July 25, 1961 R. H. KAY 2,993,805

METHOD OF PRINTING ON VESICULAR MATERIAL

Filed Sept. 12, 1958 2 Sheets-Sheet 1

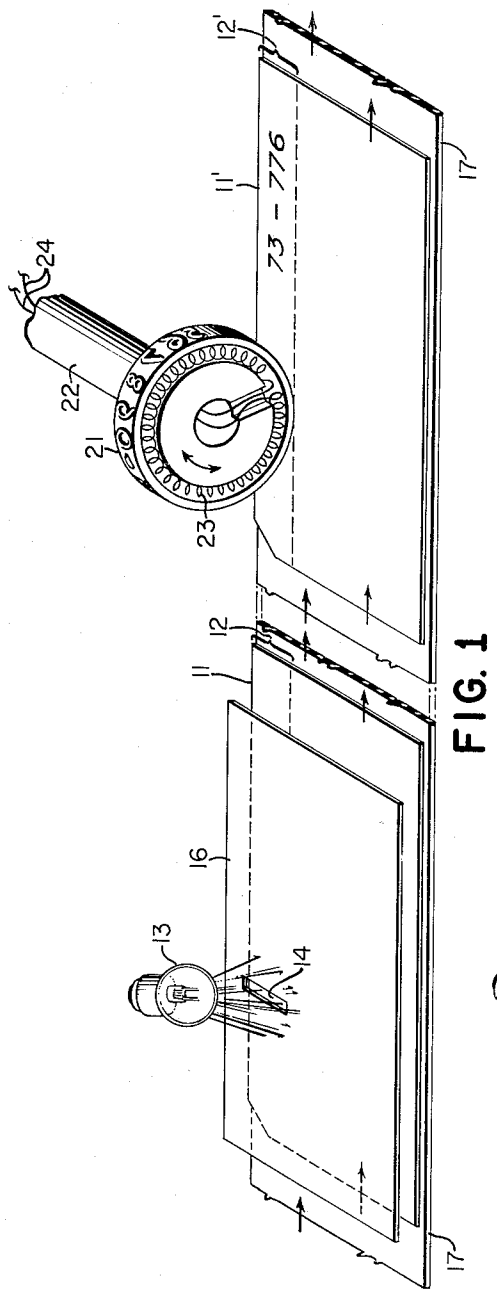


FIG. 1

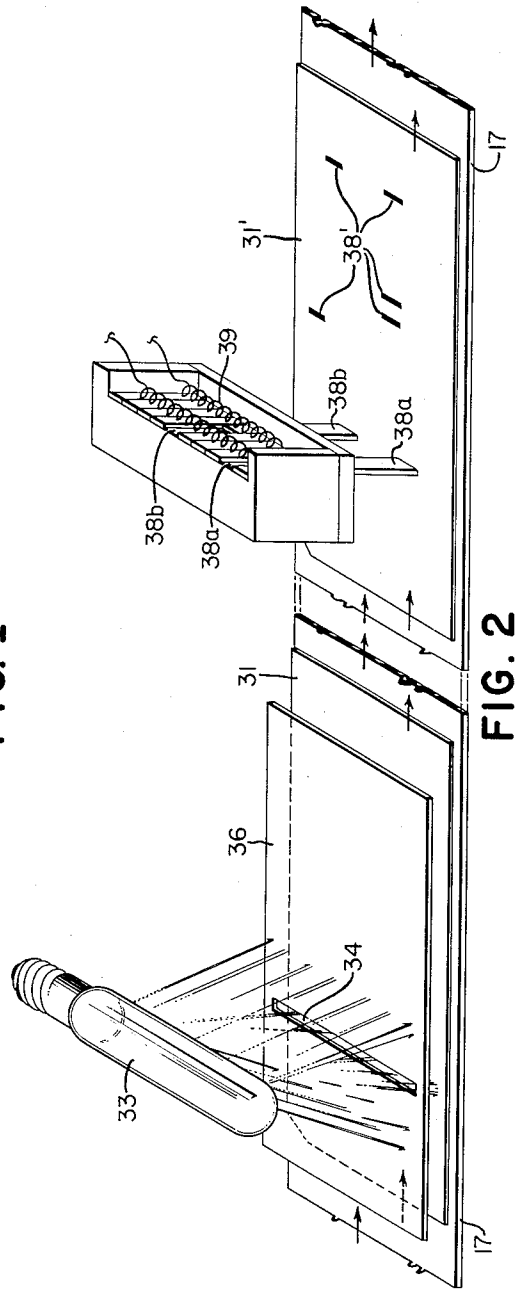


FIG. 2

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July 25, 1961 R. H. KAY 2,993,805

