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METHOD AND APPARATUS FOR THE NEGATIVE REPRODUCTION OF MASTERS ON A COPY BEARER UTILIZING A HEAT ABSORBING LAYER

Filed May 6, 1960

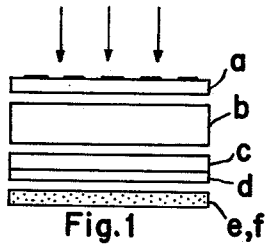

Fig.1

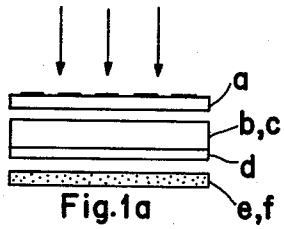

Fig.1a

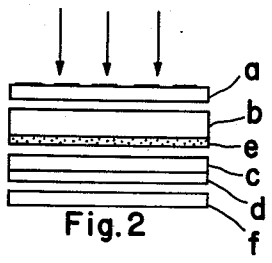

Fig.2

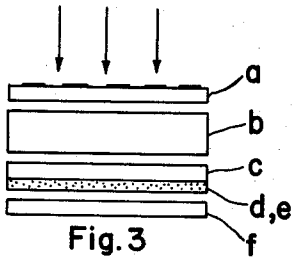

Fig.3

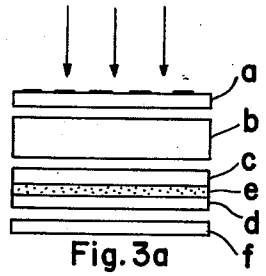

Fig.3a

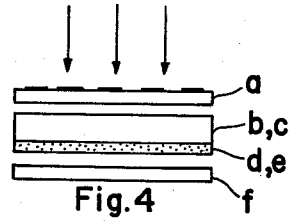

Fig.4

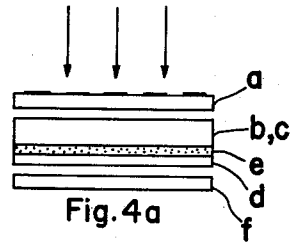

Fig.4a

INVENTOR.

ERWIN LIND

BY

J. Russell Juten

ATTORNEY

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METHOD AND APPARATUS FOR THE NEGATIVE REPRODUCTION OF MASTERS ON A COPY BEARER UTILIZING A HEAT ABSORBING LAYER

Erwin Lind, Wiesbaden-Biebrich, Germany, assignor to Kalle Aktiengesellschaft, Wiesbaden-Biebrich, Germany, a corporation of Germany

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25 Claims. (Cl. 250—65)

The present invention relates to negative reproduction of masters on a copy bearer by the use of heat and more particularly to the transfer of an image to relatively inexpensive paper.

Heretofore it has been known that copies can be produced if a master is brought into intimate contact with a reproduction material consisting of a thin paper having on one side a pigmented wax covering as reproduction coating. The master is placed on the paper side of the reproduction material and a paper, which is later to carry the copy (the copy bearer), on the wax side. If, after the material has been thus set up, heat rays are beamed upon the master, they will be preferentially absorbed in the dark parts of the master and converted into perceptible heat. This heat flows firstly through the paper of the master and then through the paper of the reproduction material to the wax coating, in which it produces melting. In the parts corresponding to the dark parts of the master the wax then becomes transferred to the copy bearer, so that a copy corresponding to the master is obtained thereon.

An object of the present invention is to provide a process and materials for making negative copies of masters by the transfer of image forming material to a copy bearer.

A further object is to provide an inexpensive process and inexpensive material for duplicating copies by the passage of heat through a master and depositing an observable image on inexpensive copy bearer material.

Other objects and advantages will be apparent from the following description.

