Aug. 22, 1972 A. GAMES 3,686,014

COPYING

Filed Feb. 24, 1966 3 Sheets-Sheet 1

Fig. 1.

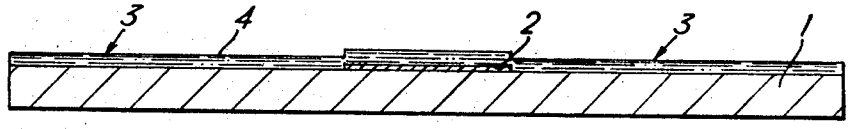

Fig. 2.

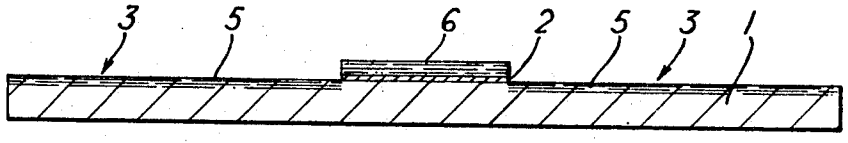

Fig. 3.

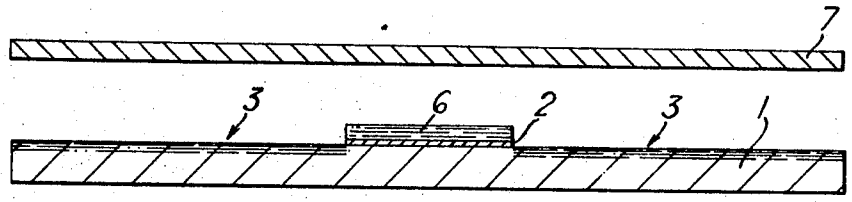

Fig. 4.

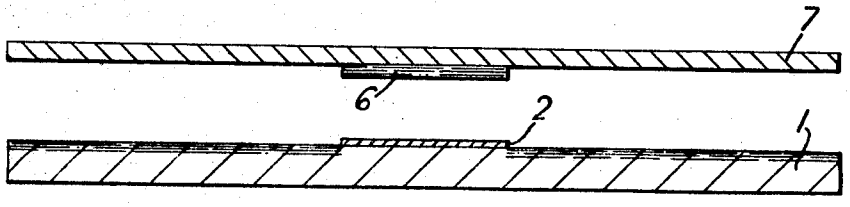

Fig.5.

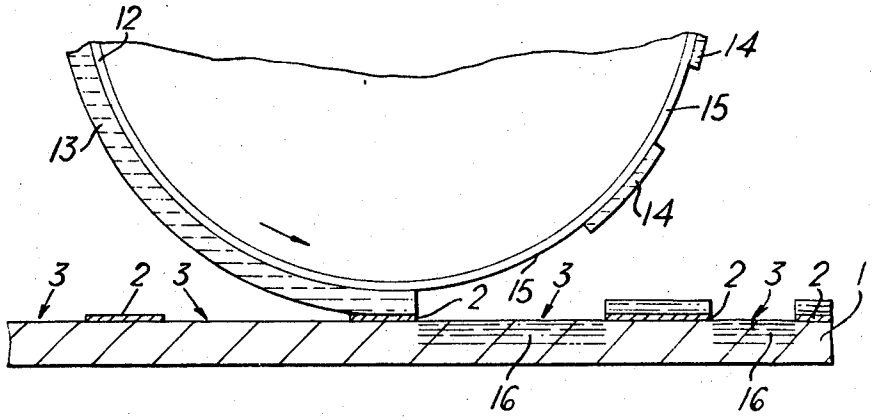
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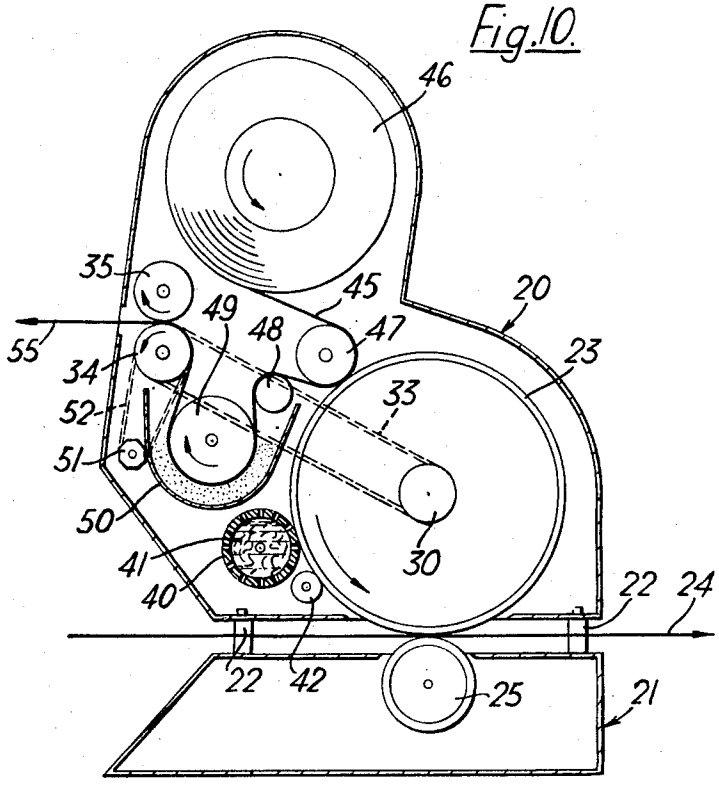
Fig.10.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Filed Feb. 24, 1966 3 Sheets-Sheet 3

