March 22, 1966 H. C. HAAS 3,241,996

HEAT-SENSITIVE COPY SHEET SYSTEM AND PROCESS OF COPYING

Filed Oct. 10, 1962

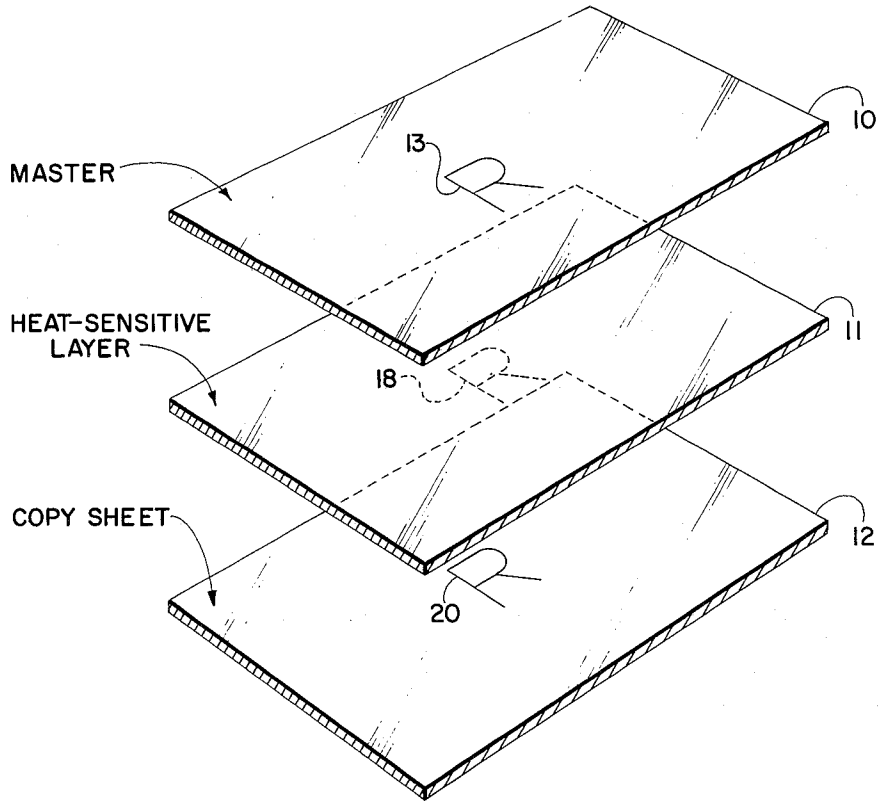

FIG. 1

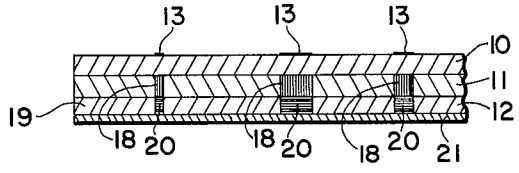

FIG. 2

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United States Patent Office 3,241,996 Patented Mar. 22, 1966

3,241,996

HEAT-SENSITIVE COPY SHEET SYSTEM AND PROCESS OF COPYING

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Filed Oct. 10, 1962, Ser. No. 229,614
13 Claims. (Cl. 117—36.2)

This invention relates to a novel process for thermographic reproduction and to novel copy products for use therein.

One object of this invention is to provide a novel heat-sensitive copy product comprising a heat-sensitive layer and a copy sheet, said heat-sensitive layer comprising a first reactant and a heat-sensitive solid which when melted comprises a solvent for said first reactant, said copy sheet comprising a second reactant and a layer adapted to receive the product of the reaction of said first and second reactants.

Another object of this invention is to provide a novel heat-sensitive copy process wherein graphic material is placed in superposed relationship to a heat-sensitive layer and a copy sheet, said heat-sensitive layer comprising a heat-sensitive solid and a first mark-forming reactant, said heat-sensitive solid being a solvent in the melted state for said reactant, said copy sheet comprising a second mark-forming reactant and a layer adapted to receive the product of the reaction of said first and second reactant, applying heat to said graphic material whereby portions of the heat-sensitive solid corresponding to the dark areas on the graphic material melt, transferring said first reactant by diffusion to the copy sheet where it reacts with said second reactant to form a reproduction of said graphic material.

