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NOVEL DUPLICATING PROCESSES

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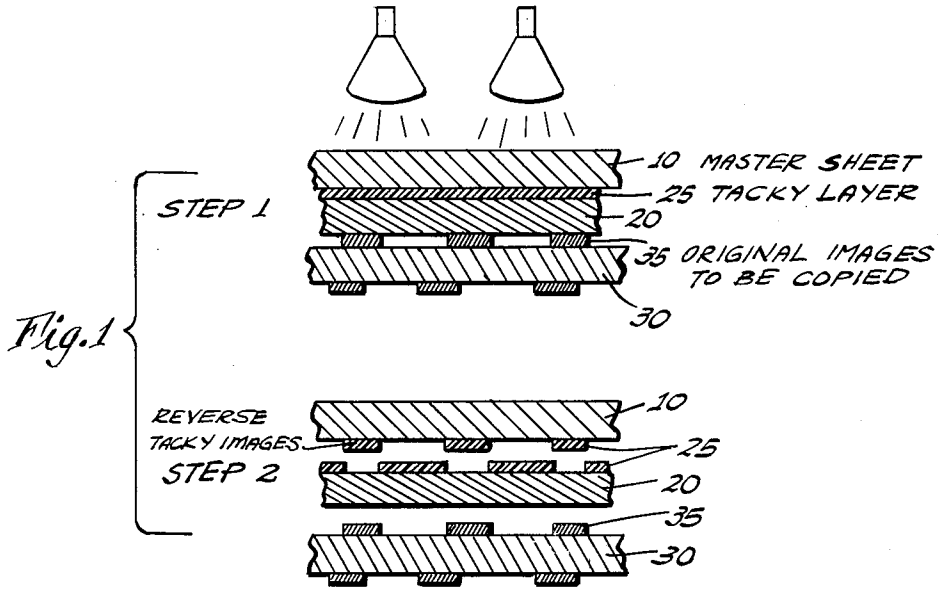


Fig. 1

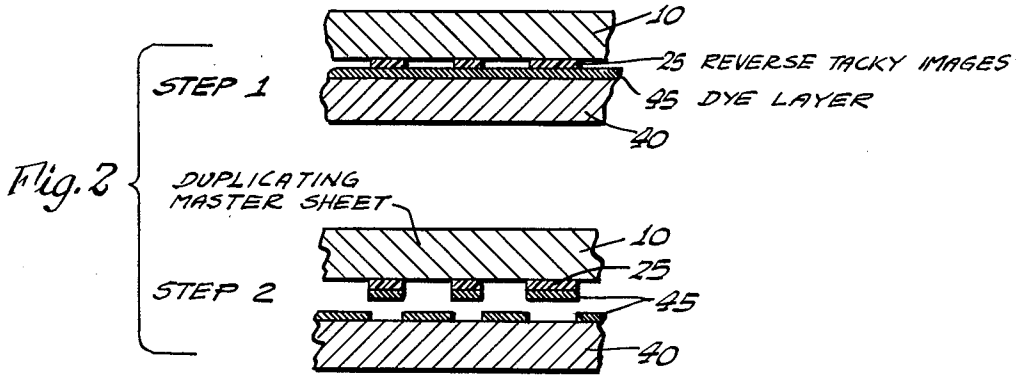


Fig. 2

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NOVEL DUPLICATING PROCESSES

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The present invention relates to novel duplicating processes and means for effecting such processes, and more particularly to the preparation of duplicate copies by thermographic means.

This application is a continuation-in-part of copending applications Serial No. 420,123, filed March 31, 1954, now abandoned, and Serial No. 19,113, filed March 31, 1960, now Patent No. 3,088,402, issued May 7, 1963, which is a continuation of parent applications Serial No. 511,855, filed May 31, 1955 and Serial No. 437,757, filed June 18, 1954, both now abandoned.

It is already known to prepare duplicating media such as hectograph master sheets directly from an original sheet by the use of infrared radiations, as taught by my said copending application Serial No. 420,123. The theory of such known processes is that infrared radiation does not generate heat until it is absorbed by some foreign body such as the images on an original sheet. Therefore, if infrared radiation is directed onto an original sheet which is in surface contact with a master sheet which in turn is in surface contact with the transfer layer of a hectograph transfer sheet, the imaging material of which does not absorb infrared radiation, the radiation is absorbed by the images of the original sheet and converted to heat in the imaged areas. The unabsorbed radiation passes relatively unaffected through the sheets and since it is not substantially absorbed thereby, it does not generate any substantial amount of heat. However, the heat generated by the absorbed radiation in the images penetrates the master sheet to the underlying transfer layer which is melted in areas corresponding to the imaged areas of the original sheet and which thus transfers to the master sheet to form the imaged master.