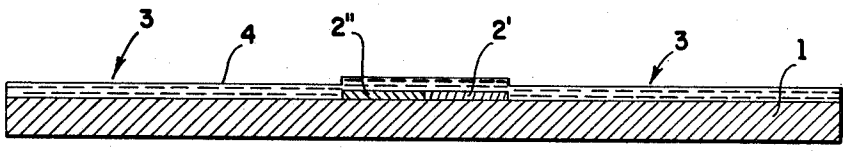

FIG. 6

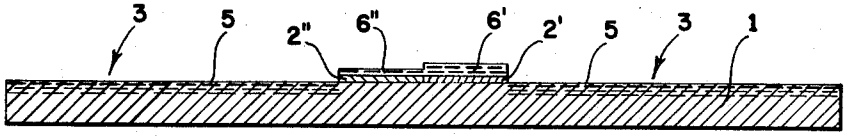

FIG. 7

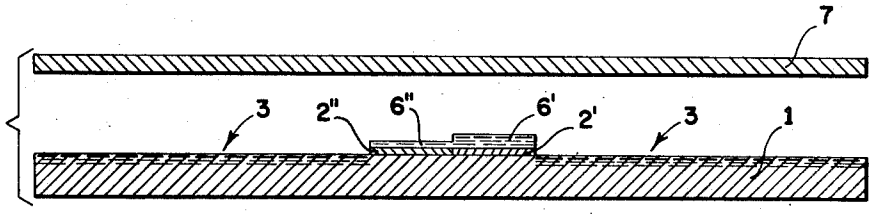

FIG. 8

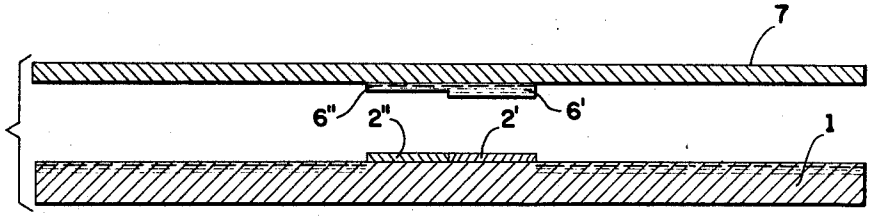

FIG. 9

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Continuation-in-part of application Ser. No. 421,886, Dec. 29, 1964. This application Feb. 24, 1966, Ser. No. 534,956
Claims priority, application Great Britain, Jan. 1, 1964, 89/64
Int. Cl. B44d 5/04; B41m 5/00
U.S. Cl. 117—1.7 38 Claims

ABSTRACT OF THE DISCLOSURE

A method of coping an original comprising locating a layer of absorbable liquid and a surface in adjacency with an original having information areas having differential liquid absorption characteristics, and removing the surface which contains a liquid pattern corresponding to the original due to the differential absorption of said liquid in accordance with the information areas on the original.

This application is a continuing application of co-pending application Ser. No. 421,886, filed Dec. 29, 1964 which is now abandoned.

The present invention relates generally to the copying of originals and more particularly to the copying of originals having information areas of different liquid absorption characteristics. Documents where printing or the like defines one information area and the non-printed portions of the carrier surface provide another information area examples of originals that can be copied. Additional examples are originals having printed materials or the like forming two information areas which completely cover the carrier surface and originals having more than two information areas due to the use of printing materials or the like of different colors.

This invention is based on the principle that the production of an original may result in the original having two or more information areas of different liquid absorption characteristics. The differential liquid absorption characteristics, such as between different types of printing and/or the non-printed background area, is used in the production of copies according to the method of copying presently disclosed. Some originals which do not exhibit differential liquid absorbency can be given a preliminary treatment so as to render them suitable for copying. The effects of absorption may be augmented to a greater or lesser extent by adsorption which increases the apparent absorption of an area. References to absorption are therefore intended to include the apparent absorption of an information area. When several different materials of varying properties, such as different colored inks, are used to define different information areas on an original, these areas will have different liquid absorption characteristics. The range of liquids which will be differentially absorbed for a particular original will depend on the nautre of the information areas on the original.

In its broader aspects, the invention operates on the principle of sandwiching a layer of differentially absorbable liquid between the image bearing surface of an original and a second surface in contact with the original. The effect of the differential absorption characteristics of the information areas is that the layer of liquid is formed into a pattern corresponding to the original. When the second surface is removed it carries with it a liquid pattern which is a copy of the original. The liquid pattern comprises an image of the original and this image may be either visible or latent and invisible.

There are a number of methods by which copies of an original can be made employing the principle set forth above. In one method the design bearing surface of the original is treated with a layer of differentially absorbable liquid and the liquid pattern resulting from the differential absorption is then transferred to a second surface brought into contact with the design bearing surface of the original. In an alternate method the layer of liquid is applied to the second surface which is then brought into contact with the image bearing surface of the original. The differential absorption leads to the formation of a liquid pattern as described above and when the second surface is removed it carries with it the liquid pattern providing the copy of the original. In either of these methods the second surface carries a liquid pattern of the less absorbent area of the original. Since the less absorbent areas normally are the printed or treated areas on the original, the copies are positives and have liquid pattern areas corresponding directly to the printed or treated areas on the original.

The methods of this invention are well suited for copying originals of different colors which cannot be successfully copied employing many of the prior art copying systems. The colored inks used in preparing the original have different absorption properties so that a liquid is absorbed to varying extents in accordance with the colors of the information areas. As a result, various areas on the second surface have different amounts of the liquid transferred thereto in accordance with the colors of the corresponding information areas on the original.