Another object of this invention is to provide a novel heat-sensitive copy process utilizing the reaction between a dithioxamide compound and a heavy metal salt.

Still another object of this invention is to provide a novel heat-sensitive copy material comprising a heat-sensitive layer containing a dithioxamide compound and a heat-sensitive solid which when melted comprises a solvent for said dithioxamide compound and a contiguous copy sheet containing a heavy metal salt and adapted to receive the product of said reaction between said dithioxamide compound and said heavy metal salt.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the several steps and the relation and order of one or more of such steps with respect to each of the others, and the product possessing the features, properties and the relation of elements which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing wherein:

FIGURE 1 is an exploded perspective view of the novel heat-sensitive copy product of this invention showing a master of graphic material in superposed relationship to said copy product; and

FIG. 2 is a fragmentary exaggerated cross-sectional view of the novel heat-sensitive copy product of this invention with a master of graphic material in superposed relationship to said copy product.

A number of processes are known in the prior art for producing graphic reproductions by means of heat-copy processes. One method provides for the reactants to be intimately associated on a copy sheet with one of the reactants in a progenitor form which is stable under normal temperature conditions but which is transformed into the active reactant or releases the reactant upon the application of heat in the copy process. As one example of such a process, mention may be made of U.S. Patent No. 2,995,466, issued August 8, 1961, wherein a heat image is formed through the controlled formation of an oxazine dye by means of heating a diazonium fluoroborate complex to its decomposition temperature whereby a Lewis acid is liberated which irreversibly converts a chromophore to the colored state. Another process in the prior art involving the chemical transformation of the reactant upon the application of the heat is disclosed and claimed in U.S. Patent No. 2,999,035, issued September 5, 1961, wherein a heat-sensitive heavy metal salt of aminodithioformic acid is utilized.

In the novel heat-copy process of this invention, the reactants are not activated by the application of heat upon the reactants themselves, but rather by the action of heat upon a solubilizing agent which, under the application of heat, acts to carry one reactant into coaction with the other. No chemical change is involved in producing the reactants. In the novel heat-copy process of this invention, one of the reactants is disposed in a heat-sensitive layer which comprises a solid which, in the melted form, is a solvent for said first reactant and which will sustain the mark-forming reaction and a second reactant in a contiguous layer adapted to receive the image-forming product of said reactants.

It may readily be seen that less exposure time and less heat energy is required to produce an image utilizing the novel heat-copy process of this invention than in prior art processes. For example, in the above noted U.S. Patent No. 2,995,466, a decomposition temperature of approximately 135° C. is necessary for release of the Lewis acid. By selecting the proper heat-sensitive solid, the first mark-forming reactant may be solubilized and transferred to the second reactant at relatively low temperatures. Preferably, the solid in the heat-sensitive layer will melt in a range of 35–85° C., more preferably between 40–50° C.

In one embodiment if this invention, the heat-sensitive layer comprises a first mark-forming reactant dispersed in a heat-sensitive solid which when melted comprises a solvent for said first reactant. The copy sheet comprises a layer of a second mark-forming reactant on a support adapted to retain the product of the reaction between said first and second reactants. When a copy is being made, the copy sheet is placed in continguous relationship to the heat-sensitive layer so that the melted solvent will transfer the first reactant to the copy sheet where, by reaction between said reactants, the image of the material to copied will be formed.

In a preferred embodiment, the heat-sensitive layer comprises a polymeric carrier or binder as well as the heat-sensitive solid and the mark-forming reactant. When a polymeric carrier is used, the heat-sensitive layer may be separate and distinct from the copy sheet. Alternatively, the heat-sensitive layer may be cast on top of the layer containing the second reactant. In preparing such a structure, however, care must be taken that premature reaction does not occur during fabrication. When the heat-sensitive copy product of this invention is a single element, means may be provided to strip or separate the copy sheet portion of the element from the heat-sensitive layer after the image has been formed on said copy sheet. Alternatively, a transparent support may be utilized for the copy sheet and the image viewed through said transparent support without the removal of the heat-sensitive layer.