Such known processes have several important disadvantages. Of principal importance is the fact that these processes are limited to the use of hectograph transfer sheets which contain dyestuffs which do not absorb infrared radiation. There are any number of duplicating dyestuffs which therefore cannot be employed because of their infrared radiation-absorbing properties. Secondly, masters prepared in this manner are generally neither sharp nor clear due to the fact that the heat which is generated by the images on the surface of the original sheet must pass through the original sheet and through the master sheet before affecting the transfer layer. These intermediate sheets function as insulators and tend to dissipate much of the generated heat. Thus, the heat which does reach the transfer layer is greatly diminished and quite uneven so that the transfer to the master sheet is light and spotty. Copies prepared in the spirit process from these masters are inferior in that the imaging is uneven, being light and illegible in spots.

Another serious disadvantage resides in the fact that copies of ordinary original sheets having imaging on both sides of the sheet, such as book pages, cannot be produced by such known processes in that since the infrared radiation is passed through the original sheet, it is absorbed by the images on either side of the sheet which both generate heat to the transfer layer. The master produced therefore carries both direct- and reverse-imaging and is useless for the production of copies.

It is therefore an object of the present invention to prepare sharper and more efficient hectograph master

sheets than heretofore possible with known thermographic processes.

It is another object of this invention to effect the thermographic preparation of hectographic master sheets corresponding to an original sheet having imaging on one or both sides of the sheet.

It is a further object of the invention to prepare hectographic masters, single carbon copies, or planographic printing plates directly corresponding to such original sheets by thermographic means, irrespective of whether the coloring material absorbs infrared radiation or not.

These and other objects may be accomplished in the manner hereinafter described.

In the drawing:

FIGURE 1 represents a segmentary cross-section, to an enlarged scale, of a master sheet **10**, a tacky sheet **20** and an original sheet **30**. Step 1 shows the sheets in position, though separated for illustration purposes, and under the infrared treatment. Step 2 shows the sheets after removal from the infrared source and separation of the sheets.

FIG. 2 represents a segmentary cross-section, to an enlarged scale, of the master sheet **10** imaged with the tacky material **25** and a hectograph transfer sheet **40**. Step 1 shows the sheets in position and under the influence of either solvent or heat. Step 2 shows the sheets after removal of the activating source and separation of the sheets.

The present invention is based upon the fact that thermoplastic-resin compositions are relatively immune to infrared radiaiton. Thus, for instance, it has been found that if a foundation sheet carrying a thin layer of thermoplastic-resin composition is subjected to infrared radiation in contact with an unimaged paper sheet, no transfer occurs. However, if the same procedure is carried out in contact with a paper sheet beiring carbon black images, the thermoplastic-resin composition becomes fused or melted in areas corresponding to the imaged areas of the paper sheet and transfers thereto.

A second important discovery resides in the fact that such thermoplastic materials when present in image form on a foundation sheet and placed in contact with the frangible transfer layer of a transfer sheet and activated in a suitable manner such as by solvent or if heated to a certain temperature, will soften and fuse to said transfer layer so that upon resetting and separation of the sheets, said transfer layer is picked off by the thermoplastic material and thus transferred to the foundation sheet over the imaged areas.

As can readily be seen, it is an important aspect of the present invention that the thermoplastic-resin composition layer be so formulated that it will transfer to a paper sheet when activated, but it will not transfer to a frangible layer under the same circumstances. In other words, the resin composition layer is frangible when activated in contact with a paper sheet but its frangibility is not as great as the frangbility of commercially available wax transfer layers of the carbon, hectograph or planographic type.

Thus, according to the present invention, use is made of a tacky transfer sheet exemplified by FIG. 1 of the drawing, as sheet **20**, carrying a heat-transferable layer of thermoplastic-resin material **25**. The foundation sheet may be in general any suitable material such as paper, glassine paper or plastic material such as cellulose acetate, polyethylene terephthalate (Mylar) or the like. The nature of the thermoplastic-resin material is not critical so long as it is within the following specifications. It must absorb little or no infrared radiation so that the direct effect of the radiation is not great enough to raise the temperature of the resin material to its softening or

melting point. Its softening or melting point must also be relatively low and in general somewhat lower than the melting or softening point of the colored transfer layer **45** of the transfer sheet **40** exemplified by FIG. 2 of the drawing.