In general, the liquid pattern formed on the second surface will require development but in some situations this is not necessary. For example, if the liquid used is hydrophobic-oleophilic, the image produced may be used directly for lithographic printing. It is also possible to use a colored liquid to obtain a visual image directly without the need for development, particularly if some discoloration of the original is acceptable. However, if the latent image is to be subsequently developed, it is preferable to use a substantially colorless liquid. In the latter case the appearance of the original is not affected in any way.

If the second surface on which the image is produced is provided by a sheet of paper the image may be developed directly on this sheet and in this case a positive mirror image or liquid pattern of the original is formed. The sheet of paper may be translucent so that the positive mirror image may be viewed from the opposite side of the sheet and thus appear right reading. Alternately, the mirror image may be developed and then offset to another surface, such as an opaque sheet, so as to give right reading developed positive image. Another method for producing a right reading image is to transfer the liquid pattern on the second surface to a receiving surface and then to develop the liquid pattern on the receiving surface. This step of transfer converts the positive mirror image to a positive right reading image so that after development no further step is necessary.

When carrying out the offsetting of a developed image from the second surface or alternately transferring the image formed by the liquid pattern from the second surface to a receiving surface, the second surface may conveniently be provided by the surface of a roller. After this roller has been rolled over the surface of the original it carries the liquid pattern defining the image and this may either be developed on the roller and then offset by a further rolling action or alternately the liquid pattern may be transferred to a receiving surface by a rolling action and then developed on the receiving surface.

When a roller is used in this way it may either merely pick up the liquid pattern or alternatively it may first be treated with the liquid so that when rolled over the original the liquid pattern is formed simultaneously with the application of the liquid to the original. In other

words, the layer of liquid on the surface of the roller is largely absorbed over the non-image areas and remains largely intact over the image areas owing to the effect of differential absorption and this establishes the liquid pattern previously described. By using a hollow, porous roller the liquid may be applied to the surface from its interior instead of by external treatment. After formation of the liquid pattern it must then be transferred to the receiving surface fairly promptly before the whole surface of the roller is again flooded with liquid from the interior of the roller.

If the liquid is applied to the original in advance of treatment with the roller this may be carried out either with a separate coating roller or by means of a spray. If applied by means of a roller the liquid will generally be in the form of a continuous film while if sprayed on, the resultant coating may not be completely continuous. The term "layer" is therefore used to include either a continuous film or a coating applied for example by means of a spray. In whatever manner the liquid layer is applied, the effect of the differential absorption characteristics of the information areas of the original is to establish the liquid pattern.

In the simplest example of the process, i.e. the copying of a printed document, the printing ink normally used for lithographic and letterpress printing on to art or coated paper decreases the absorbency of the image areas relative to the non-printed background areas for a wide range of liquids. If a sheet of translucent paper, tissue or plastic carrying a layer of liquid which is subject to differential absorption is brought into contact with the printed original the liquid is mostly absorbed by the non-image areas but is less readily absorbed by the printed areas. This establishes the liquid pattern previously referred to and when the sheet is removed from the original the resultant positive image may then be developed. This may be by application of a powder which adheres to the positive liquid pattern and is then fixed. For example, the powder may comprise a pigment and a thermoplastic binder which is fixed by heat or it may comprise a pigment and a material capable of being fixed by pressure. Such methods of developing and fixing apply to all the different versions of the process already described. If the process includes a step of offsetting this is carried out before or at the same time the developed image is fixed.

The powders used for development may be selected for special applications and may comprise resins, waxes, shellacs, dyes or particles of metal, glass, magnetic material, conductive material, expanding material or corrosive material and may be of any required color. The powder may even be colorless so that subsequent treatment is required to render it visible. For example, powder may be used consisting of a mixture of pyrogallic acid and ferrous sulphate. This is applied to the liquid image and is then rendered visible and fixed by the application of moisture in the form of water or steam. The powder may be applied from a squeeze container or by any other convenient method such, for example, by cascading, or from a powder reservoir.

As an alternative to powder development the liquid used may consist of or include a material which reacts chemically with a second material to give a developed image. A dilute solution of pyrogallic acid may be used to form the liquid pattern and the resulting image may then be developed by the application of a solution of ferrous sulphate. Other reagents may be chosen for the same purpose. The reagent need not be dissolved but may be suspended or dispersed in the liquid so as to be incorparated in the liquid pattern. Development with the proper reagent then renders it visible and fixed. The second reagent may be applied in advance as an overall coating to the surface on which the final copy is to be produced. Consequently when the liquid pattern is formed on or transferred to this surface a developed image representing a positive copy of the original is produced.

Materials which become visible only when heated may be added to the liquid or such materials may themselves constitute the liquid.

The methods of this invention are capable of making copies of originals embodying a wide variety of different types of materials and in general the differentially absorbable liquid to be used needs to be chosen in accordance with the nature of the material. If an original is to be prepared specifically for use in a copying process in accordance with this invention, then particularly favorable conditions may be achieved. Many types of paper may be used and in particular those of the baryta clay coated or art paper type are excellent absorbers of liquid. Esparto paper is also very absorbent and other papers may be specially prepared to be absorbent. Imitation versions and high gloss papers are also suitable while zinc oxide coated papers as used for electrostatic copying may be used. Additionally, duplicating and bond papers as well as newsprint, rice paper and tissue may be used.

Materials other than paper also have the necessary absorbency to give good results such as plastics, sintered metals, absorbent ceramics, clays, wood and the like. Copies may also be produced from originals which are themselves copies produced by the method of the invention or which may have been produced on ordinary and zinc-coated papers using electrophotographic copying techniques. Copies may also be produced on a wide variety of surfaces such as metals, e.g. zinc and aluminum, particularly for use as lithographic plates, glass, ceramics, rubber, plastics, wood and the like.