The present invention includes a process for the preparation of copies from a master by the action of heat by means of a reproduction layer which is in contact with a copy bearer characterized in that a heat-ray transmittant, heat-conduction inhibiting intermediate layer, is set between master and reproduction coating and heat rays are then passed therethrough, provision being made by means of heat-absorbing agents that the parts of the reproduction layer corresponding to the image-free parts of the master are preferentially heated so that a negative image of the master is formed on said copy bearer in contact with the reproduction layer.

The masters used may be of many different kinds. They are normally thin, heat-ray transmittant materials made in particular of cellulose products or plastics and furnished on one side with a text or drawing. For the heat-ray transmittant, heat-conduction inhibiting intermediate layer thin foils of transparent or opaque (light-diffusing) material can be used provided they adequately transmit heat-rays and are capable of inhibiting heat-conduction. For example, foils made of cellulose products such as paper, cellulose hydrate, cellulose esters such as cellulose acetate, cellulose propionate and cellulose acetobutyrate, various plastics, e.g., polyolefines such as polyethylene, polypropylene, polyvinyl alcohol, polyvinyl chloride and polyvinylidene chloride, polyamides, polyesters such as polyterephthalic acid glycol ester, polycarbonates and polyurethanes may be used. In particular, foils made of cellulose acetate, polyolefines, polyvinyl-compounds with chlorine content and polyesters are suitable. It is also possible for thin glass plates to be used but in general flexible foils are to be preferred.

The inhibition of heat-conduction is, among other things, a function of the thickness of the layer. Selection of the appropriate thickness for the heat-ray transmittant heat-conduction inhibiting layer will give the required effect. In general, layers of a thickness within the range of about 20 to 300μ, preferably of about 100μ to about 200μ will be used. Layers of greater thickness only seldom give an improved effect. Layers of less thickness will not adequately inhibit heat conduction, except in special cases and under very accurate conditions, so that thin layers will only very seldom be resorted to.

The reproduction material used consists of a support furnished with a reproduction layer.

The support may, for example, consist of thin foils made of cellulose products such as paper and cellulose hydrate, cellulose esters such as cellulose acetate and cellulose propionate. Equally well thin foils made of plastics as detailed in the previous paragraph as suitable for the heat-ray transmittant, heat-conduction inhibiting intermediate layer may be used. Because of their cheapness and effectiveness the cellulose products are in general preferable. The thickness of the support is preferably from about 20 to about 40μ. Thinner and also thicker supports may be used.

The reproduction layers used are in general ones of which the melting point is between 30 and 140° C., preferably between 50 and 110° C. Those having wax-type properties are preferred. The required properties are in general achieved by a combination of a number of substances. Primarily, natural and synthetic waxes, advantageously so-called hard waxes such as carnauba wax, esparto wax, candelilla wax and mixtures of such products are used. In addition to these hard waxes, the reproduction layers generally contain substances that increase flexibility and decrease brittleness. For this purpose, mineral oils or other paraffin hydrocarbons such as petrolatum, ozocerite, ceresin, Vaseline or soft paraffins are added. Also, natural and synthetic resins such as colophony, shellac, polystyrene, polyethylenes, polyacrylates, alkyl cellulose, dyestuffs, pigments and fillers may be worked into the coating mixture.

An example of a simple reproduction layer is one consisting of equal parts of carnauba wax and mineral oil into which a dyestuff is mixed.

The essential characteristics of the reproduction layer comprise a melting point within the required range and a certain wax-like stickiness, enabling the layer to be easily transferred to the copy bearer, to which it will then adhere.

It is therefore not absolutely esesntial that the reproduction layers should consist of or contain a wax in a narrow sense; other naturally occurring or synthetic products with wax-like properties, e.g. paraffins higher fatty acids, higher aliphatic alcohols and higher aliphatic ketones, polyglycols, polyethylene oxides, polyglycerine, and substitution products such as chloroparaffins can also be used. The expression "wax-type substances" used in this invention should comprise all the naturally occurring waxes and the synthetic waxes and the products with wax-like properties mentioned above.

