Oct. 17, 1967 D. A. NEWMAN 3,347,696

THERMOGRAPHIC METHOD OF IMAGING A COPY SHEET

Filed May 18, 1965

Fig. 1

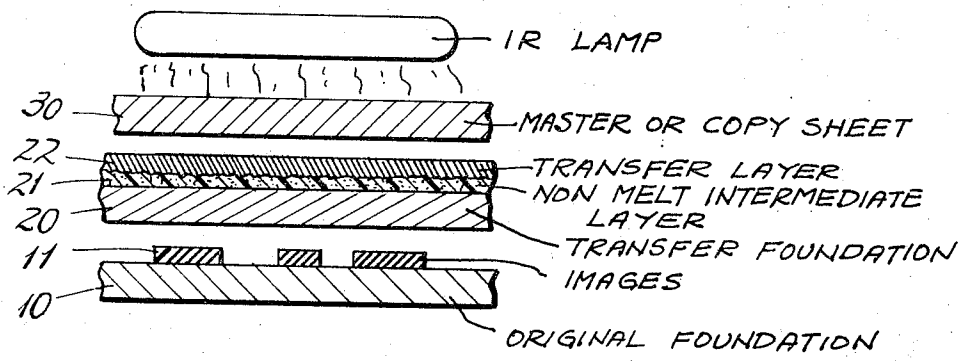


Fig. 2

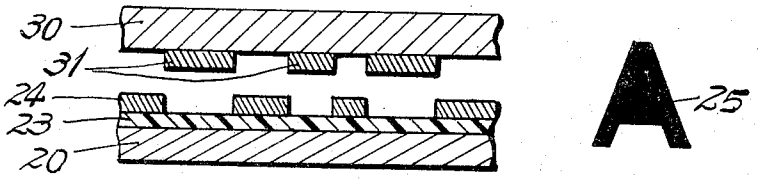
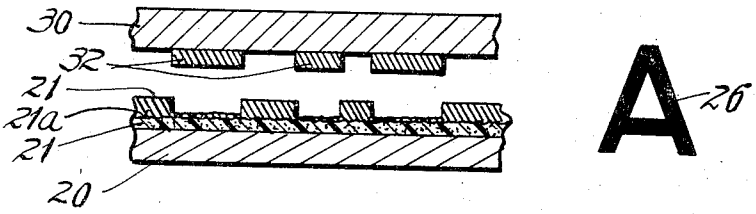


Fig. 3



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THERMOGRAPHIC METHOD OF IMAGING A COPY SHEET

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4 Claims. (Cl. 117—38)

This application is a continuation-in-part of parent application, Serial No. 162,605, filed Dec. 27, 1961, now abandoned.

This invention relates to thermographic methods for imaging copy or master sheets, such as hectograph master sheets and planographic printing plates, and to the novel transfer sheets for effecting the same.

The parent application relates to improving the quality of images transferred thermographically from a transfer sheet to a copy or master sheet under the effects of infrared radiation, the improvement being effected through the use of thermographic transfer sheets having a thin paper foundation carrying a plastic intermediate layer supporting the heat-transferable imaging layer.

I have now discovered that one of the embodiments of the parent application represents a substantial improvement over the others and in fact broadens the scope of the parent invention by permitting the use of plastic film foundations as well as paper foundations while retaining the improved transfer characteristics mentioned in the parent application.

In the field of hectograph duplication, the somewhat recent development of using infrared radiation to image a hectograph master sheet directly from an imaged original has received widespread attention. The method, in brief, relies upon the use of an imaged original sheet on which the images have the ability of absorbing infrared radiation and converting it to heat. An image heat pattern is thus generated and transmitted to a hectograph master sheet and a hectograph transfer sheet so as to effect softening of the hectograph composition and transfer thereof to the master sheet in the image areas to provide a spirit duplicating master sheet corresponding to the original sheet. Illustrative patents are Nos. 2,769,391 and 2,808,777.

In practice, much difficulty has been encountered in preparing satisfactory master sheets according to these thermographic methods. It has been nearly impossible to effect the transfer of the hectograph imaging composition to the master sheet in the form of duplicating images which are uniform, sharp and dense enough to be commercially practical.

Applicant has found that these difficulties are attributed to the nature of the hectograph transfer sheets heretofore known and used. In order to function properly in the thermographic processes, the hectograph transfer sheet must be substantially translucent to infrared radiation so as not to absorb substantial amounts thereof. Thus the transfer sheet foundation should consist of thin translucent paper. Such foundation, however, does not provide satisfactory results, one of the greatest defects thereof being the tendency of the paper to crimp or wrinkle about and under the image areas during the heat transfer process.

Plastic foundations also have this disadvantage, to a greater or lesser degree depending upon the properties of the particular plastic employed, since plastic films tend to expand in heated areas. The effect is somewhat opposite to the shrinking problem with paper but the end result of wrinkling and crimping is the same.