It may be desirable to treat the surface of the copy sheet, in order to facilitate the reception of the mark-forming product of the reaction. For example, a barrier

layer or sizing may be applied, in order to prevent excessive penetration of the mark-forming materials into the suport. An adsorbent receptive layer may also be applied to prevent excessive spreading of the material in order to insure thereby a sharp, well-defined copy of the printed material. Clays and waxes may be used satisfactorily for such purposes. Colloidal silica, such as that sold by E. I. du Pont de Nemours & Co., Wilmington, Delaware, under the trade name "Ludox," has been found especially useful. It may also be desirable to select a layer with a particular degree of acidity or alkalinity most favorable to the reception of the mark-forming materials.

It may readily be seen that, since the production of a copy in the novel process of this invention does not involve the heat sensitivity of the reactants themselves, a more stable image is formed than in prior art processes. This is particularly true when the heat-sensitive layer is physically separated from the copy sheet after the formation of the image. Accidental exposure of the copy sheet to heat after such separation wil not affect the image thereon.

Referring now to FIGURE 1, a master **10**, containing a printed area **13** is shown in exploded relationship to a heat-sensitive layer **11** and a copy sheet **12**. Said heat-sensitive layer **11** comprises a first reactant and a meltable solid which is a solvent for said first reactant when melted and said copy sheet **12** comprises a second reactant and a layer adapted to receive the product of the reaction between said first reacant and second reactant. Upon the exposure of the master **10** to a source of heat, the printed area **13** absorbs the heat more strongly than the surrounding area and melts the corresponding portion **18** of heat-sensitive layer **11** thereby transferring a portion of said first reactant to said copy sheet **12** where said first reactant reacts with said second reactant to form a reproduction **20** of said printed area **13**.

FIG. 2 is a cross-sectional view of the novel heat-sensitive copy product of this invention showing a master **10** with a printed area **13** thereon, a heat-sensitive layer **11** comprising a first reactant and a meltable solid and a copy sheet **12** containing a second reactant, a layer **19** adapted to receive the product of said first reactant and said second reactant and a support **21**. Upon the application of heat to the master **10**, those portions **18** of the heat-sensitive layer **11** corresponding to the printed area **13** of the master **10** melt transferring said first reactant to said copy sheet **12** whereby said reactants form a reproduction **20** of the printed area.

The preferred mark-forming reactants for use in this invention are dithioxamide compounds and heavy metal salts; more preferably, dithioxamide and a mixture if nickel acetate and copper acetate which upon reaction produces dense black marks. Such dense black marks produce high quality images with a good contrast and are especially desired in copy processes. The term "heavy metal salt" is intended to include inorganic, organic and complex organic salts. As examples of such complex organic salts, mention may be made of nickel salicylate and nickel acetylacetonate.

As examples of suitable heat-sensitive solids which when melted are solvents for dithioxamide compounds, mention may be made of ethyl carbamte, propionamide, acetamide and allylurea.

The following nonlimiting example illustrates the novel products and processes of this invention.

Example

A solution was prepared by dissolving 1 gm. of cellulose acetate in methanol and acetone to which was added a solution comprising 0.5 gm. of ethyl carbamate and 0.5 gm. of dithioxamide. A sheet was cast from the solution and allowed to harden. A copy sheet was prepared by coating a sheet of paper with a layer of Ludox and with a dilute solution of nickel acetate and copper acetate and drying. The heat-sensitive layer was then superimposed on top of the copy sheet and the printed sheet to be copied was placed face up on top of the heat-sensitive sheet. Heat was then applied to the printed page from an infrared heat lamp for approximately 1 min. The printed sheet was then removed and the copy sheet and the heat-sensitive layer separted. A positive image of the printed page was visible on the copy sheet.

It should be noted that the novel heat copy products of this invention may also be used in conventional thermal exposure devices such, for example, as that sold by Minnesota Mining and Manufacturing Co., St. Paul, Minnesota, under the trade name "Thermofax."