The wax-type reproduction layer is applied to the sup-

porting material in known manner. The material is melted and is applied to the support by casting, roller application or spraying. For the prevention of curling, the application of a back-coating to the support is often advisable. For this purpose a thin, non-pigmented, wax-type coating can, for example, be used.

The substances used as heat-absorbent material are ones that heavily absorb heat rays and convert them into perceptible heat. Dark-colored layers or layers consisting of dark material, e.g., plastics or paper foils colored black throughout, are suitable. Foils to which a black coating has been applied are also suitable. Photographic papers or films which have been exposed to light, developed and fixed are thus very satisfactory.

For preference, however, a dark dyestuff or dark substance such as carbon-black is added directly to the wax-type reproduction layer and the heat absorption thus effected. The essential thing is for dark-colored, preferably black materials to be brought into intimate contact with the wax-type reproduction layer, either by layer-to-layer contact or by the presence of the two materials in one layer. The heat-absorbent substance can with advantage be selected so that it has an absorption maximum in the wave-length region transmitted by the heat radiator.

Suitable heat radiation sources are ones which have a sufficiently high temperature, e.g., from some hundreds of degrees to several thousands. In general, commercially available infra-red radiators are used. It is an advantage if the rays are concentrated by means of reflectors on the image surface. It is advisable for the quantity of heat necessary for the melting of the reproduction layer to be applied in a brief radiation of high intensity. In this way sharper images are obtained than when the same quantity of heat is applied by less intensive radiation of longer duration.

Foils of the most varied materials, in particular foils such as already detailed above as suitable material for the heat-transmittant, heat-conduction inhibiting intermediate layer, can be used as the supporting material for the final copy, i.e., as the copy bearer. However, here too papers and other cellulose products are used for preference. The copy bearer can also consist of metal foils or glass. Foils made of metal such as aluminum, copper or zinc or those made up of several layers of metal, e.g., chromium on copper, as used for the preparation of printing plates, are particularly suitable. In same cases it is possible to use dark colored copy bearers which also serve at the same time as light absorbent layers.

There are a number of ways in which the present invention can be carried into effect.

For example, FIGURE 1 shows a master *a* with printing on one side which is placed upon a heat-ray transmittant, heat-conduction inhibiting intermediate layer *b* and then the two together are placed upon the reproduction material consisting of a support *c*, e.g., paper, and the wax-type reproduction layer *d*. The reproduction material is arranged in such a way that the reproduction layer *d* is away from the master. A black paper is then placed on the reproduction layer as copy bearer *f* and the heat rays are beamed upon the master thus irradiating the various superposed layers. The arrows show the direction of the heat rays used. Due to its black color the copy bearer *f* serves also as heat absorbing material *e*. An image is obtained on the copy bearer which is a negative of the master. If a light-colored reproduction layer is used, readily legible copies which are light on dark ground are obtained.

A modification of this procedure (FIG. 1*a*) consists in the application of the reproduction layer *d* directly to the heat-ray transmittant, heat-conduction inhibiting intermediate layer *b*. Thus intermediate layer *b* at the same time serves as support *c* for the reproduction layer *d*. For the reproduction layer to be effective the intermediate layer (*b*=*c*) must have adequate thickness. Thicknesses greater than 20/μ and up to about 300/μ, preferably from about 100 to about 200/μ, are considered adequate. Layers of even greater thicknesses can be used but in general no further improvement of the effect is achieved.

A further procedure (FIG. 2) consists in the placing of a reproduction material consisting of a support *c* and the reproduction layer *d* downwards, upon a copy bearer *f* and in the placing thereon of a material which on the side facing the reproduction material has a dark, powerfully heat-absorbent layer *e*, e.g., exposed, developed and fixed photographic material, as heat-ray transmittant, heat conduction inhibiting layer *b*. Upon this mtaerial the master *a* is then placed and the heat rays beamed thereon.