As previously described a layer of liquid may most conveniently be applied to the original or the second surface by means of a roller. Gelatine composition rollers have been found excellent but rubber, glass, metal and plastic rollers may also be used. "Alathon" (DuPont registered trademark) E/VA Copolymers are particularly suitable. Such rollers may be used both for the step of applying the differentially absorbable liquid either to the original itself or to a second surface which is to be pressed against the original, the step of picking up the liquid pattern thus established and the simultaneous application of liquid and forming of the pattern.

When operating under particularly favorable conditions as mentioned above a single application of liquid may produce a number of copies. Thus between three and ten copies have been produced as a result of a single application of differentially absorbable liquid. For example, when the liquid pattern is established on the surface of a roller, it may be rolled over a strip of copy material so as to transfer the liquid pattern a number of times in succession. Liquid may then be applied again to the original, the process repeated and under the favorable conditions already mentioned this may be done as many as five to fifteen times. After this the non-image areas of the original may become so saturated with liquid that the differential effect is lost. Moreover if the image areas of the original are constituted by a fine powder the successive applications of liquid to the original will eventually cause this powder to absorb liquid. When the above conditions occur the original can generally be restored to its previous condition either by allowing the absorbed liquid to vaporize of its own accord or by assisting this vaporization by the application of heat. If a large number of copies is required a liquid should be chosen with this factor in mind. The lighter and less viscous liquids tend to vaporize rapidly at room temperatures while the heavier and more viscous liquids may need the application of heat. If it proves possible to obtain as many as ten copies from each application of liquid and liquid may be applied as many as fifteen times before the original becomes saturated, this gives a maximum of about one hundred and fifty copies before the original needs to be heated to restore it to its previous condition.

Methods such as those just described may be used with originals produced from a variety of materials in addi-

tion to printing inks. These examples include, for example, ball point pens, pencils, colored pencils and crayons, wax pencils and drawing inks of any color (generally of the India ink or waterproof variety) imaging materials consisting of glycerine gelatine solution or castor oil or other materials responding in a manner similar to printing inks. These materials may, if required, be incorporated in typewriter ribbons or carbon papers so as to give originals which are particularly favorable for use in a process in accordance with the invention. The image areas of the original may also be in the form of a resist which may be applied, for example, by transfer. In this way masks can be prepared for the production of copies, the masking material being either liquid-repellent or liquid-resistive, e.g. plastic, grease paper and so forth.

Drawings of charts and maps or printed forms to be filled in with suitable materials for marking may be prepared for copying by the process. Of the originals not especially prepared for copying by the process, black and white or colored documents in pencil, ink and various marking materials, typing and duplicating, newspaper and magazine pages, letterpress, lithographic and photogravure printed with fine half tone screens are all suitable as also are photographs. The essential requirement is, of course, that during copying there should be differential absorption between the various information areas of the original. As mentioned above, if the original is not suitable in itself, it must be treated to render it so. The process has a wide variety of applications including for example, business systems, addressing machines operating from master strips, copying of computer outputs and copying of the output of instruments such as oscillographs.

The above described methods can be employed to copy original having different colored image areas thereon. The inks or other materials which are employed to form the different colored image areas also have differential absorbency characteristics. Thus, as a layer of differentially absorbable liquid is applied to the original, the liquid will be absorbed to a greater extent in image areas of one color and to a lesser extent in the image areas of another color. The liquid will be relatively completely absorbed in the background areas of the original. A liquid pattern of the multi-colored original is provided which may be developed. Powder is caused to adhere to the liquid pattern in varying amounts in accordance with the differential absorption characteristics of the different colored image areas on the original. In this manner the image areas of different color on the original appear as areas of different shades of gray on the resultant positive copy and are readily distinguishaable. This process can be employed to copy originals having a large number of different colored information areas.

The copying process can also be employed to make copies which are enlargements or reductions of originals. In making a reduction, the second surface is formed from an elastic material such as latex, which is stretched to a desired extend and is then treated to form a positive liquid image thereon corresponding to the information on the original. As described above, this treatment is accomplished by initially coating the original or the stretched second surface with the layer of differentially absorbable material and placing the stretched second surface in pressure contact with the original. After the liquid pattern has been formed on the second surface the latter is relaxed and permitted to return to its unstretched state. The reduced liquid image is then developed or transferred as required in a given application. Enlargements are made by stretching the second surface after the liquid image corresponding to the original has been formed on the second surface. For exact enlargements and reductions the second surface should be stretched in all directions. However, uneven stretching of the second surface can be used to provide various distortions in the copies which may be desirable in certain applications. The second surface can be a sheet or sheath on a roller as described above and apparatus can be included for automatically stretching the second surface.

The differentially absorbable liquid used may be selected in accordance with the type of original, that is to say the nature of the material forming the original, and in addition the number of copies required. The liquids used may also be selected with regard to special applications, for example, these liquids may act as mordants for etching purposes, or as varnishes, glazes, resists, conductor, insulators, solvents or hydrophobic-oleophilic lithographic images. If a liquid acts as a solvent to dissolve dyes or pigments it will thus be useful in hectographic applications when brought in contact with dyed sheets so as to dissolve the dyes in image areas before offsetting the resulting dyed image to paper. This may be regarded as one form of development. From a more general point of view a wide range of liquids may be used. These include water, both distilled or otherwise, and also milk. The liquid is not required to change its character or property either chemically of physically throughout its operation in the process nor, is it required to affect the image in any way other than by its absorption.