While the preferred reactants of this invention comprise dithioxamide and a mixture of copper and nickel acetate to form a dense, black precipitate, it should be understood that other combinations of dithioxamide compounds and heavy metal salts may be used to achieve precipitates of various colors. As examples of other dithioxamide compounds which may be used, mention may be made of substituted dithioxamide, particularly N,N'-disubstituted-dithioxamides such as N,N'-dimethyldithoxamide and N,N'-dibenzyl-dithioxamide.

Since certain changes may be made in the above product and process without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A heat-sensitive copy product for the reproduction of graphic materials superposed thereon, comprising a heat-sensitive layer and a copy sheet, said heat-sensitive layer comprising a first reactant and a heat-sensitive solid, said solid when melted comprising a solvent for said first reactant whereby said first reactant may be transferred by dissolution and diffusion to said copy sheet, said copy sheet containing a second reactant adapted to react with said first reactant to form a reproduction of said graphic material on said copy sheet, and said copy sheet comprising a strippable layer contiguous to said heat-sensitive layer which, when stripped, is capable of providing a stable copy of said graphic material which is substantially free from heat-sensitive material.

2. A product as defined in claim **1** wherein said heat-sensitive layer contains a polymeric carrier.

3. A heat-sensitive copy product for the reproduction of graphic materials superposed thereon, comprising a polymeric carrier carrying a heat-sensitive layer comprising a dithioxamide compound in a heat-sensitive solid, said solid when melted comprising a solvent for said dithioxamide compound, and a copy sheet in superposed relationship to said heat-sensitive layer, said copy sheet comprising a support and a heavy metal salt thereon, which heavy metal salt is capable of reacting with said dithioxamide compound when said dithioxamide compound is solubilized and transferred thereto, said copy sheet further being adapted to be stripped from said heat-sensitive layer following reaction between said dithioxamide compound and said heavy metal salt to provide a copy of said graphic material, which copy is substantially free from heat-sensitive material.

4. A product as defined in claim **3** wherein said dithioxamide compound is dithioxamide and said heavy metal salt comprises a mixture of nickel acetate and copper acetate.

5. A product as defined in claim **3** wherein said polymeric carrier is cellulose acetate.

6. A product as defined in claim **3** wherein said heat-sensitive solid is ethyl carbamate and melts at 39° C.

7. A heat-sensitive copy process comprising the steps of contacting a page of graphic material with a heat-sensitive layer comprising a first reactant and a heat-sensitive solid, said solid when melted comprising a solvent for said first reactant, applying heat to said page whereby said solid coextensive with the graphic material

on said page melts and dissolves said first reactant, transferring said dissolved first reactant by diffusion to a superposed copy sheet containing a second reactant adapted to react with said first reactant whereby an image of said page is reproduced on said copy layer, and stripping said copy layer from said heat-sensitive layer to provide a stable copy of said page which is substantially free from heat-sensitive material.

8. A process as defined in claim **7** wherein said heat-sensitive layer is contained in a polymeric carrier.

9. A heat-sensitive copy process comprising the steps of contacting a printed page with a heat-sensitive layer comprising a dithioxamide compound and a heat-sensitive solid, said solid when melted comprising a solvent for said dithioxamide compound, applying heat to said printed page whereby those portions of the heat-sensitive solid coextensive with the printing melt and dissolve said dithioxamide compound contained therein, transferring said dissolved compound by diffusion to a superposed copy sheet containing a heavy metal salt adapted to react with said dithioxamide compound, whereby a reproduction of said printed page is produced on said copy sheet, and stripping said copy sheet from said heat-sensitive layer to provide a stable copy of said printed page,

which copy is substantially free from heat-sensitive material.

10. A process as defined in claim **9** wherein said dithioxamide compound is dithioxamide and said heavy metal salt is a mixture of nickel acetate and copper acetate.

11. A process as defined in claim **9** wherein said heat-sensitive layer contains a polymeric carrier.

12. A process as defined in claim **11** wherein said polymeric carrier is cellulose acetate.

13. A process as defined in claim **9** wherein said heat-sensitive solid is ethyl carbamate and melts at 39° C.

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