In the drawing, FIG. 1 shows the two-step imaging of a master sheet **10** with reverse images of thermoplastic-resin material **25** inversely corresponding to the images **35** on the surface of the original sheet **30** facing the radiation source. The positioning of the sheets in the order shown by FIG. 1 results in the formation of reverse-images and is therefore the order used where the preparation of hectograph master sheets is desired. Where, however, it is desired to prepare direct-reading images such as in the production of single carbon copies or planographic plates, then one has but to reverse the tacky sheet **20** and the master sheet **10** so that the radiation is directed onto the back of the tacky sheet **20** and passes through the tacky layer **25**, through the master sheet **10** to the original sheet **30**. Another suitable method of producing direct-reading images from an original sheet having images on only one side is to place the original sheet on top, images facing the light source, and place the tacky sheet **20** in the middle, the resin layer facing away from the radiation source and in contact with the master sheet which is on the bottom.

FIG. 2 of the drawing shows the master sheet **10** carrying the reverse-reading resin images placed together with a hectograph transfer sheet and activated by heat or solvent so that the resin images fuse to the hectograph dye layer and cause its transfer to the resin-imaged areas upon separation of the sheets. It should be noted that the treatment may be by solvent or heat. This same procedure exemplified by FIG. 2 is used where single carbon copies or planographic plates are desired to be made, the only difference being that the images **25** on the master sheet **10** are direct-reading images produced in the manner hereinbefore explained, and the transfer sheet **40** carries a transfer layer **45** of the carbon black or planographic pigment type.

In accordance with the present invention, the thermoplastic-resin-carrying transfer sheet is produced in the following manner. A suitable foundation sheet such as paper or plastic film is coated with a thin layer of suitable thermoplastic-resin material. Suitable resin materials are the halogenated hydrocarbon polymers such as the Arochlor resins, cellulosic materials, such as ethyl cellulose; polyterpene resins such as Piccolyte and Nypene; unsaturated hydrocarbon polymers such as the polyisobutylenes like Vistanex and Indopol; acrylate and methacrylate polymers such as polymethyl acrylate and poly-n-butyl methacrylate, plasticized polyvinyl chloride and acetate; and the vinyl alkyl ethers such as Oppanol C which is vinyl-n-butyl ether.

The resin material may be applied to the foundation sheet in any desired manner such as by solvent coating, hot melt, spraying, etc. In general it is preferred to employ the hot melt method.

In all cases, it is important that the resin layer be frangible to the degree set forth hereinbefore so that under the effect of heat it will adhere and transfer to an adjoining sheet in contact therewith while it will adhere to and pick off an adjoining transfer layer.

One method of effecting this frangibility is to render the resin layer porous or honeycomb in structure. This may be accomplished in many ways. One such way is to dissolve the resin, prior to coating it upon the foundation sheet, in a mixture of volatile ingredients, one of which is a solvent for the resin and the other of which is a non-solvent therefor. The selection of the different volatile components is, of course, dependent upon the nature of the resin material employed and is well within the purview of those skilled in the art. An example of such method demonstrating the use of ethyl cellulose as the thermoplastic resin, methanol as the solvent and water as the non-solvent is as follows:

Ingredients:	Parts by weight
Ethyl cellulose (low viscosity	40 to 55
Lower alkyl alcohol (methanol)	400 to 500
Water	25 to 75

The softness, hardness or frangibility of the tacky layer may be controlled by regulating the amount of water used, higher amounts resulting in a more porous and more frangible layer. The components are thoroughly mixed and spread on a suitable foundation as a thin uniform coating and allowed to dry by evaporation of the volatile components. Suitable plasticizers may be included to modify the heat softening range.

Any of the aforementioned thermoplastic resinous materials may be substituted in the above formula, variations being made in the nature of the solvent and non-solvent materials, depending upon the solubility characteristics of the resin selected.

Another suitable method of obtaining the desired degree of frangibility resides in the use of waxes and/or oils and fillers in the resin composition and applying the same by the hot melt method. An example of such a resin composition is as follows:

Ingredients:	Parts by weight
Carnauba wax	40
Indopol H–300 (polyisobutylene resin)	40
Mineral oil	5
Arochlor 5460 (halogenated hydrocarbon polymer)	15
Clay	40
Crystal violet (if desired for proofreading purposes)	1.3

Where desired, an additional 4–5 parts of blown castor oil, triphenyl phosphate or Carbowax 4000 may be added for increased frangibility.