As already mentioned the liquid should in general be colorless so as not perceptibly to mark the original but in addition it should have little or no odor and be nontoxic in handling. Liquids which may be used include alcohol C. 10, Carbitol, triacetin, diacetin, hydrogenated terphenyls such as those sold under the trademark "H.B. 40," by Monsanto Chemicals Limited, chlorinated diphenls and polyphenyls, such as those sold under the trademark "Aroclor" by Monsanto Chemicals Limited, fusus and mineral oils, printing ink distillate, diethyl and dimethyl phthalates, odorless solvents such as that sold by Shell Chemicals Limited under the trademark "Shellsol," silicone fluids, high boiling petroleum fractions, white oil fractions, hydrogen peroxide, iso paraffinic solvents such as that sold under the trademark "Isopar" by Esso Chemicals Limited, glycerine, glycols, isopropyl oxitol-acetate and isoeugenol. In addition to these, essential oils of many types may be used, such as copaiba, linalol, and sandlewood oil and witch hazel, also acids such as dilute benzoic acid. Materials which vaporize rapidly at room temperatures may be used such as surgical or methylated spirits. The term "liquid" is used to include materials which behave as liquids, e.g. supercooled liquids and liquefied gases such as those sold by Imperial Chemical Industries Limited under the trademark "Arcton" together with other gases which may be sprayed from aerosol containers. These gases must, however, be developed fairly rapidly before evaporation occurs. On the other hand, when using the less volatile liquids, development may be delayed for an appreciable time and the liquid image may be retained either on the roller or on such other surface as may be used for its production. Liquids may be mixed or formulated to extend their use over a variety of originals and additives may be included to increase or accelerate the absorbent effect. In particular eugenol acetate may provide the necessary liquid layer.

The method is essentially a simple one which can be carried out manually with little equipment and supplies. The process is therefore particularly suitable for use outside the office and may be utilized in the field and remote areas as well as in the home. No external power, light or heat is essential but a hot kettle, for example, will provide both heat for fusing developing powders and also steam and moisture. This can provide both the liquid for forming the image and also for chemical fixing as well as for driving off accumulated liquid from an original.

Although such manual methods are satisfactory for small numbers of copies, if large numbers are required a semi automatic form of apparatus is preferable. Such apparatus comprises basically an image roller for rolling over the surface of the original to be copied, means for supplying a layer of liquid to the surface of the roller

so that as the roller engages the surface of the original a liquid pattern is formed on the surface of the roller, means for feeding a copy receiving surface into contact with the roller at a point in the rotation of the roller following the area of engagement with the original and preceding the liquid supply means, whereby the liquid pattern is transferred to the copy receiving surface. In addition the apparatus may include means for developing the image on the copy receiving surface. Conveniently the copy receiving surface may be a sheet in strip form and the apparatus may include a support for a roll of such strip, rollers defining a path for the strip including an area of contact with the image roller and a region of contact with the developing means.

Methods and apparatus operated and constructed in accordance with the invention will now be described in more detail by way of example with reference to the accompanying drawings in which:

FIGS. 1–4 illustrate successive stages in one form of the process;

FIG. 5 illustrates similar stages in another form of the process; and

FIGS. 6–9 illustrate successive stages in yet another form of the process; and

FIG. 10 is a cross sectional view showing a form of apparatus suitable for carrying out the process.

Referring first to FIGS. 1–4, part of the original to be copied as shown as **1** and an image information area is shown as **2**. The image area **2** is less absorbent than the non-image information areas indicated generally as **3**. As the first step in the process a layer of differentially absorbable liquid is applied over the entire surface of the original **1** and at the instant of application extends over the whole of the surface as shown in FIG. 1. Almost immediately thereafter the liquid is absorbed by the non-image areas **3** and this absorbed liquid is indicated as **5** in FIG. 2. The liquid in the image area **2** indicated as **6** is not absorbed, however. For purposes of illustration, FIG. 2 shows complete absorption in the non-image areas **3** and no absorption in the image area **2**. This may occur in practice but there may also be slight absorption in the image **2** and incomplete absorption in areas **3**. In the next stage of the process as illustrated by FIG. 3 a sheet **7** is brought into contact with the original **1**, being pressed against it to ensure good contact. When the sheet is removed as shown in FIG. 4 it carries with it a liquid pattern corresponding to the image area **2** and this liquid pattern defines an image which is a positive copy of the original. Although for purposes of illustration all the liquid **6** is shown as transferred to the sheet **7** in practice some may remain in the image area **2**.

The liquid pattern on the sheet **7** represents a positive mirror image and if developed on the sheet **7** must either be offset or the sheet **7** needs to be translucent so that the image can be viewed from the other side. Alternatively, the fluid pattern can be transferred to a receiving surface where it is developed to give a right reading copy.

Another form of the process is illustrated in FIG. 5. Here part of the original **1** is again shown as having image areas **2** and non-image areas **3**. A roller **12** which has previously been provided with a surface layer of differentially absorbable liquid **13** is rolled across the original **1** from right to left, thus turning in a counterclockwise direction. FIG. 5 shows the roller **12** at the midpoint of its travel. It will be seen that to the left of its point of contact the layer **13** is intact but that where the roller **12** has already engaged the original **1** the layer **13** has been depleted in the image areas **2** on the right hand side to give corresponding areas **14** and that in the non-image areas **3** the liquid layer **13** has been substantially completely removed as indicated at **15**, the absorbed liquid being indicated as **16** within the thickness of the original **1**. In other words the part of the surface of the roller which has engaged the surface of the original is left with a liquid pattern constituted by the areas **14** which defines an image corresponding to the image areas **2** of the original **1**. The image on the roller **12** is a positive mirror image, and by rolling the roller **12** over a further surface a positive right reading liquid image is obtained which can then be developed. As previously described a number of copies can be made in this way as a result of a single passage of the roller **12** over the original **1**.