The tendency of thin translucent paper foundations to crimp and wrinkle about and under the heated image areas appears to be due mainly to a loss of water from

the paper in the heated areas with resultant shrinkage in these areas and loss of dimensional stability. Also there appears to be some localized penetration of the heat melted transfer composition into the foundation in the heated areas which gives rise to a difference in the dimensional stability of the foundation between the penetrated and unpenetrated areas. In any event, the used transfer sheet can be seen to be crimped or wrinkled about and under the image areas and the images transferred to the master sheet have linear voids therein corresponding to the wrinkles on the transfer sheet. Also the formed images are not dense and do not contain sufficient hectograph composition, in the case of imaging hectograph master sheets, to provide many spirit copies in the duplicating process. These defects appear to be due to the fact that the wrinkled heated areas of the transfer sheet partially lose contact with the copy or master sheet so that the resultant transfer is spotty and uneven, and also due to the impregnation of the heated transfer material into the foundation in the image areas.

My aforementioned parent application was concerned with overcoming the wrinkling or crimping characteristics of a paper foundation through the use of a plastic intermediate layer, and while such a layer does provide an important improvement in this regard I have discovered that an even greater improvement in the transfer characteristics of the transfer layer is possible, even when plastic film foundations are used, if the transfer sheet is provided with a heat-insulation layer between the foundation and the heat-transferable layer.

Therefore, it is an object of the present invention to effect the thermographic imaging of master or copy sheets with transfer composition in the form of sharper and more uniform images than heretofore possible.

It is another object of this invention to produce heat-insulated transfer sheets which do not crimp or wrinkle when heated in localized areas and which confine the heat to the image areas and allow for sharp and uniform transfer under the effects of heat.

These and other objects and advantages are accomplished as more fully disclosed in the following description and the accompanying drawing in which:

FIGURE 1 represents a diagrammatic cross-section, to an enlarged scale, of a transfer sheet according to the present invention superposed together with an imaged original sheet and a master or copy sheet under the effects of infrared radiation, the sheets being spaced merely for illustrative purposes.

FIG. 2 is a diagrammatic cross-section, to an enlarged scale, of an undercoated transfer sheet and a copy sheet after thermographic irradiation in the manner exemplified by FIG. 1. The transfer sheet carries a plastic intermediate layer **23** which is free of insulating filler materials. One of the images **31** formed on the copy sheet **30** is shown in perspective as image **25**.

FIG. 3 is a diagrammatic cross-section, to an enlarged scale, of the transfer sheet and copy sheet of FIG. 1 after irradiation and separation, showing the images **32** transferred to the copy sheet in areas corresponding to the location of images **11** on the original sheet. One of the images **32** formed on the copy sheet is shown in perspective as image **26**.

According to the present invention, a novel transfer sheet has been developed which has the ability of transversely conducting a heat pattern of sufficient intensity to cause preselected areas of the transfer layer to soften and sharply and uniformly transfer in the thermographic process while insulating the heat pattern against lateral conduction and resultant broadening thereof.

The heat-sensitive transfer sheets of the present invention comprise a thin plastic film or paper foundation, having adhered thereto a nonmelting nontransferable

plastic intermediate layer containing a substantial amount of insulating filler material and a heat-transferable top imaging layer, the total transfer sheet being free of materials which absorb sufficient amounts of infrared radiation on instantaneous exposure thereto to cause transfer of the imaging layer.

The preferred form of transfer sheets according to this invention are those which are particularly well adapted to be used in the superposed order of sheets exemplified by FIG. 1 of the drawing. When so superposed, the heat generated by the original infrared radiation-absorbing images **11** must pass through the transfer sheet foundation **20** and intermediate layer **21** before affecting the transfer layer **22**.

The preferred transfer sheets of the present invention have a translucent foundation such as tissue paper or plastic film and carry a plastic intermediate layer which has a thickness of from about ¼ to about 7 points (0.000025 to 0.0007 inch) and which contains from about ½ to about 10 parts by weight of insulating filler material per part by weight of plastic binder material. The heat-transferable layer is applied to the surface of the plastic layer, preferably has a thickness of from about ½ to about 6 points, and is preferably based upon a wax binder material containing the required amount of non-infrared radiation-absorbing colorant.

The insulating filler material is the most important element of the present invention. It serves at least two important functions. Primarily it disrupts the continuity of the plastic intermediate layer and thereby prevents or substantially reduces lateral conduction of a heat-pattern applied thereto. The filler in the heated image areas appears to absorb the heat so that the applied heat is confined to the heated areas and not conducted laterally to adjacent areas of the intermediate layer.

