

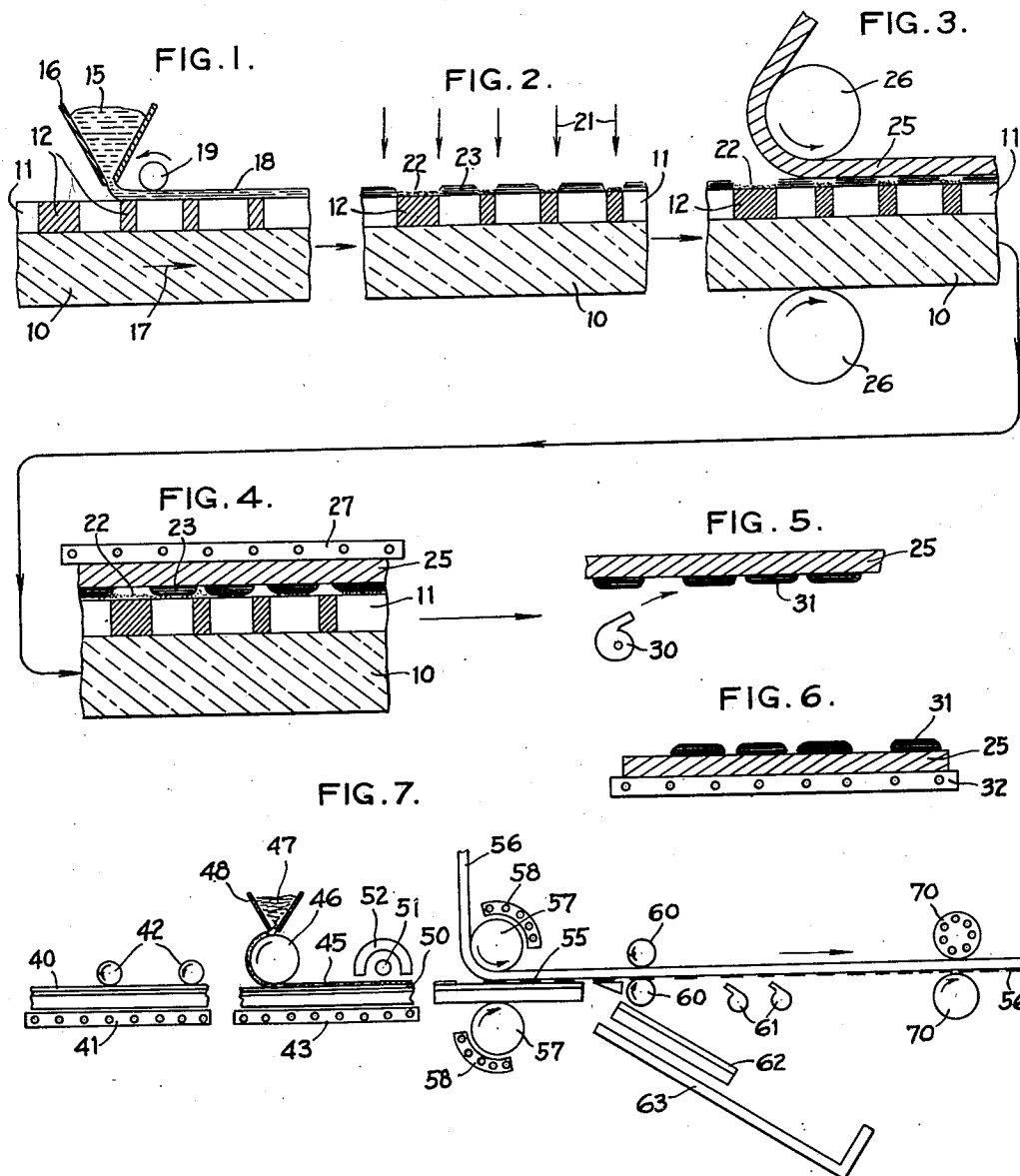
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EVAPOROGRAPHY

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This invention relates to photothermography. It may be considered a modification of the form of fusion photothermography described in Serial Number 768,977, filed concurrently herewith, but it is evaporography rather than fusion photothermography because the formation of the final image is prior to and independent of any fusion which may take place.