Exactly the same effect is obtained if a sheet coated with a layer of differentially adsorbable liquid is used in place of the roller **12** and is pressed into contact with the original **1**. When the sheet is removed it carries a positive liquid pattern represented by the areas **14** as already described. The image defined by this liquid pattern may then either be transferred to a further surface or developed in situ in which case it may either be viewed through the sheet or offset to a further surface.

Referring now to FIGS. 6–9, the original **1** to be copied has a apir of image information areas **2'** and **2''** of different colors formed on a carrier surface which defines non-image areas **3**. The image area **2'** is of one color and the image area **2''** is another color. The material forming image area **2''**. A layer **4** of differentially absorbable liquid is applied over the entire surface of the original **1** and at the instant of application extends as is shown in FIG. 6. The liquid is very quickly absorbed by the non-image areas **3** as indicated by the reference numeral **5** in FIG. 7. Also, the liquid is partially absorbed by the colored image area **2''** but it is not absorbed by the differently colored image area **2'**. For purpose of illustration, the absorption of the liquid has been shown as complete in the non-image area **3**, approximately one-half in the image area **2''** and non absorbed in the image area **2'**. This is intended to be a schematic representation of the differential absorption effects and the actual amounts absorbed by any information area will depend on the characteristics of the material forming the same.

A sheet **7** is pressed against the coated original **1** and when the sheet is removed it carries with it a liquid pattern as shown in FIG. 9. The liquid pattern on sheet 7 represents a positive mirror image of the original and has an area **6'** having substantial liquid thereon corresponding to colored image area **2'** of the original having no appreciable liquid absorption characteristic and a second area **6''** having less liquid thereon corresponding to colored image area **2''** of the original having a limited liquid absorption capability.

The liquid pattern on the sheet **7** represents a positive mirror image and if developed on the sheet must either be offset or the sheet **7** needs to be translucent so that image can be viewed from the other side. Alternatively, the liquid pattern can be transferred to a receiving surface where it is developed to give a right reading copy. The developer adheres to or otherwise reacts with liquid pattern in accordance with the amount of liquid in a given area. Thus, the copy will have developed areas of different shades of gray corresponding exactly to the different colored image areas **2'** and **2''** on the original. It should be recognized that an original may be completely coated with material of different colors so there are no areas of the supporting carrier surface that are visible.

Different forms of method disclosed above are described in more detail in the following examples:

EXAMPLE 1

A thin sheet of cellophane is coated on one side with a fine film of triacetin and brought into contact with a page of a magazine printed on art paper. Pressure is applied to the back of the film by means of a pad of material held in the hand and slid across the back of the film. The sheets is then removed and is found to carry a liquid pattern defining a positive mirror image of the original. This image is then cascaded with a developing powder available under the trademark "Graph-O-Fax" from Philip A. Hunt Inc. Slight heat is applied to fix the developing powder and thus fix the image which, when viewed through the sheet,

is a right reading copy of the original. This example is in accordance with the modification of the process illustrated in FIG. 5 in which the roller **12** is replaced by a transparent sheet.

EXAMPLE 2

The first stage of the above example is repeated but after the film has been removed from the original a sheet of thin tissue or rice paper is pressed against the original provided by the maagazine page. Part of the liquid pattern which is formed between the original and the film is left on the original and is then transferred to the sheet of tissue or rice paper. This effect is assisted by subjecting the sheet of tissue or rice paper to pressure either by means of a pad or roller and the sheet is then removed. It now bears a liquid positive mirror image which is developed in the same way as in the previous example and fixed by means of heat. The image on the original film is also similarly developed to give two separate copies from a single application of liquid.

EXAMPLE 3

A roller having a surface of gelatine is coated with a fine film of linalol, odorless solvent or printing ink distillate and is rolled slowly across a sheet of newspaper. The surface of the roller then carries a positive liquid mirror image of the image areas on the newspaper. The roller is then rolled in the reverse direction across a sheet of ordinary bond paper thus transferring the mirror image to the paper to give a right reading image. This image on the bond paper is then developed with a powder consisting of ground resin known as Dragons Blood and the resulting image is fixed by heat to produce a right reading copy having a brown color.

EXAMPLE 4

The preliminary steps of Example 3 are repeated to give a liquid pattern on the bond paper and this image is then developed with a powder developer constituted by a mixture of gum and carbon black which is fixed by fusing with steam.

EXAMPLE 5

A roller having a surface layer of gelatin or polyurethane is coated with a film of solvent sold under the trademark "Shellsol" by Shell Chemicals Limited and is rolled slowly across a sheet of typing on a bond paper. This gives a positive mirror image of the typing on the surface of the roller which is then rolled in a reverse direction across a sheet or opaque bond paper to give a right reading image on this paper. This image is then developed as in Example 3 or as in Example 4 to give a right reading copy of the typing on a opaque bond sheet.

EXAMPLE 6

Triacetin is sprayed on a page of printing on art paper to give a layer of liquid on the page. A latex roller is rolled across the page to give a mirror image on its surface and is then rolled in the same direction along a strip of bond paper for a distance corresponding to ten times the circumference of the roller. This gives ten successive right reading images on the bond paper which are developed by cascading with a developing power consisting of a mixture of carnauba wax and carbon black. This is fixed by means of pressure applied by a metal rod having a non-stick silicone or fluorcarbon coating.

EXAMPLE 7

A black and white bromide photographic print is coated with a solution of benzoic acid and water. After 30 seconds a sheet of bond paper or translucent material is pressed against the print. Contact is assured by rolling a metal roller over the back of the sheet. On removing the sheet developing it with a black powder (as in Examples 1 and 2) a positive mirror image of the black areas of the print is produced.