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Filed Sept. 12, 1958 2 Sheets-Sheet 2

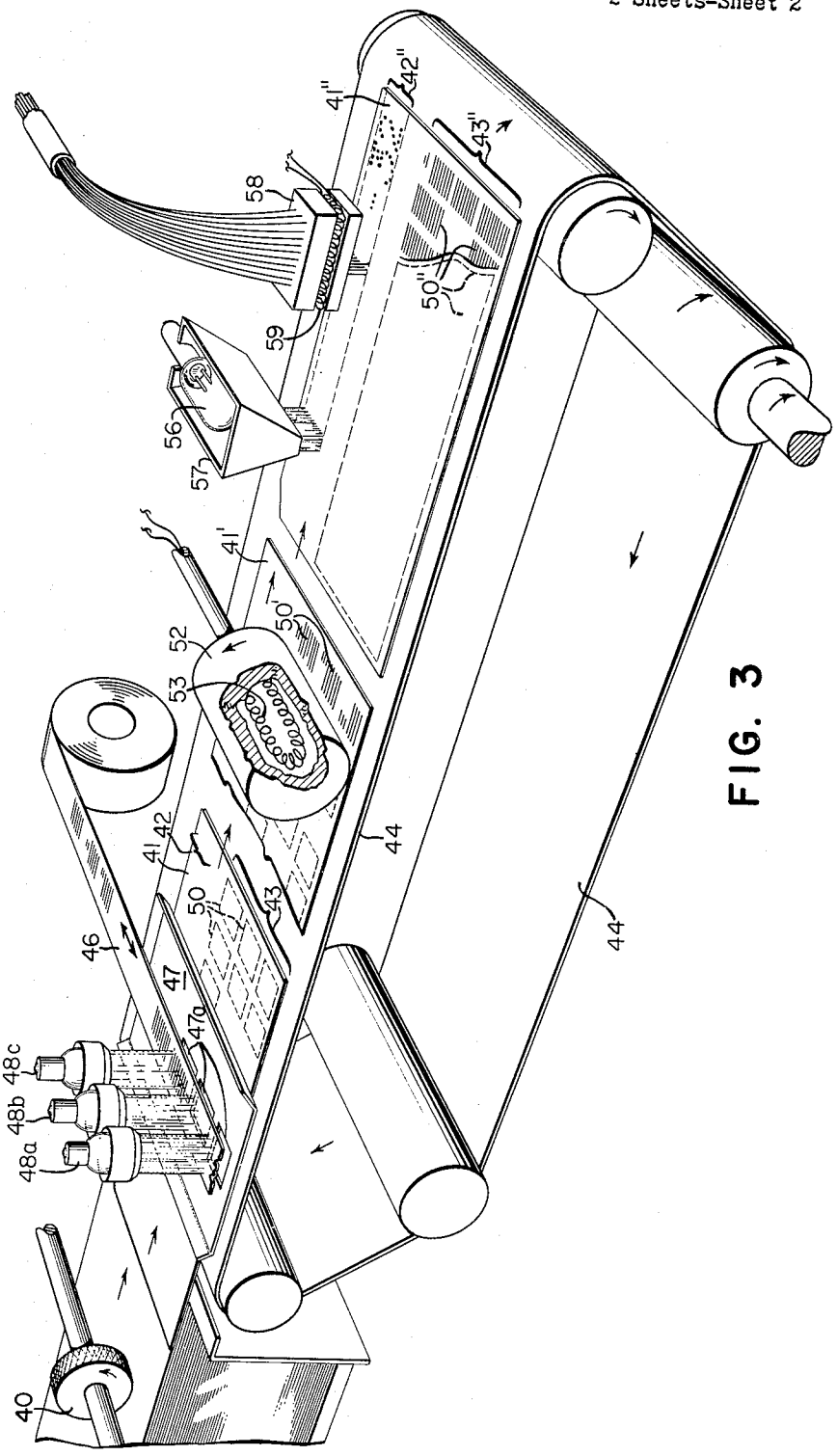


FIG. 3

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2,993,805
METHOD OF PRINTING ON VESICULAR MATERIAL

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1 Claim. (Cl. 117—62)

The present invention relates in general to methods of printing and relates more particularly to methods for printing on vesicular material.