A particularly effective procedure (FIG. 3) by which the process can be carried out consists in the placing of a reproduction material consisting of a support *c* and a reproduction layer *d*, with its reproduction layer *d* against the copy bearer *f*, the reproduction layer in this case containing a dark dyestuff or a dark pigment such as carbon-black, as heat-absorbing agent. Therefore the reproduction layer at the same time serves as heat absorbing material *e*. A heat-ray transmittant, heat-conduction inhibiting sheet *b* is placed on the reproduction material, and then the master *a* is laid on top. Heat rays are then beamed upon the master and in this way the copy is produced on the copy bearer *f*.

It is also possible (FIG. 3*a*) to coat the support *c* with a heat absorbing layer *e* and to coat this layer *e* in turn with a reproduction layer *d* instead of incorporating the heat absorbing material into the reproduction layer.

A further (see FIG. 4) simplified modification of the process described above (in FIG. 3) consists in the application of the reproduction layer *d* containing the heat-absorbing agent *e* directly to the heat-ray transmittant, heat-conduction inhibiting intermediate layer *b* serving at the same time as support *c*. Reproduction material of this type is placed with the reproduction layer (*d*=*e*) against the copy bearer *f* and the master *a* is placed on top.

It is also possible not to incorporate the heat absorbing material into the reproduction layer but to coat both materials in two separate layers (see FIG. 4*a*).

The procedure described in FIG. 4 is particularly suitable for continuous processing. In such case there may, for example, be, in a transparent hollow roller making up the heat-ray transmittant, heat-conduction inhibiting layer, a device which presses the master from inside. The heat radiation source is also in the hollow roller and so also may be the reflector which concentrates the heat rays on the image surface. The reproduction material and the material serving as copy bearer are passed over the roller.

The copying process described above enables negative copies to be prepared from masters simply and rationally. The copies keep satisfactorily at room temperature and if heated to 80–100° C. can be transferred to another supporting material. Also, if a metal is used as copy bearer, the parts not covered with the reproduction coating can be etched and in this way printing plates can be produced.

Examples

(1) A coating preparation produced by the melting together of 40 parts by weight of carnauba wax, 40 parts by weight of mineral oil and 15 parts by weight of carbon black is cast upon a thin wax base paper with a weight of 40 g. per square metre. When the reproduction layer has cooled, the coated paper is placed coated side upon a copy bearer, e.g. a sheet of typewriter paper, and the uncoated side is covered with a cellulose hydrate foil about 100μ thick. The master that is to be copied is placed on the cellulose hydrate foil. These sheets are then passed all together at a constant speed of several metres a minute through the image plane of a focused 1500 watt infra-red radiator. The reproduction layer becomes hot under the non-absorbent parts of the master and becomes transferred to the typewriter paper beneath it which is to serve as copy bearer. From a negative master a positive image

which at room temperature has very good stability is obtained.

(2) A coating preparation produced by the melting together of 36 parts by weight of carnauba wax, 1 part by weight of ozocerite, 40 parts by weight of mineral oil, 5 parts by weight of oleic acid, 3 parts by weight of crystal Violet and 15 parts by weight of carbon black is cast upon a cellulose hydrate foil of a thickness of 100μ. The coated foil is exposed under a master to radiant heat as described in Example 1. The cellulose hydrate foil serving as supporting material for the coating preparation acts simultaneously as heat-insulating intermediate layer.

(3) 30 parts by weight of carnauba wax, 10 parts by weight of crude montan wax, 40 parts by weight of mineral oil and 5 parts by weight of Sudan Red BK are melted together to form a coating preparation. This preparation is coated upon a carbon tissue paper with a weight of 25 g. per square metre. The coated paper is placed coated side upon a copy bearer, the opposite side being covered with a photographic film that has been exposed to light, developed and fixed and which will absorb the heat radiation passing through the original. It is the black side of the film that is put in direct contact with the back of the wax-coated paper. The acetate film with the silver coating serves simultaneously as heat ray transmittant, heat-insulating intermediate layer. In the copying process the master is laid on the heat-insulating film. A negative red image of the master appears on the copy bearer.