Secondly, the filler provides the plastic intermediate layer with a rough surface, shown as **21***a* in FIGS. 1 and 3, which has good "tooth" or holding power for the top heat-transferable layer. While such holding power is an advantage, it is not the prime object of the rough surface. The roughness of the surface of the plastic layer has been found to substantially reduce lateral conduction of the heat-pattern and to prevent melting and flowing of the portion of the transfer layer adjacent the plastic layer. In cases where the plastic layer is smooth and free of insulating filler, the transfer layer thereon completely melts and the smooth surface of the plastic intermediate layer functions as a hot plate which causes the transfer composition adjacent thereto to flow so that the formed images are sometimes filled-in or blurred.

While the heat transferable layers of the present invention transfer nearly completely, there always remains behind an amount of the imaging composition which is firmly bonded to the intermediate layer as shown by FIG. 3 of the drawing. In this manner, the transferred images correspond exactly in sharpness and clarity to the sharpness and clarity of the heat-pattern generated by the original images.

Suitable insulating filler materials useful according to the present invention are finely divided solids which do not absorb infrared radiation to any substantial extent. Suitable materials are silica, kaolin, calcium carbonate, barium sulfate, titanium dioxide, zinc oxide, clay and the like, and silica appears to provide the best results. It is a critical requirement that the intermediate layer does not absorb infrared radiation to any substantial degree.

The following example is given by way of illustration and should not be considered limitative.

A 0.5 mil polyethylene terephthalate film foundation is coated on one side with a solvent-applied clear plastic layer of the following composition.

Ingredients:	Parts by weight
Saran (vinylidene chloride-vinyl chloride copolymer)	10
Syloid (silica)	10
Methyl ethyl ketone	80

After evaporation of the volatile solvent, the hardened vinyl layer has a thickness of ½ point. A hectograph transfer layer of the following composition is applied by hot melt thereover in a thickness of 3 points.

Ingredients:	Parts by weight
Carnauba wax	11
Ouricury wax	4
Lanolin	7
Blown rapeseed oil	8
Mineral oil	11
Crystal violet dyestuff	59

As illustrated by FIG. 1, the plastic intermediate layer **21** on the foundation **20** has a rough surface **21***a* with which the hectograph transfer layer **22** becomes integrated.

The foregoing transfer sheet is then compared with a transfer sheet prepared by applying the aforementioned transfer composition to a clear undercoating consisting of saran copolymer on the aforementioned thin plastic film foundation. Both sheets are superposed with identical translucent master papers and identical imaged originals as illustrated by FIG. 1 and irradiated for a period of about three seconds. Sufficient pressure is applied to keep the sheets in intimate surface contact.

The results are illustrated by FIGS. 2 and 3 of the drawing which show in FIG. 2 the transfer sheet foundation **20** carrying the clear intermediate plastic layer **24** with complete transfer of broadened images **31** to the master sheet **30** from hectograph layer **24**. The formed master sheet carries the transferred imaging composition in the form of images **31** having broadened outlines. One of the images is shown in perspective as image **25** to demonstrate the fill-in of the intended island in the letter A.

FIG. 3 on the other hand shows the sharp, clear transfer of images **32** to the master sheet and illustrates the amount of transfer composition which remains behind on the transfer sheet in the heated areas due to the rough surface of insulating layer **21***a*. One of the images **32** is shown in perspective as image **26** to demonstrate the sharpness and clarity of the formed letter A.

While the present invention is directed primarily to the field of hectograph duplication, it should be understood that the transfer layers according to this invention may be used to prepare individual duplicate copies or to image planographic plates or for any similar transfer purpose, the only requirement being that the particular imaging material used must not absorb sufficient amounts of infrared radiation on instantaneous exposure thereto to cause transfer of the imaging layer. Thus small amounts of various dyes and colored pigments may be used when individual duplicate copies are to be prepared.

In the case of imaging lithographic printing plates, the transfer composition may even be free of any coloring matter, the only requirement being that the transfer composition is oleophilic so as to accept printing ink when the formed master is used in the planographic process of producing copies. Since all conventional waxes are oleophilic, the transfer layer may be based solely on wax, or a mixture thereof with oil, with the addition of small amounts of coloring matter, if desired, for inspection purposes. The following is a typical formulation for a heat-sensitive plate imaging transfer sheet.

A thin translucent 5½ pound kraft paper foundation is coated on one side with a solvent-applied translucent plastic layer of the following composition.

Ingredients:	Parts by weight
Vinylite XYSG (polyvinyl butyral)	5
Ethanol	85
Silica filler	6

After evaporation of the ethanol solvent, the hardened vinyl layer has a thickness of about ½ point. An oleophilic transfer layer of the following composition is applied by hot melt thereover.

