Jan. 20, 1970 A. GAMES 3,490,371

COPYING PROCESSES

Filed Oct. 4, 1965

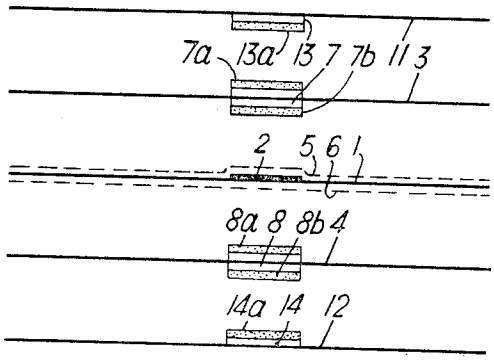


Fig. 1.

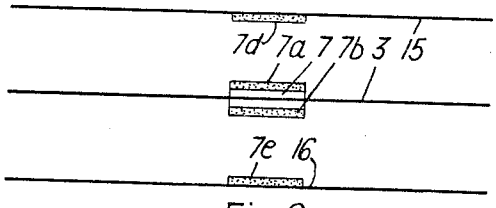


Fig. 2.

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COPYING PROCESSES

Abraham Games, London, England, assignor to Imagic Limited, London, England a British company

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U.S. Cl. 101—426 8 Claims

ABSTRACT OF THE DISCLOSURE

A method of producing a master to give a number of copies of an original design is disclosed. A vaporizable material is caused to evaporate over areas representing the original desin and to condense to form a latent image on a sheet porous enough to permit penetration of the condensed material to permit development of the material at the remote side of the sheet. The sheet can then be developed on both sides or the material can be vaporized from that sheet to an additional sheet or sheets.

This invention relates to the copying of original designs for example in the form of printed matter, pictorial designs, photographs, and so forth. It is particularly concerned with the method of copying described and claimed in United Kingdom patent specification No. 943,401 in which a vaporizable material or "oil" is caused to evaporate under the influence of heat over areas representative of the original design and condensed on a receiving surface to form an image. The term "oil" is defined in this earlier specification and also for the purposes of the present specification as including materials whether liquid or solid not normally regarded as oils but which are nevertheless, capable of behaving in the manner just described. The image formed by the condensation of such oil is usually a latent image which requires to be treated (preferably with a powder capable of adhering to the areas of oil) and thus to produce a developed image. The method is most conveniently carried out under the influence of infrared heat which is absorbed by the areas representative of the original design and thus causes the evaporation of oil over these areas. It will therefore be understood that the nature of the material defining the image areas of the original design strongly influences the speed at which the process may be carired out. If the image has a high concentration of carbon, metal or other heat-responsive material then the vaporisation temperature is achieved more rapidly than where the concentration of such material is low.

Good copies of original designs in which the image areas contain a very low proportion of heat responsive material can be produced but under these circumstances more heat is generally required by prolonging the exposure. Since generally speaking a fixed source of radiation will be used for all originals this is quite feasible but tends to be inconvenient particularly when more than one copy is to be produced. Repeated readjustment of the power source as an alternative to length of exposure is also inconvenient.

According to the present invention oil is caused to evaporate under the influence of heat over areas representative of the original design as described above and this oil is condensed to form a latent image on a sheet of paper or similar material which is sufficiently thin and porous for the oil defining the latent image to penetrate the sheet at least to an extent sufficient to permit development on the side of the sheet remote from the original. The latent image is then developed on both sides of the porous sheet to give a double-sided master

from which subsequent copies may be taken. It is a simple matter for this master sheet to be developed by material having a high concentration of heat responsive material so that when the master is used for the production of subsequent copies a considerably shorter standardised exposure may be used. Instead of merely shortening the exposure, however, it is possible to use a normal length exposure with a considerably less powerful source of radiation. The fact that the image is on both sides of the master sheet will further increase the concentration of heat-sensitive material and in addition it makes it possible to take copies from both sides of the master sheet simultaneously with a consequent advantage in resolution due to the presence of the second developed image on the master sheet.

When relatively large numbers of copies are required, two double-sided masters may be produced at the same time. For this purpose it is necessary that the original design should be on a translucent sheet and a film of oil is then applied to both sides of this sheet. Oil is then caused to evaporate simultaneously from both sides of the translucent sheet and to condense on two separate master sheets arranged on opposite sides of the translucent sheet. The latent images formed on these master sheets are then developed as previously described.