The object of the present invention is to provide a simpler, more direct printing system and one of the distinguishing features thereof is the fact that the ink is transferred from a negative image rather than from a positive image as covered by the latter of the two cases just mentioned. Another distinguishing feature is the extent to which the vapor pressure and volatility of the ink is employed as well as the ability of the ink to fuse.

According to the present invention a negative two-tone image is made up in heat absorbing material. A two-tone image is one which has only light areas and dark areas such as a line drawing or a halftone image. A heat absorbing material, as far as the present invention is concerned, is one which absorbs radiation and converts it into heat; the term "heat absorbing" is commonly used in this sense although strictly speaking a more exact term would be "radiation-absorbing-heat-producing." A halftone negative image made on extremely high contrast photographic film of the type employed by the printing trade is quite satisfactory for the present invention. The silver deposit in the halftone satisfactorily absorbs radiant energy and converts it into heat energy, whereas the radiation is not absorbed in the clear areas. According to the invention this two-tone negative image is coated with a layer of substantially non-fluid ink, i. e. a solid, powdered, or highly viscous ink, at least part of which is highly volatile. That is, the vehicle of the ink has a high vapor pressure at room temperature or at temperatures just slightly above room temperature.

For a later step of the process it is also necessary that the ink melt and fuse to a support at a temperature above room temperature, but not too high. Acetone oxime, which melts at 60–61° C., or p-dichlorobenzene, which melts at 52.5–53° C., is satisfactory as the volatile and fusible part of the ink vehicle. Thus the ink must melt and boil (or perhaps sublime if in free space) all at temperatures not far above room temperature. The low boiling point is concomitant to the required high vapor pressure.

The coated negative is then uniformly radiated,

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either all over at once or by passing the negative under a highly intense line of light, preferably a source of light rich in infrared or other radiation which is absorbed by the silver or whatever heat absorbing material is used. The exposure is of sufficient intensity and for a sufficient time to heat the ink adjacent to the dark areas of the negative and to evaporate the ink from those areas, without removing it from the other areas of the negative. This leaves the ink pigment in powdered form without any fusible vehicle, or at least any easily fusible vehicle, over the dark areas of the negative. Before the rest of the ink has had an opportunity to volatilize, a paper or other final print support is pressed into contact with the ink layer. The contacting layers are then heated and in the confined space the ink fuses into the paper support to form a positive image therein. The support is then allowed to cool and is separated from the negative. If any of the unwanted ink pigment has carried over on to the support, but has not fused thereto because of the absence of fusible vehicle in those areas of ink, this unwanted ink is removed by brushing or preferably by a pneumatic squeegee.

In general, I prefer to include in the ink vehicle a second fusible material which melts at a temperature above that at which the main part of the vehicle evaporates. A satisfactory material for this purpose is a thermoplastic resin such as ester gum. Thus after the ink from the dark areas of the negative has evaporated, the pigment in these areas is still contained in a fusible vehicle, but this does not transfer to the paper support because the temperature is not raised high enough to transfer it. However, after the ink in the other areas has transferred by fusion of the volatile vehicle, and the ink from the unwanted areas has been removed, the whole print is raised to a still higher temperature to fuse the remaining pigment into the paper permanently.

For example, using one part of any dry pigment color with one part of a thermoplastic resin fusing at about 120° C. and 2 parts of acetone oxime, I have made a satisfactory ink by powdering the three ingredients together. This mixture is spread on a silver negative image, either halftone or line as described above, and is exposed from either side of the negative. The oxime fuses and simultaneously evaporates or sublimates from the exposed areas leaving the pigment in these regions without fusible material. A paper sheet which is to constitute the final support is pressed against the powder by a plate heated to 65° C. which fuses the oxime in the confined

space where momentarily it cannot volatilize. The fusion of the oxime has some effect toward softening the resin and fusing it permanently to the film, but certain thermoplastic resins are not soluble in acetone oxime in which case the image is subsequently fixed permanently in the paper by passing the film quickly over an element maintained at a temperature slightly in excess of 120° C. Satisfactory resins for this purpose are as follows: ester gum, ethyl cellulose, polystyrene.