(4) An exposed, developed and fixed photographic silver halide film is coated on its layer side with a melt containing 10 parts by weight of paraffine (melting point 56–58° C.) and 1 part by weight of Sudan Yellow GG (Color Index, 2nd Edition, Vol. 3, No. 11020). The reproduction material thus produced is placed with its layer side onto a white duplicating paper, which serves as the copy bearer, and then briefly exposed under a master to infra-red radiation. Under the image-free areas of the master, the yellow coating on the silver halide film melts and a yellow image is produced on the contacting white duplicating paper, which is a negative with regard to the master used.

(5) A carbon tissue paper having a weight of 20 g. per square metre is coated with a melt made up of 10 parts by weight of a synthetic wax ("Gersthofener Wachs KP"), 10 parts by weight of paraffine of a melting point of 56–58° C., and 20 parts by weight of castor oil. Further, 6 parts by weight of titanium dioxide were added, while stirring, to the melt as pigment. The reproduction material thus obtained is then placed coated side down on a paper pigmented black throughout which serves as the copy bearer. Prior to irradiation of the reproduction material with infra-red rays through a master, there is superimposed on the uncoated side of the reproduction material an about 100μ thick polyvinyl chloride film which serves as heat insulating layer and prevents the conduction of heat from the heat-absorbent areas of the master toward the reproduction layer. By this heat treatment, a white image corresponding to the image-free areas of the master is formed on the black colored paper.

(6) The melt described in Example 5 is coated onto a 100μ thick cellulose hydrate film. The film is placed coated side on a paper colored black throughout and, after superimposing a master on the uncoated side of the cellulose hydrate film, the assembly is exposed to a short, intensive infra-red radiation. For this purpose, the reproduction material is passed in close contact over the image plane of a focused 1375 watt infra-red radiator at a speed of some metres per minute. The cellulose hydrate film used as the support serves also as the heat-insulating layer and prevents the conduction of heat from the heat-absorbing areas of the master toward the reproduction layer. The infra-red radiation passing through the image-free parts of the master is absorbed by the black paper serving as the copy bearer. The reproduction layer in contact with the black paper melts in the heated areas and on the black paper a white image is formed which is a negative of the master used.

It will thus be seen that applicant has provided an efficient and simple process of making copies by transferring an image to a copy bearer and it will be apparent that various changes may be made in the application of the invention within the valid scope of the appended claims.

What is claimed is:

1. The method of reproduction comprising superimposing on a heat absorbing layer a reproduction layer which is coated on a support and superimposing on said support a heat ray transmittant, heat conduction inhibiting layer, applying a master on said heat ray transmittant, heat conduction inhibiting layer and passing heat rays through the master toward said heat absorbing layer for forming a negative image of the master on said heat absorbing layer.

2. The method of reproduction comprising superimposing on a heat absorbing layer a reproduction layer which is coated on a heat ray transmittant, heat conduction inhibiting layer, applying a master on said heat ray transmittant, heat conduction inhibiting layer and passing heat rays through the master toward said heat absorbing layer for producing a negative image of the master on said heat absorbing layer.

3. The method of reproduction comprising superimposing on a copy bearer a reproduction layer which is coated on a support and superimposing on said support a heat ray absorbing layer coated on a heat ray transmittant, heat conduction inhibiting layer, applying a master on said heat ray transmittant, heat conduction inhibiting layer and passing heat rays through the master toward said copy bearer for producing a negative image of the master on said copy bearer.

4. The method of reproduction comprising superimposing on a copy bearer a dark colored reproduction layer which is coated on support and superimposing on said support a heat ray transmittant, heat conduction inhibiting layer, applying a master on said heat ray transmittant, heat conduction inhibiting layer, and passing heat rays through the master toward said copy bearer for producing a negative image of the master on said copy bearer.