The use of vesicular materials in so-called "scatter photography" for the storage of images of different documents and the like is well known. Vesicular materials are materials which are capable of producing an image when they are irradiated with selected radiation, usually ultraviolet light, and then heated to at least a predetermined temperature. Most of such vesicular materials comprise a vehicle or binder which is impregnated with a light sensitive diazonium salt which decomposes when exposed to light to evolve nitrogen gas. This nitrogen gas is generally in the form of small bubbles which form the latent image in the material. Upon heating of the material, the smaller bubbles expand to produce larger bubbles which form light scattering centers to produce the image. Once the smaller bubbles have expanded into the larger bubbles the image thereby formed becomes irreversible and permanent. The vesicular material may be either transparent, in which case the irradiation and heating cause selected areas of the material to turn opaque, or the material may be opaque, in which case the irradiation and heating produce a whitening in the selected areas. The vesicular materials are generally available in the form of sheets having a layer of vesicular material bonded to a sheet of backing material, either transparent or opaque.

These vesicular materials have heretofore been utilized by first selectively irradiating the material in the pattern of the image to be formed on the material, such as through a stencil or film negative, to form a latent image of the pattern in the vesicular material. The irradiated material is then heated to enlarge the latent image bubbles forming the pattern, thus producing light scattering centers which cause the material to turn opaque or which reflect incident light in the image area, to produce a permanent and irreversible image. This method is suitable for the photo-reduction of documents and the like, where there is a considerable amount of information to be recorded for each image, but where there is only a relatively small amount of information and/or this information is to be changed frequently, the above method has the disadvantage of requiring that a different stencil or negative be made for each change of information.

The present invention is directed to a method of utilizing vesicular material by first generally irradiating the material to substantially uninformly expose the entire vesicular material to the radiation. After this general irradiation, the material is selectively heated in a pattern or configuration corresponding to the information to be recorded, to thus selectively produce an image on the vesicular material according to the configuration of the heated portion thereof.

While it is well known in the prior art to use heat sensitive printing media for recording and other purposes, the present invention differs from these prior art methods in utilizing essentially a two-stage printing process requiring both the general irradiation of the vesicular material and then the heating of selected portions of the vesicular material in accordance with the information to be recorded. By virtue of the two-stage process utilized in the present invention to produce a permanent image on the material,

it is possible to alternately print on separate areas of the same sheet of vesicular material by selective exposure to light followed by general heating or general exposure to light and selective exposure to heat. That is, one portion of a sheet of vesicular material may be printed by means of selective exposure to radiation followed by general heating of this portion, while another portion of the sheet may be printed by general exposure to radiation followed by selective heating.

The present invention may be utilized in a number of ways in producing a permanent image on a vesicular material. As one example, the present invention may be utilized in conjunction with the printing of document images on transparent vesicular material to print some type of information relative to the documents. In this application, images of the documents or other papers to be stored are projected onto a predetermined portion of the vesicular material by means of the selected irradiation. Either prior to, simultaneously with, or subsequent to this projection, another portion of the sheet is generally exposed to the irradiation. Thus, the sheet of vesicular material has on one portion thereof the latent images of the documents to be stored, and has on another portion thereof a band which has been generally exposed to the radiation but which has no latent image thereon. The separate portions of the sheet may then be heated, either sequentially or simultaneously. The portion which has the latent images of the documents is heated over its whole general area, to fix the latent images present in the vesicular material. The portion of the material which has been generally exposed to irradiation is selectively heated by means of a heated element having a configuration corresponding to the information to be printed, to produce printing on this portion corresponding to the configuration of the heated element.

As another example, the method of the present invention may be utilized to provide machine-readable representations or marks on a sheet of vesicular material, either transparent or opaque. In this application, a sheet of vesicular material may be first generally exposed to selected radiation, and then the irradiated vesicular sheet may be selectively contacted by heated elements which produce localized heating of selected portions of the sheet to produce a visual mark or indicia at these selected portions. In one embodiment, the sheet of vesicular material may be in the general shape of a conventional business machine card and the heated elements contacting the vesicular material may be the heated punch bars of a punch normally utilized to provide coded openings in a business machine card, but which in the present application are adapted to just contact the surface of the vesicular material to provide a localized heating corresponding to the general area of the punch. Thus, the sheet has produced thereon selectively positioned visual marks which may be subsequently optically read by a machine for sorting or other operations which may be performed with the sheet.

It is therefore an object of the present invention to provide improved methods and apparatus for printing on vesicular material and particularly on transparent vesicular material.

It is a further object of the present invention to provide improved methods and apparatus for printing on vesicular material in which the material is first generally exposed to irradiation and then the irradiated material is selectively heated in accordance with the configuration of the information to be printed.

Objects and advantages other than those set forth above will be apparent from the following description when read in connection with the accompanying drawings, in which:

FIG. 1 diagrammatically illustrates one embodiment of

the present invention in which the selective heating of the irradiated vesicular material is accomplished with a heated printing roller;

FIG. 2 diagrammatically illustrates an alternative embodiment of the present invention in which the selective heating of the irradiated material is accomplished with heated bars which contact the surface of the irradiated material; and

FIG. 3 diagrammatically illustrates a further embodiment of the present invention in which sheets of vesicular material have printed thereon images from a photo-image reduction apparatus and which also have information printed thereon by means of selective heating of the material.