As mentioned originally it is necessary that the sheet used for the formation of the master should be sufficiently thin and porous for the latent image to be developed on both sides. Provided that the oil passes right through the master sheet it is then possible to place yet a further sheet in contact with the side of the thin porous master sheet remote from the original when the oil passing through the master sheet will also form a latent image on the further sheet. Quite apart from the production of copies from the master, the latent image on the further sheet may be developed either to form an additional copy or to be used in the production of still further copies.

The copies produced from the double-sided master or from the further sheet just described are most simply obtained by offsetting. For this purpose the various latent images may be developed by means of powdered ink or other methods disclosed in United Kingdom specification No. 943,401, which offsets are taken before or during fixing of the developed images. The image on one side of the master will be right-way-round so that the further copies produced from it will be mirror images and in general will therefore need to be formed either on a translucent sheet so that they can be viewed from the other side or alternatively may be rendered visible on that side as described in the copending application Ser. No. 333,182 filed Dec. 24, 1963. The image on the other side of the master will be a mirror image so that the copy or copies produced from it will be right-way-round and may thus be produced directly on opaque material. By use of an appropriate ink for developing purposes it is possible to take more than one offset from each developed image on the master sheet and it is also possible to take one or more offsets from the offset copies. Since each step of offsetting effectively reverses the image it is, of course, necessary to select the proper paper as described above. By means of the various methods just described or a combination of such methods quite large numbers of copies from a single exposure of the original design may be produced at high speed and the developed and fixed images of the master sheet may give yet a further copy.

When multiple copies are produced by offsetting in this way there will be inevitable minor variations in the density of the different copies and if it is desirable to avoid this the copies may be produced by further steps of evaporation and condensation rather than offsetting. In

this event the images on both sides of the master sheet are first fixed and the further copies may then be taken either from one side of the master sheet or from both sides simultaneously. If copies are taken from both sides simultaneously then double the number of total copies will be produced but even when copies are taken from only one side considerable advantages result for the reasons given originally, namely, that the images on the master sheet can be developed with an ink having a high content of thermally responsive material and the presence of a layer of this material on both sides of the thin porous sheet gives a master which is highly responsive to heat, enabling exposures to be materially accelerated for any given source of radiation and improved resolution as mentioned above.

Generally speaking the oil needed for the further evaporation may be applied to the master sheet as a continuous film or it may be applied overall in the form of a spray. The oil may also be concentrated in the image areas by developing the latent images on both sides with an ink which includes oil for the subsequent step of evaporation as well as a high proportion of heat responsive material. No overall film of oil then needs to be applied to the master and copies may be taken until all the oil in the image areas is exhausted. In theory it is not necessary to use infrared radiation under these circumstances but it is usually more convenient to do so since apparatus intended for use with a variety of types of original masters in any case includes a source of infrared radiation.

A double-sided master produced in accordance with the invention may also be used in the production of one or more negative copies of an original design. For this purpose a film of oil is applied to one side of the master which is placed in contact with a barrier surface which is preferably absorbent to infrared radiation. An infrared transmissive receiving surface is placed in contact with the other surface of the master and the combination is then heated. The evaporated oil passes through the thin porous master sheet except in the areas defining the image since the presence of the ink in these areas acts as a mask and renders the sheet non-porous. Accordingly the oil passes through the sheet only in the non-image areas and then condenses on the receiving surface to form a latent image which is subsequently developed. Since these developed areas corresponds to the non-image areas of the original design the resultant image is a negative one. By selecting the side of the double sided master to bear the oil the copy produced may be either a right reading or mirror image copy. Both a negative and positive copy may be produced simultaneously by the method in which case the surface adjacent that side of the master bearing the oil is developed in addition to the negative copy.

The various oils, inks, and developing methods described in United Kingdom specification No. 943,401 are in general suitable for use in a process in accordance with the invention. Of the oils described in this previous specification some are particularly suitable for incorporation in the powdered ink for developing purposes and then serve for subsequent evaporation in the production of multiple copies. Of these oils, mineral oils, H.B. 40, essential oils, chlorinated diphenyls and polyphenyls available under the registered trade mark "Aroclor" are suitable, as also is triacetin (glyceryl triacetate). The thin porous sheet used for the master is preferably of thin tissue such as used as lens or cosmetic tissue or as a base for office stencils. A suitable type of paper is of Japanese origin and is of about 9 g.s.m. substance. This is known as a long-fibred tissue and is available under the name "Tengujo." Such tissue enables vaporized oil from the original design to pass freely through it to enable the latent image to be developed on both sides of the sheet and it also permits the passage of sufficient vaporized oil for the formation of a latent image on a further sheet as described above.