EXAMPLE 8

A colored original including flat and tonal areas of red, blue, yellow and cerise printed in offset litho with super-imposition of colors is passed slowly between a latex covered roller and a metal support roller. The latex covered roller is coated in advance with a thin layer of white oil fraction and after the original has been passed through it is followed by a sheet of white bond paper to which a proportion of the liquid defining the image is transferred. Further sheets of white bond paper are then passed between the rollers and pick up a liquid image which becomes progressively fainter with each sheet. Each image is then developed with a black powder as in Examples 1 and 2 to give a copy of the original with distinguishable tonal areas in black and gray representing the different colors and tones of the original.

EXAMPLE 9

The procedure of Example 8 is repeated with an original including flat and tonal areas of red, blue, yellow and black printed by letterpress on art paper. The liquid used in a mixture of glycerine and water and the resultant images are developed as in Example 8 to give a similar result.

When copying colored originals by means of a roller, the speed of the roller is an additional factor to be taken into account since it controls the period allowed for absorption. If moved too quickly, in the order of 12 inches per second, for example, the tendency will be for an even response from all colors so that these are not differentiated. Full differentiation requires considerably slower speeds of movement, in the order of 12 inches per minute, but the exact speed will be determined by factors such as the type of original, color response required, type of liquid and roller surface used.

The foregoing examples are all concerned with direct manual manipulation but the general process described in Example 5 is particularly suitable for semi automatic operation by means of the apparatus shown in FIG. 10. This apparatus comprises two halves, namely, an upper half **20** and a lower half **21** having releasable connections **22** so that it can be removed if required. When the lower half **21** is removed the upper half **20** is manipulated by hand and an image roller **23** is then rolled across an original **24** supported on a flat surface. When the lower half **21** is fitted in position as shown in the drawing this provides a base for the apparatus as a whole and the original **24** is then fed between the image roller **23** and a second roller **25** mounted in the base part **21**. The result obtained is the same whether or not the part **21** is in position but the apparatus may be used in either of these two ways according to the circumstances.

When the lower part **21** is removed the action of rolling the apparatus over the original turns the roller **23** and associated parts which are about to be described. When the lower part **21** is fitted the roller **23** requires a drive which is provided from an input shaft **30** which may be turned by a handle, a clockwork or electric motor, not shown. A belt drive **33** connects the shaft **30** with a roller **34** which is coated with a non-stick material. Prior to the start of the operation the surface of the image roller **23** which consists, for example, or gelatine or latex is coated evenly with a fine film of differentially absorbable liquid from a reservoir provided by a porous roller **40** filled with cotton wool or similar absorbent material **41** soaked in the liquid. The image roller **23** turns in a counterclockwise direction and a doctor roller **42** removes excess liquid. The layer of liquid on the roller **23** then passes into contact with the original **24** so as to produce the effect illustrated in FIG. 5, leading to the production of a liquid pattern on the surface of the roller **23**.

During the further rotation of the roller the image defined by this liquid pattern is transferred to a copy sheet defined by a strip **45** drawn from a reel **46**. The

strip 45 passes between a roller 47 and the image roller 23, and at this point picks up the image from the roller 23, after which it passes over a guide roller 48, about a further roller 49 and then between the driven roller 34 and a cooperating pressure roller 35. The grip provided by the rollers 34 and 35 draws the strip 45 from the reel 46 and about the path just described and off the reel 46.

While passing about the roller 49 the strip travels through a trough 50 of developing powder which is maintained in a mobile state by means of a vibrator 51 driven by a belt 52 from the roller 34. Owing to the mobility of the powder it adheres only to the image areas and the excess falls away. The powder used is capable of being fixed by pressure as previously described so that the pressure exerted between the rollers 34 and 35 carries out the necessary fixing action and a fixed copy emerges from the apparatus at 55. During the initial application of liquid to the image roller 23, the roller 47 may be moved away from the roller 23 so that an even coating can be obtained without wastage of copy paper.

If more than one copy is required as a result of a single passage of the original 24, the rollers 40, 42 and 25 may be moved slightly clear of the surface of the image roller 23 after the formation of the first copy so that the image is retained on the surface of the roller 23 and is again transferred to the strip 45 during the next revolution of the image roller 23. Unless the rollers 40 and 42 are moved back in this way a further film of liquid is applied and the liquid image is, of course, obliterated, the roller 23 then being in a condition ready for the reception of a fresh image or a further part of the same original.

Various minor modifications may be made to this apparatus according to the particular requirements. If, for example, copies are required on single sheets instead of on a continuous strip 45, these sheets can be fed into the nip between the rollers 23 and 47 and then giuded, for example, by means of a continuous belt through the developing trough 50 and out between the fixing rollers 34 and 35. If chemical development is desired the powder in the trough 50 can be replaced by a liquid reagent. If a colored liquid is applied by the roller 40 then no development is required. The image produced on the surface of the image roller 23 is a positive mirror image but owing to the step of transfer on to the strip 45 this image is reversed to give a right reading image. Accordingly opaque copy sheets may be used although copies may also be obtained on a transparent material if required.

I claim:

1. The process of producing a copy of a graphic original having image areas and background areas of differing absorption properties, said process comprising the steps of:

(1) applying a film of a differentially absorbable liquid on the surface of the original;

(2) contacting said original with a receiving surface whereby the liquid film that is not absorbed on the original is transferred as a liquid image to the receiving surface;

(3) removing the receiving surface from the graphic original;

(4) contacting the receiving surface with a copy sheet to transfer the liquid image thereon to the copy sheet; and

(5) developing the liquid image on the copy sheet.

2. The process of producing a copy of a graphic original having image areas and background areas of different absorption properties, said process comprising the steps of:

(1) applying a film of a differentially absorbable liquid on the surface of the original;

(2) contacting said original with a receiving surface whereby the liquid film that is not absorbed on the original is present as a liquid image on the receiving surface;

(3) removing the receiving surface bearing the liquid image from the graphic original;

(4) developing the liquid image.