5. The method of reproduction comprising superimposing on a copy bearer a reproduction layer which is coated on a heat ray absorbent layer, the latter in turn being coated on a support, and superimposing on said support a heat ray transmittant, heat conduction inhibiting layer, applying a master on said heat ray transmittant, heat conduction inhibiting layer, and passing heat rays through the master toward said copy bearer for producing a negative image of the master on said copy bearer.

6. The method of reproduction comprising superimposing on a copy bearer a dark colored reproduction layer which is coated on a heat ray transmittant, heat conduction inhibiting layer, applying a master on said heat ray transmittant, heat conduction inhibiting layer, and passing heat rays through the master toward said copy bearer for producing a negative image of the master on said copy bearer.

7. The method of reproduction comprising superimposing on a copy bearer a reproduction layer which is coated on a heat ray absorbing layer, the latter in turn being coated on a heat ray transmittant, heat conduction inhibiting layer, applying a master on said heat ray transmittant, heat conduction inhibiting layer and passing heat through the master toward said copy bearer for producing a negative image of the master on said copy bearer.

8. The method of transferring an image to a paper sheet comprising interposing a heat ray transmittant, heat conduction inhibiting layer between a master and a supported heat absorbent image forming layer and placing a copy bearer in contact with the image forming layer, whereby at least a portion of the heat absorbent layer will

be transferred to the copy bearer when heat rays are passed through the master to the copy bearer.

9. The method of forming a negative image from a master comprising applying the master on a heat ray transmittant, heat conduction inhibiting layer which is in contact with a layer of image forming heat absorbing material, whereby transmitted heat rays passing through the master and the heat ray transmittant, heat conduction inhibiting layer will selectively heat the portions of the image forming layer.

10. A process for the preparation of copies from a master by the action of heat comprising providing a reproduction layer in contact with a copy bearer, positioning a heat ray transmittant, heat conduction inhibiting layer adjacent the reproduction layer and on the opposite side of such reproduction layer from the copy bearer, placing a heat absorbing agent closely adjacent the reproduction layer, placing the master adjacent the heat transmittant heat conduction inhibiting layer, and passing heat rays therethrough so that the heat rays are absorbed by heat absorbing agents closely adjacent the reproduction layer corresponding to the non image areas of the master so that a negative image of the master is formed on the copy bearer in contact with the reproduction layer.

11. A process according to claim 10 in which a wax-type reproduction layer is used.

12. A process for the preparation of copies from a master by the action of heat comprising providing a reproduction layer in contact with a copy bearer, positioning a heat ray transmittant heat conduction inhibiting layer of a thickness from about 20μ to about 300μ between the reproduction layer and the master, providing heat absorbing agent in a layer adjacent the reproduction layer, which heat absorbing agent serves to absorb heat in such layers, and passing heat rays through said layers thereby preferentially heating the reproduction layer and forming an image in the negative on said copy bearer.

13. A process for the preparation of negative copies from a master by the action of heat comprising providing a reproduction layer in contact with a copy bearer, providing a heat absorbing layer adjacent to said reproduction layer which will absorb radiant energy to which it is exposed, positioning a heat ray transmittant heat conduction inhibiting layer closely adjacent the heat absorbing layer and the reproduction layer and selecting the thickness of such heat ray transmittant heat conduction inhibiting layer so that radiant energy passing through said layer will selectively heat the portions of the reproduction layer in the non-image areas of the master thereby forming a negative image of the master.