The steps in the formation of the various images in a method in accordance with the invention can best be described by reference to the accompanying drawings in which:

FIGURE 1 shows an assembly of sheets used in the production of one or two double-sided masters, and

FIGURE 2 shows the use of one such master for the production of copies.

Turning first to FIGURE 1 a sheet bearing an original design is shown as **1** and one of the image areas of the design is shown as **2**. If only a single master is required only one side of the original needs to be operated on but as illustrated two double-sided masters are produced simultaneously as shown at **3** and **4**, in which case the original requires to be suitably translucent. For this purpose the image-bearing side of the original **1** is given a film of oil **5** and the rear of the sheet is given a film of oil **6**. The master sheets **3** and **4**, which are of thin porous material as previously described, are brought into contact with these oil films and oil is then caused to evaporate under the influence of heat over areas corresponding to the image area **2**. As described in United Kingdom specification No. 943,401 the evaporated oil from both sides of the original **1** condenses on the master sheets as indicated at **7** and **8** respectively and owing to their nature oil penetrates the sheets so as to form latent images on both sides as indicated.

Further sheets **11** and **12** placed outside the master sheets **3** and **4** also receive latent images **13** and **14** respectively from oil which has passed through the master sheets and all the latent images, namely, the double-sided images **7** and **8** and the single-sided images **13** and **14** are then subsequently developed, preferably by means of powdered ink as described in the earlier specification referred to.

The layers of ink constituting the developed images are shown as *7a*, *7b*, *8a*, *8b*, *13a*, and *14a*, respectively. If the masters are to be used for the production of further copies by further steps of evaporation and condensation of oil the images are first fixed but if the copies are to be produced by offsetting they are, of course, not fixed until after or during offset. The step of offsetting from one of the masters **3** is illustrated in FIGURE 2, from which it will be seen that the developed images *7a* and *7b* are partially transferred to form further images *7d* and *7e* on receiving sheets **15** and **16** respectively. Depending on the nature of the ink used a number of offsets can be taken from the images *7d* and *7e*. The same assembly is used where the double sided master **3** is developed with an ink incorporating oil and latent images are formed simultaneously on sheets **15** and **16**.

Although FIGURE 1 illustrates the formation of the maximum number of latent images it will, of course, be understood that the sheets **11** and **12** may be omitted and that if only a single master is required it is preferable to work from the image side of the original to give the master shown as **3**. The production of such a master will now be further described with reference to the following examples. In each example the heat was supplied by a 1500 watt tubular infra-red lamp mounted 3/8" from the surfaces to be heated. The assembly of sheets was passed beneath the lamp at a speed dependent on the length of exposure required.

EXAMPLE 1

A double-sided master was produced by coating the image side of the original with a fine film of triacetin and covering this with a sheet of thin porous paper of 8.6 g.s.m. The oil was then caused to evaporate under the influence of heat as described in the basic specification referred to above. On separation from the original the porous paper was developed simultaneously on both sides with a powdered ink consisting of a mixture of colophony resin and carbon black. The master sheet thus formed was then heated to fuse and thus fix the double-sided

image and was then ready for the production of copies by further steps of evaporation and condensation.

EXAMPLE 2

The initial steps of Example 1 were repeated and after the formation of the latent image one side of the porous paper was developed with a red pigmented ink and the reverse side was developed with a black ink. After fixing each side was clearly distinct in colour.

EXAMPLE 3

The initial steps of Example 1 were repeated and both sides of the thin porous sheet were developed by a powdered ink consisting of three parts by volume of white damar resin and two parts by volume of Hexalac black (trademark of Pointings Ltd.). The images on both sides of the porous sheet were then offset, the mirror image on to a sheet of bond paper and the right reading image on to a sheet of translucent paper. For this purpose the three sheets were assembled together and pressure from a metal roller caused the ink on the porous sheet to be partly offset to each of the outer sheets. The resultant images were then fused to give three separate copies.

EXAMPLE 4

The steps of Example 3 were repeated to the stage of offsetting the images on to the two outer sheets. After this these offset images were again offset, that from the translucent sheet on to bond paper and that from the bond paper to a translucent sheet to give a mirror image visible through the sheet. All five images were then fused to give a total of five copies.