3. A method of producing a copy of an original on a surface, said original comprising at least two image-defining areas on said surface, the first of said image-defining areas being less absorbent then the second of said image-defining areas whereby said image-defining areas have differential liquid absorption characteristics, said processes comprising the steps of providing a layer of a differentially absorbable liquid on said surface over said image-defining areas, said liquid being capable of covering said surface and being differentially absorbable in said image-defining areas, maintaining said liquid on said surface for a time sufficient to permit differential absorption of said liquid in accordance with the differential absorption characteristics of said image-defining areas to form a liquid image pattern on the surface of said original comprising a layer of said liquid over said first, less absorbent, image-defining areas, contacting said original bearing said liquid with a receiving surface and separating said receiving surface and original to provide a liquid pattern copy of said original on said receiving surface.

4. A method according to claim 3 wherein said original is a photograph and said liquid comprises benzoic acid.

5. A method according to claim 3 wherein said receiving surface is elastic and is maintained in a stretched position while adjacent said original and relaxed thereafter whereby said liquid pattern copy is a reduced copy of the original.

6. A method according to claim 3 wherein said receiving surface is elastic and is stretched after separation from the original to produce an enlarged copy of the original.

7. A method according to claim 3 wherein said original is contacted with said receiving surface subsequent to the provision of the layer of differentially absorbable liquid on said original.

8. A method according to claim 3 wherein said original is contacted with said receiving surface substantially simultaneously with the provision of the layer of differentially absorbable liquid on said original.

9. A method according to claim 3 wherein, after separation of said receiving surface and original, said original is contacted with a further receiving surface and said further receiving surface is separated from said original to provide a further liquid pattern copy of said original on said further receiving surface.

10. A method according to claim 3 wherein said first image-defining area is an image area and said second image-defining area is a non-image area.

11. A method according to claim 10 wherein said liquid is maintained on said surface for a time to permit substantially all of the liquid overlying said second image-defining areas to be absorbed into said surface whereby said liquid pattern comprises liquid overlying said first image-defining areas only.

12. A method according to claim 3 wherein said first and second image-defining areas are image areas having different colors.

13. A method according to claim 12 wherein said liquid image pattern comprises a layer of liquid over said first, less absorbent, color image area and a thinner layer of liquid over said second, more absorbent, color image area.

14. A method according to claim 13 wherein the liquid pattern copy of the original is developed on said receiving surface.

15. A method according to claim 13 wherein the liquid pattern copy of said original is transferred to a further receiving surface to provide a right reading liquid pattern copy of said original.

16. A method according to claim 15 wherein said right reading liquid pattern copy of said original is developed.

17. A method according to claim 3 wherein the layer of differentially absorbable liquid is provided on the original surface by contacting said surface with a member provided with a layer of said differentially absorbable liquid.

18. A method according to claim 17 wherein said member comprises a sheet, said layer of said differentially absorbable liquid being provided on a surface of said sheet.

19. A method according to claim 18 wherein said differentially absorbable liquid comprises water.

20. A method according to claim 17 wherein said member comprises a roller.

21. A method according to claim 20 wherein, upon contacting said original with said roller, said liquid is absorbed from said roller into the second, more absorbent, image-defining areas of said original, and said liquid is not completely absorbed from said roller into the first, less absorbent, image-defining areas of said original, and wherein, upon moving said roller relative to said original, the liquid pattern copy of the original is provided on the roller, said roller thus constituting said receiving surface.

22. A method according to claim 21 wherein the liquid pattern copy of the original on said roller is transferred to a further receiving surface to provide a right reading liquid pattern copy of said original.

23. A method according to claim 22 wherein said right reading liquid pattern copy is developed.

24. A method according to claim 3 wherein said receiving surface comprises a roller.

25. A method according to claim 24 wherein said roller is porous.

26. A method according to claim 25 wherein the liquid pattern copy of the original on the porous roller is transferred to a further receiving surface to provide a right reading liquid pattern copy of said original.

27. A method according to claim 26 wherein said right reading liquid pattern copy is developed.

28. A method according to claim 3 wherein the liquid pattern copy of said original is developed on said receiving surface.

29. A method according to claim 28 wherein said liquid pattern copy is developed by applying powder which adheres to said liquid pattern.

30. A method according to claim 29 wherein said powder comprises a pigment and a thermoplastic binder.

31. A method according to claim 28 wherein said liquid pattern copy is developed by applying a pressure sensitive developer to said pattern and applying pressure to fix said developer.

32. A method according to claim 28 wherein said liquid pattern copy is developed by treatment with an agent which reacts chemically with said liquid to produce a developed image.

33. A method according to claim 32 wherein said chemical agent is provided on said receiving surface prior to formation of the liquid pattern copy of the original thereon.

34. A method according to claim 3 wherein said liquid pattern copy of the original on said receiving surface is transferred to a further receiving surface to provide a right reading copy of said original on said further surface.

35. A method according to claim 34 wherein said right reading copy is developed.

36. A method according to claim 35 wherein the step of development comprises contacting the right reading copy with a powder which adheres to the liquid pattern.

37. A method according to claim 36 wherein said powder comprises a pigment and a thermoplastic binder.

38. A method according to claim 34 wherein said further receiving surface is provided with an agent capable of developing the liquid pattern transferred thereto.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,686,014 Dated August 22, 1972

Inventor(s) Abram Games

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading to the printed specification after line 4, insert -- assignor to Imagic Limited, London, England --.

Signed and sealed this 3rd day of April 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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