The operation of the invention is illustrated in the accompanying drawing in which:

Figs. 1 to 5 constitute a flow chart illustrating various steps of a preferred embodiment of the invention.

Fig. 6 illustrates an alternative additional step which may be used.

Fig. 7 illustrates schematically one form of continuous printing apparatus incorporating the invention.

In Fig. 1 a film support 10 carries a halftone high contrast negative image 11 in gelatin. This is represented schematically by a greatly enlarged cross section of such a film in which the silver dots are illustrated at 12. A volatile fusible powdered ink 15 is deposited from a hopper 16 as the film 11 moves under the hopper as indicated by the arrow 17. The layer of ink 18 as thus deposited is pressed by a roller 19 into firm contact with the halftone negative 11.

In the next step of the operation of the invention as illustrated in Fig. 2, the coated negative 11 is uniformly illuminated by infrared radiation indicated by arrows 21 which is of sufficient intensity to heat the silver spots 12 and thus to volatilize the ink vehicle from the adjacent areas, leaving only the powdered pigment 22 in those areas, but leaving fusible ink 23 in the areas adjacent to the clear parts of the negative 11. This printing plate is immediately pressed into contact with a paper or film final support 25 by means of a roll 26 as illustrated in Fig. 3. The sandwich is then heated by a hot plate 27 as shown in Fig. 4 which causes the areas 23 to fuse into the paper support 25 forming a positive image therein. The powdered pigment 22, however, does not fuse into the paper support and is either removed with the negative 11 or as shown in Fig. 5 is removed by an air squeegee 30 which blows any powdered ink away from the unfused areas, leaving the positive image 31 on the paper or film support 25.

After all of the unwanted ink from the positive image is removed as shown in Fig. 5, the final print may be further heated as illustrated in Fig. 6 by laying it on a hot plate 32 to insure permanent fusion of the ink layer 31 into the paper support 25.

A complete cycle of operation of the invention is illustrated in Fig. 7, in which a halftone negative 40 is preheated on a hot plate 41 to a suitable temperature just below the evaporation point of the ink to be used. It is then moved forward by means of driving rollers 42 engaging the edge of the negative, and on to a second hot plate 43. At the same time it is coated with an ink layer 45 by means of a roller 46 on to which a volatile fusible ink 47 is fed from a hopper 48. The coated negative labeled 50 at this stage passes

under the highly intense infrared source 51, provided with a gold plated reflector 52, which volatilizes the ink from the dark tone areas of the negative 50. The negative which now carries a positive image in highly viscous fusible ink 55 is pressed into contact with a roll of paper 56 by means of pressure rollers 57. The rollers 57 are maintained at a temperature above the melting point of the ink 55 by means of heaters 58. The positive ink image fuses to the paper 56 and passes between pressure rollers 60 after which any unwanted ink is blown off the paper by means of an air squeegee 61. The negative from which the print has just been made is labeled 62 and passes on to an inclined table 63. The press may alternatively be provided with suitable brushes for removing all residual ink from the negative 62 so that it may be used over again immediately, or alternatively the negative being printed may be on a cylinder or continuous band as described in my coiled application mentioned above, to provide continuous operation of the press. The additional heating step illustrated in Fig. 6 is also provided in Fig. 7 by means of heated rollers 70 maintained at very high temperature to fuse the residual components of the ink into the paper 56.

The invention is not limited to the particular structures disclosed above but is of the scope of the appended claims.

I claim.

1. The method of printing which comprises coating onto a two-tone negative image formed of a material which absorbs infrared radiation and converts it to heat, a layer of ink which contains a pigment and which is not fluid enough to flow around, at least part of which ink is volatile enough to volatilize under infrared radiation and is fusible and transferable when fusing, uniformly radiating the coated negative with infrared radiation of sufficient intensity and for sufficient time to evaporate all of the volatile and fusible part of the ink from the areas of the coating overlying the infrared absorbing areas of the image without removing it from the other areas of the image, placing a final print support to which the ink will transfer and fuse without hurting the support, in contact with the remaining ink layer, heating the contacting layers to fuse the ink in said other areas into the support to form a positive image therein and removing the negative and all unfused ink from the support.

2. The method according to claim 1 including the additional step of heating the final positive image on the support to a high temperature to fuse the image permanently into the support.

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