14. A method of making negative masters from a positive original by radiant heat comprising placing a heat ray transmittant master having heat absorbent indicia in contact with one surface of a heat ray transmittant heat conduction inhibiting member, positioning a copy bearer adjacent the other surface of said heat ray transmittant heat conduction inhibiting member, positioning a heat softenable reproduction layer between said heat ray transmittant heat conduction inhibiting member and said copy bearer with the heat softenable reproduction layer in contact with said copy bearer and placing a heat absorbing layer closely adjacent said heat softenable reproduction layer whereby heat rays originating on the side of said positive original away from said copy bearer and away from said heat ray transmittant heat conduction inhibiting member pass through said positive original and said heat ray transmittant heat conduction inhibiting member concentrating heat on said heat absorbing layer causing softening of said heat softenable reproduction layer and adherence of the softened portion of said heat softenable reproduction layer on said copy bearer whereby a negative image of said positive original is produced on said copy bearer material.

15. Reproduction materials for making negative copies from the master comprising a support, a meltable reproduction layer on said support for direct contact with a copy bearer, a heat ray transmittant heat conduction inhibiting layer for positioning between a master to be copied and the reproduction layer and a heat absorbent layer on the side of said heat ray transmittant heat conduction inhibiting layer away from the master.

16. The invention according to claim 15 in which the heat absorbent layer is incorporated in the copy bearer, and the heat ray transmittant heat conduction inhibiting layer is separate from said support layer.

17. The invention according to claim 15 in which the heat absorbent layer is incorporated in the copy bearer and the support and heat ray transmittant heat conduction inhibiting layer are incorporated in a single layer.

18. The invention according to claim 15 in which the heat absorbent layer is mounted on the surface of said heat ray transmittant heat conduction inhibiting layer away from the master, and the heat ray transmittant heat conduction inhibiting layer is separate from the support.

19. The invention according to claim 15 in which the heat absorbent layer is incorporated in the reproduction layer, and the heat ray transmittant heat conduction inhibiting layer is a separate layer from the support.

20. The invention according to claim 15 in which the heat absorbent layer is mounted on the support between the support and the reproduction layer, and the heat ray transmittant heat conduction inhibiting layer is a separate layer.

21. The invention according to claim 15 in which the support and heat ray transmittant heat conduction inhibiting layer are a single layer and the heat absorbent layer is incorporated in the reproduction layer.

22. The invention according to claim 15 in which the support and heat ray transmittant heat conduction inhibiting layer are a single layer and the heat absorbent layer is mounted between the said single layer which is the support and the heat ray transmittant heat conduction inhibiting layer and the reproduction layer.

23. The invention according to claim 22 in which the said single layer which is the support and the heat ray transmittant heat conduction inhibiting layer and the heat absorbant layer are an exposed and developed film.

24. A reproduction material for making negative copies from a master comprising a support, a heat absorbing layer positioned on said support with one surface of said heat absorbing layer mounted on one surface of said support, and a meltable reproduction layer mounted with one surface thereof on the other surface of said heat absorbing layer whereby one surface of a heat ray transmittant heat conduction inhibiting layer may be placed on the other surface of said support, a master placed on the other surface of said heat ray transmittant heat conduction inhibiting layer, and a copy bearer placed on the other surface of said reproduction layer, so that heat rays may be passed through the master toward said copy bearer heating the non-image areas of the heat absorbing layer and thereby heating the meltable reproduction layer in said non-image areas to transfer the reproduction layer in said non-image areas to said copy bearer.

25. A reproduction material for making negative copies from a master comprising a support, said support providing a heat ray transmittant heat conduction inhibiting layer, a heat absorbing layer mounted with one surface on one surface of said support providing a heat ray transmittant heat conduction inhibiting layer, and a meltable reproduction layer mounted with one of its surfaces on the other surface of said heat absorbing layer whereby a master may be placed on the other surface of said support providing a heat ray transmittant heat conduction inhibiting layer and a copy bearer placed on the other surface of said reproduction layer and heat rays passed through said master, through said heat ray transmittant heat conduction inhibiting layer in a direction from said master toward said copy bearer thereby heating the non-image areas of the heat absorbing layer and the meltable

reproduction layer in said non-image areas to transfer the reproduction layer in said non-image areas to said copy bearer.

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