Ingredients:	Parts by weight
Carnauba wax	75
Petroleum wax	25
Milori blue (if desired)	1.3

In the case of hectograph duplication, other hectograph imaging materials may be used in place of the dyestuffs. For instance, substantially colorless complementary color-forming chemical compounds such as gallic acid and iron salts may be used, one in the transfer layer and the other in the spirit duplicating fluid or on the copy sheet surfaces as taught by U.S. Patent No. 2,872,863; or substantially colorless dye intermediates and couplers therefor may be used in a similar fashion as taught by U.S. Patent No. 2,748,024.

In place of the saran or polyvinyl butyral plastic of the foregoing examples, any translucent thermoplastic material may be used provided that it does not melt at temperatures below about 500° F. Illustrative plastics include the vinyl resins such as polyvinyl acetate, polyvinylidene chloride, vinyl chloride-vinyl acetate copolymers, acrylic and methacrylic acids and esters, and the like; cellulose plastics such as ethyl cellulose, cellulose acetate, cellulose nitrate; and various other pastics such as nylon polyamides, polyethylene terephthalate polyesters, polycarbonates and the like.

It should further be pointed out that there is no criticality in superposing the sheets in the order shown by FIG. 1. For instance, the transfer sheet may be placed on the bottom with its transfer layer facing up and against the master sheet while the original sheet is on top. Also the separate original sheet may be dispensed with by applying the images 11 to either surface of sheet 30 to be imaged. In any event, the copy sheet, master paper or planographic plate is preferably a translucent paper having the necessary wet strength and hydrophilic properties as the end use requires, and the original sheet is also preferably translucent. However, when it is desired to use a non-translucent original or copy sheet, the non-translucent sheet is superposed at the bottom of the pile as illustrated by FIG. 1 of the drawing so that the radiation does not have to pass therethrough. The only requirement is that the original sheet or the copy sheet must not absorb sufficient radiation on instantaneous exposure thereto to cause the imaging layer to transfer.

The transfer sheets of the present invention may be made into convenient transfer units by removably attaching the transfer sheet to a translucent copy sheet, master sheet or planographic plate. In this way the sheets are perfectly aligned for use, and the unit has uniform radiation translucency, being free of materials which absorb sufficient infrared radiation on instantaneous exposure thereto to cause transfer of the imaging layer. As can be easily understood, the transfer properties and exposure time will vary when different copy sheets are used depending upon the degree of translucency thereof whereas the present units contain identically translucent copy sheets, so that the correct exposure time for perfect transfer may be calculated and will remain constant. This is important since underexposure or overexposure results in wasted materials and loss of time. The attachment of the transfer and copy sheets may be effected by a weak adhesive or by means of weakened severance lines.

According to another embodiment, the transfer layer may be so positioned on the paper foundation to provide clean marginal areas along all four extremities thereof to give the sheet a picture-frame appearance. These marginal areas are free of imaging composition but many contain the plastic intermediate layer since the latter is nontransferable under the effects of heat or pressure. The advantages of such transfer sheets, prepared by printing or otherwise, is that the edges of the transfer sheet are free of imaging composition which may transfer to and contaminate the belts and rollers of conventional infrared radiation duplicating machines such as the Thermo-Fax machine. This problem is most important in the case of hectograph transfer compositions which spread quite easily and are difficult to remove.

As the infrared source it is preferred to use an infrared lamp which emits radiations rich in the infrared range, and to use a convenient apparatus containing the same such as a Thermo-Fax machine which also has means for keeping the sheets in intimate surface contact during irradiation.

Variations and modifications may be made within the scope of the claims and portions of the improvements may be used without others.

I claim:

1. In the thermographic method of imaging a copy sheet in areas corresponding to the location of infrared radiation-absorbing images on an original sheet by means of a transfer sheet carrying a layer of heat-transferable imaging composition, the improvement which comprises using a translucent transfer sheet which does not absorb infrared radiation to any substantial extent comprising a translucent flexible plastic film foundation sheet having on one surface thereof a heat-insulation layer of plastic binder material having a thickness of from about ¼ to about 7 points and containing from about ½ to about 10 parts by weight of an infrared radiation nonabsorbing finely divided filler material per part of binder material and selected from the group consisting of silica, kaolin, calcium carbonate, barium sulfate, titanium dioxide, zinc oxide and clay, said layer having a rough outer surface, and having integrated with said rough outer surface a layer of heat-transferable imaging composition having a thickness of from about ½ to about 6 points, whereby under the effects of heat generated by the heated original images those portions of the imaging layer integrated with the rough surface of the heat-insulation layer remain integrated therewith while overlying portions of the imaging layer transfer to the copy sheet in areas corresponding to the location of the original images.

2. The method according to claim 1 in which the plastic binder material comprises a vinyl resin.

3. The method according to claim 1 in which the filler material comprises silica.

4. The method according to claim 1 in which the heat-transferable imaging composition comprises wax binder material and coloring matter.

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