Still another suitable method of rendering the resin layer frangible resides in the use of a non-volatile plasticizer which is a non-solvent for the resin at ordinary room temperatures but is a solvent for the resin at elevated temperatures. Such resin dispersions are commonly known by the name plastisol or organosol as pointed out by Schildknecht at pages 434 and 435 of his book "Vinyl and Related Polymers," Wiley & Sons, New York (1952). According to this aspect of the present invention, a suitable foundation sheet may be coated with an organosol composition mixed as follows:

Ingredients:	Parts by weight percent
Vinylite VYHH (soft copolymer of vinyl chloride and vinyl acetate)	30 to 50
Plasticizer (dioctyl phthalate)	15 to 25
Solvent (ethyl acetate)	20 to 50

The thermoplastic-resin transfer sheet produced according to any of the preceding formulations is then used to image a suitable master sheet in the following manner. An original sheet, from which it is desired to produce a hectograph master sheet, is placed together with the sheet carrying the layer of the resinous composition and a master sheet and subjected to infrared radiation in the manner exemplified by FIG. 1 of the drawing. The images facing the infrared source will be copied in reverse on the master sheet in the form of the thermoplastic resin. Where the original sheet has images **35** on only one surface, then the infrared radiation may be passed through the pack from the underside, i.e. the radiation is directed against the unimaged side of the original sheet. Likewise a change in the order of the sheets may be made if direct-reading copies or planographic plates are desired to be produced in the manner set forth hereinbefore.

The resin-imaged master sheet is then placed in surface contact with a suitable transfer sheet of the carbon black, hectograph or planographic type and treated so that the

resin becomes tacky and adhesive and binds to the transfer layer. Upon separation of the sheets, a substantial amount of the transfer layer is picked off the transfer sheet by the resin images on the master sheet to produce a hectograph master sheet, a carbon copy or a planographic printing plate, depending upon the nature of the transfer sheet employed. The resin images on the master sheet may be treated in a variety of ways to render them tacky and adhesive. Where they are to be imaged by a hectograph master sheet it is generally preferred to use physical heat as the activating means. Thus the hectograph transfer sheet and the resin-imaged master sheet are heated to a temperature sufficiently high to bond the resin to the hectograph layer but not sufficiently high to melt the hectograph layer. In general, temperatures in the range of from about 100° to about 160° F. are preferred for this purpose depending upon the melting point of the hectograph layer. Another suitable method where hectograph transfer sheets are used is to subject the transfer sheet and the resin-imaged master sheet to treatment with a material which is a solvent for the resin composition and a non-solvent for the hectograph layer or the dyestuff contained therein. The preferred method of accomplishing this is to employ a volatile component and contact the sheets with only the vapor thereof. The selection of an appropriate solvent depends of course upon the thermoplastic resin employed as well as the nature of the colorant in the transfer layer. In general, volatile solvents such as the chlorinated hydrocarbons, ketones, ethers and esters are suitable.

The source of infrared radiation is in general not critical although it is preferred to employ a convenient apparatus such as the Thermo-Fax machine or the flat bed thermographic machine, both of which employ infrared lamps. The exposure time varies between about two and twenty seconds to build up a temperature of between about 100° to 160° F. in the selected areas of the thermoplastic-resin sheet.

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. The process of preparing duplicate copies from an imaged original sheet having thereon images containing material which is infrared radiation-absorbing heat-generating, which comprises the steps of (1) placing in surface contact the imaged original sheet, a copy sheet and a transfer sheet, the transfer layer of which comprises a thermoplastic resin composition; (2) subjecting the superposed sheets to infrared radiation for a period of time sufficient to fuse the transfer layer to the copy sheet in areas corresponding to the imaged areas of the original sheet; (3) separating the sheets to produce the copy sheet which is imaged with the thermoplastic resin composition in said areas; (4) placing said resin-imaged copy sheet in surface contact with the colored wax-base transfer layer of a transfer sheet; (5) treating said sheets to render the thermoplastic resin composition adhesive and cause it to bond to said transfer layer; and (6) separating the sheets to produce the copy sheet bearing the colored transfer layer overlying the resin images.

2. The process of claim 1 in which the colored transfer layer contains hectograph dyestuff and the final copy sheet is a spirit-duplicating hectograph master sheet.

3. The process of claim 1 in which the colored transfer layer contains planographic pigments and the final copy sheet is a planographic master sheet.

4. The process of claim 1 in which the step of rendering the thermoplastic resin composition adhesive is accomplished by heating of the sheets.

5. The process of claim 1 in which the step of rendering the thermoplastic resin composition adhesive is accomplished by treating the sheets with a material which is a solvent for said thermoplastic resin.

References Cited in the file of this patent

UNITED STATES PATENTS

2,073,033	Szasz	Mar. 9, 1937
2,567,435	Kraus	Sept. 11, 1951
2,769,391	Roshkind	Nov. 6, 1956
2,808,777	Roshkind	Oct. 8, 1957
2,810,661	Newman et al.	Oct. 22, 1957
2,872,340	Newman	Feb. 3, 1959
2,949,849	Gundlach	Aug. 23, 1960

FOREIGN PATENTS

722,023	Great Britain	Jan. 19, 1955
813,637	Great Britain	May 21, 1959
1,029,837	Germany	May 14, 1958
1,165,125	France	May 27, 1958