the original. But since the wax transfer and copy sheets are outermost, their temperatures rise more rapidly. This causes a flow of heat inwardly from the wax transfer and copy sheets toward the original. In the areas where the heated letters are located, however, or in the places where there are air gaps, this inward flow of heat is blocked, and the copy sheet temperature accordingly rises more rapidly in those places. Of courses, when the letters become sufficiently hot, heat emanates from them backwardly toward the wax and a portion of this return heat is in the form of radiation.

In order to eliminate unevenness of the inward flow of heat from the copy sheet 12 toward the original 14, I take several special precautions. First, I make the wax sheet 10 as thin as possible and provide it with an ample wax coating. I find that the wax itself transmits both the heat and radiation relatively rapidly and uniformly, but that the fibers in the paper backer for the wax transfer sheet are a definite source of uneven temperature rise and heat flow. In my above said application, I mentioned employing a 9 lb. per ream paper (3300 square feet) called "Trent." I find now I can use a 5½ lb. per ream "Trent" to even better advantage.

The copy sheet 12 need not be especially thin, as long as it is highly uniform both in infra-red absorption and heat conduction. (Of course, it cannot be infra-red opaque.) Thus I find I can make excellent copy on a 34 lb. coated paper in which a conventional mineral filler and casein coating is applied very flatly and with uniform density as by blade coating. Preferably the paper should be coated on both sides.

In the preferred embodiment of this invention, I place a .001" film of Mylar 16 between the original 14 and the copy 12. Of course, the Mylar 16 is a good transmitter of the incident radiation, so it interposes but little hindrance to the selective heating of the letters on the original. On the other hand, the Mylar is very smooth, has a relatively high specific heat as compared to paper, and conducts heat very rapidly as compared to air. Thus the flow of heat to the Mylar is substantially uniform and remains so until the return heat from the letters is sufficient to melt the wax. In effect, the Mylar is a buffer, or damper, eliminating the effect of small disconformities in the original but permitting major heat variations to be felt by the wax sheet 10. In order to facilitate positioning and repeated use, I mount the Mylar film 16 on a backer 18, and place the original between the two. In my machine as in the drawing herein, these pieces go in face down and issue face up after passing under the light.

It should be noted that my Mylar sheet 16 is between the original and the copy. I emphasize this because I am aware of a competitive process which places the original and a copy sheet under a plastic flap mounted on a backer. The similarity is only superficial because in the said competitive process, the plastic flap is definitely not placed between the copy and the original. In fact, by that process, as by any other thermographic processes of

which I am aware, placing anything between the original and the copy is emphatically discouraged.

Mylar has some disadvantage from the viewpoint of aging in that it buckles slightly under the influence of heat. Cellulose acetate does likewise. Of course this disadvantage does not prevent these materials from being operative in the context. Nylon and polyethylene are adequate. In fact, any clear, flexible plastic which is smooth and relatively non-absorbent to radiation of a wave length between about .5 to 3 microns, will do, and accordingly it is not my intention to limit this particular embodiment of my invention to the precise form of plastic shown herein, but rather to claim it broadly as to the class of smooth, clear, flexible and light transmitting plastics.

Also in view of the teachings of this invention, a number of modifications or variations will be apparent to those skilled in the art and therefore, it is also my object to include them within the scope of the claims. Recognizing that the evening or damping effect of the film 16 is due to the fact that it is cooler than the original and copy sheet between which it lies (because it absorbs less of the incident radiation) it is apparent that the inner side of the copy sheet itself can be treated to approximate this same function. Thus a thin application of cellulose acetate or polyethylene on the surface of the copy adjacent to the original improves results. Conversely a coating of white mineral coating materials on the surface of a copy sheet made of clear film, with the said coating being placed adjacent to the wax, provides good results. The important thing is to provide a temperature gradient in the copy from warmer, adjacent to the wax, to cooler adjacent to the original and back again to warmer in the original. In this way the part immediately adjacent to the original serves somewhat as a "heat sink" and thereby masks the tendency of uneven flow of heat into the original without preventing an intense build-up of heat in the letters on the original from being felt through the copy and back to the wax.

Of course, cost is an important factor and although such complex combinations of plastic coated papers or coated films provide excellent copy, they are expensive. A good workable compromise is provided by applying a coating of wax to a thin paper sheet. The trouble with a wax coating on the copy, however, is that it may melt and deposit on the original. For this reason high melting point waxes are chosen for this particular purpose.

The possibility of harming the original is ever present in the practice of my invention and is one of the reasons why I prefer the embodiment of my invention which employs the thin flap of Mylar 16 herein specifically described. It serves to protect the original in cases of inadvertent mishandling of the machine.