EXAMPLE 5

An original document was coated with a thin film of triacetin and covered with a sheet of the same porous paper as in Example 1. This in turn was covered by a sheet of thin cellulose acetate of 0.001" gauge. The combination was then exposed to cause evaporation of oil from the image areas which pased through the porous sheet and on to the cellulose acetate sheet to form latent images. The images on both sides of the porous sheet were developed with red ink on one side and with black ink on the other side and the cellulose acetate sheet was similarly developed with black ink to give a mirror image visible through the sheet. Offsets as described in Example 3 were then taken from both sides of the porous sheet and all images were then fused to give a total of four copies.

EXAMPLE 6

A original on translucent paper was coated on both sides with a thin film of eugenol and a porous sheet (as in Example 1) was placed against each side. The combination was exposed to heat to cause the evaporation of oil which penetrated each porous sheet and each of these sheets was then developed on both sides. Offsets were taken from both sides of both porous sheets and the images fused to give a total of six copies.

EXAMPLE 7

A double sided master was produced in accordance with Example 1 from a document printed by a litho-offset process at an exposure speed of 30 feet per minute. A film of triacetin was then applied to the side bearing the mirror image which was placed against a sheet of bond paper. The combination was exposed through the porous master and an exposure speed of between 120 and 150 feet per minute was found to give the best results. The latent image thus produced on the bond sheet was then developed and fused. The speed of exposure when working from the double-sided master was thus just over four times as great as when working directly from the printed original itself.

EXAMPLE 8

A double sided master was first produced using the basic method of Example 1 but developing the two images with a powdered ink consisting of 1.5 parts by volume solid Aroclor 1268 (registered trademark of Monsanto Ltd.), a solid chlorinated bi-phenyl, and one part by volume carbon black. The developed images were lightly fused to avoid evaporating the Aroclor. A sheet of bond paper was placed against the side of the master bearing the mirror image and a translucent sheet placed against the other side. The combination was then exposed to heat to give latent images on both copy sheets as a result of vaporisation and condensation of the Aroclor, and these latent images were then developed and fused. The process was repeated with further pairs of copy sheets until the Aroclor was exhausted, which was found to occur after 60 copies had been produced.

EXAMPLE 9

A double sided master was made in accordance with Example 1 and a thin film of mineral oil was applied to the side having a right reading image. This was placed face downward on a black heat absorbent support and a sheet of infra-red-transmitting bond paper was placed over the uppermost side bearing the mirror image, after which the combination was exposed to heat through the bond sheet. The inked areas of the master were found to constitute a mask, but oil passed through the non-inked areas and condensed on the bond sheet to form a latent image corresponding to the non-inked areas of the master. This latent image was developed and fused to produce a negative copy of the original.

I claim:

1. A method of producing a master to give a number of copies of an original design, in which vaporizable material is caused to evaporate under the influence of heat over areas representative of the original design and to condense to form a latent image on a sheet which is sufficiently thin and porous for the material defining the latent image to penetrate the sheet at least to an extent sufficient to permit development on the side of the sheet remote from the original, after which the image is developed on both sides of the sheet to give a double-sided master.

2. A method according to claim 1, in which the original design is on a translucent sheet to both sides of which a layer of vaporizable material is applied, the evaporated material being caused to condense simultaneously on two thin porous sheets one on each side of the original, on both of which the latent images are developed on both sides to give two masters.

3. A method according to claim 1 in which a futrher sheet is placed in contact with the side of the thin porous master sheet remote from the original, the this porous sheet being such as to permit said vaporizable material to pass through it and to form a latent image on the further sheet which is also developed.

4. A method of producing a number of copies of an original design by use of a master produced in accordance with claim 1 in which two copies are produced from both sides simultaneously.

5. A method according to claim 4, in which the copies are taken from both sides of the master sheet by offsetting.

6. A method according to claim 4, in which the developed images on the master sheet are fixed and the copies are taken by a step of evaporation of vaporizable material from both sides of the master sheet simultaneously, the evaporation occurring under the influence of heat over areas representative of the original design and being followed by condensation to form latent images defining the further copies, which are then developed.

7. A method according to claim 6, in which the image on both sides of the thin, porous sheet is developed with

an ink including a high proportion of heat responsive material and further including vaporizable material for the subsequent step of evaporation.

8. A method of producing a negative copy of an original design by use of a master prdouced in accordance with claim 1 in which a layer of vaporizable material is applied to one side of the master which is placed in contact with a barrier surface while a receiving surface is in contact with the other surface of the master, after which the combination is heated to cause evaporation of vaporizable material through the porous master over the non-image areas to form a negative latent image on the receiving surface which is then developed.

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ALFRED L. LEAVITT, Primary Examiner

C. R. WILSON, Assistant Examiner

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