A second embodiment of this invention has a special application in the reproduction of signatures written with "ball point" pens. This is a topic which has in the past initiated considerable criticism of infra-red thermographic copying processes. By re-arranging certain of the components described above and by heavily indenting the impression of the point of the pens, such signatures can be copied by my process. Thus, a smooth uniformly dense relatively transparent original is employed. The copy sheet is preferably of greater infra-red absorbency than the original, and is also smooth and uniformly dense. Preferably a thin, smooth wax transfer sheet is used. With this combination, an indentation on the face of the original causes an air gap which in turn blocks the flow of heat from the copy toward the original. This results in a build-up of heat in the copy which selectively melts the wax and causes it to print where the indentation is. In this instance the smooth, uniformly absorbent and relatively cool "heat sink" is in the original itself, and it performs the evening or damping function described above except in places where the letters or intentional indentations appear on its face. In this way the "ball point"

ink is not the cause of the selective melting of the wax but rather the indentation caused by the pen point.

By the foregoing teachings it will now be clear to those skilled in the art that various adjustments in the infra-red absorberency of the components will be dictated by the type of copying involved. If voids or indentations alone are being copied a relatively sharp gradient is best with the copy being both comparatively highly conductive and highly infra-red absorbent, and with the original being highly conductive. In this way the copy gains heat more rapidly and heat flows from it both toward the wax and toward the original. In this case, the original is relatively cool because but little incident radiation reaches it. The voids in this case rather than the black letters are then the major block to the passage of heat into the original and by causing the heat to build up locally in the copy, they in turn cause the wax to melt and transfer from the wax sheet to the copy sheet in those areas. With this arrangement, however, the copy must not be so thick or so absorbent to infra-red that the temperature of its surface adjacent to the wax rises too rapidly in relation to the temperature of its opposite surface adjacent to the original. Thus photographic film with a black coating on one side makes excellent copy from voids in an original if the black coated side is placed adjacent to the voids, but virtually no copy at all if the black coated side is placed adjacent to the wax.

By increasing the infra-red transparency of the copy, the heat flow interference from the black letters on the face of the original can be made to be about equal to that of the voids so that they will print with about equal intensity. Of course, when the copy is highly transparent to the incident infra-red it remains relatively cool, heat flows toward it rather than away from it, and the hot letters on the original cause printing more readily than do the voids. This latter arrangement is illustrated by the above described embodiment in which a Mylar flap is interposed between the original and the copy.

It will be noted, however, that the common point between the foregoing arrangements is that in each one a smooth, uniformly dense, and relatively good conductor is employed in the manifolded sheets in such a way that it is cooler than its surroundings and serves as a "heat sink" which permits uniform temperature rise of the copy and wax transfer sheets and a more accurate control of selective wax melting to produce copy.

Having thus described and disclosed preferred embodiments of my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In a thermally induced transfer copying process in which a copy sheet is placed over an original having indicia thereon to be copied and a transfer sheet having

a heat meltable dyed coating thereon is placed over the copy sheet with the said coating adjacent to said copy sheet, the improvement comprising: providing said copy sheet with a substantially smooth, uniformly dense, transparent and conductive heat sink which is substantially as transmissive to radiation as said copy sheet between said copy and said original; thereafter applying intense, richly infra-red irradiation to said original through said transfer and copy sheets and through said heat sink, whereby the temperature of said transfer sheet is caused to rise more rapidly than that of said copy sheet and said heat sink respectively thereby causing a flow of heat therefrom toward said heat sink; said heat sink being more transparent than said original and selected in relation thereto to transmit sufficient incident radiation to said original to cause said original to rise in temperature due to said incident irradiation at about the same rate as said heat sink; whereby voids on the surface of said original have no substantial influence in the heat flow pattern between said adjacent members.

2. In a thermally induced transfer copying process in which a copy sheet is placed over an original having indicia thereon to be copied and a transfer sheet having a heat meltable dyed coating thereon is placed over the copy sheet with the said coating adjacent to said copy sheet, the improvement comprising: placing next to said copy sheet a separate, substantially smooth, uniformly dense, transparent and conductive heat sink which is substantially as transmissive to radiation as said copy sheet between said copy and said original; thereafter applying intense, richly infra-red irradiation to said original through said transfer and copy sheets and through said heat sink, whereby the temperature of said transfer sheet is caused to rise more rapidly than that of said copy sheet and said heat sink respectively thereby causing a flow of heat therefrom toward said heat sink; said heat sink being more transparent than said original and selected in relation thereto to transmit sufficient incident radiation to said original to cause said original to rise in temperature due to said incident irradiation at about the same rate as said heat sink; whereby voids on the surface of said original have no substantial influence in the heat flow pattern between said adjacent members.

References Cited in the file of this patent

UNITED STATES PATENTS

2,808,777	Roshkind	Oct. 8, 1957
2,813,043	Clark	Nov. 12, 1957
2,844,733	Miller	July 22, 1958
2,954,311	Vander Weel	Sept. 27, 1960

FOREIGN PATENTS

722,023	Great Britain	Jan. 19, 1955
---------	---------------	---------------