Referring to FIG. 1, reference character **11** designates generally a sheet or card of vesicular material which is to be printed in accordance with the present invention. As indicated heretofore, sheet **11** may be of any suitable vesicular material which has the property of forming light scattering centers by means of bubble formation in response to irradiation by selected illumination, followed by heating of the irradiated area of the material. one of such materials which I have found satisfactory for the purposes of the present invention is sold under the trademark "Kalvar." An example of this material and the techniques involved in its processing are described in a paper entitled The Kalfax System of Microfilm Duplication, by Floyd T. Neth, Proceedings of the National Microfilm Association, 7th Annual Meeting, April 21–23, 1958, pages 27–40. In the illustrated embodiment of FIG. 1, sheet **11** is generally in the shape of a standard business machine card, and as such may be adapted for use in business machine systems.

Assuming that it is desired to produce printed information on a top portion **12** of card **11**, the card is first exposed to suitable radiation, such as that produced by an ultraviolet source indicated generally as a lamp **13**. The illumination from lamp **13** passes through a slit **14** in a masking member **16**, the long dimension of slit **14** corresponding to the width of the portion **12** of the card on which the printing is to be produced. The entire length of portion **12** may be exposed to irradiation simultaneously, or as in the embodiment illustrated in FIG. 1, card **11** may be carried by suitable means such as a belt **17** which moves card **11** under mask **16** and slit **14** so that the portion **12** is sequentially exposed along its length to irradiation from source **13**. The radiation from source **13** produces a plurality of small bubbles in the portion **12** of the vesicular material, by virtue of the gas evolution mechanism discussed above.

After the irradiation from source **13**, the irradiated portion of the card has heat applied thereto in a configuration corresponding to the information to be printed. In the embodiment illustrated in FIG. 1, such heating is done by means of a heated printing roller or member **21** which is driven by a shaft **22**. Roller **21** may bear any suitable printing indicia corresponding to the information to be printed on card **11**, and in the illustrated embodiment such indicia is in the form of digits formed by raised portions of roller **21**. Roller **21** is heated by any suitable means, shown diagrammatically as a heating coil **23** disposed adjacent the outer surface of roller **21** so as to heat the raised digit-bearing portion thereof. Heating coil **23** may be energized from any suitable electrical circuit (not shown) through conductors **24** extending out of shaft **22**.

As card **11** is carried along by belt **17**, it passes under roller **21**, as shown by the position **11'**, so that the portion **12'** thereof lies under roller **21**. The information to be printed on portion **12'** of the card may be disposed on roller **21** in sequential form, so that the roller may be merely rotated as card **11** passes thereunder to print the desired information on the card. Alternatively, suitable indexing means may be provided for lifting and rotating roller **21** to print any selected combination of digits, numerals, or other symbols on portion **12'**. As the heated, raised characters of roller **21** contact portion **12'**, the heat causes the smaller bubbles produced by the prior irradiation to expand, thus producing light-scattering centers in the region contacted by the heated printing mechanism. Portion **12'** thus has permanently printed thereon the information carried by the heated printing element, such as the digits shown in the embodiment of FIG. 1.

FIG. 2 illustrates an alternative embodiment of the present invention in which machine-readable information is printed on a vesicular material in accordance with the present invention. In FIG. 2, a sheet or card of vesicular material **31** is exposed throughout substantially its entire width to radiation from an ultraviolet source **33** through a slit **34** in a mask **36**. Card **31** is carried along by belt **17** so that the entire length of card **31** passes under slit **34** to sequentially irradiate substantially the entire length of the card. After this irradiation to produce a plurality of bubbles in the vesicular material of card **31**, the card next passes under a device for selectively heating areas of the irradiated material in accordance with the information to be printed thereon. Such heated printing means may be in the form of a plurality of heated bar members **38***a*, **38***b*, etc. which are adapted to be selectively moved to just contact the surface of the moving card **31**.

Bars **38***a*, **38***b*, may be heated by any suitable means, such as a heating coil **39** disposed in the bar housing so as to heat the bars to the required temperature. Bars **38***a*, etc., may be of any suitable type, and may for example be of the type utilized to punch rectangular openings in conventional business machine cards. In this case, such a punch could be modified by the addition of heating coil **39** and by shortening the stroke of the punch bars so that they just contact the surface of card **31**, rather than penetrating therethrough as in the case of the punching of conventional business cards.

As the selected bars **38** are actuated downwardly to contact card **31**, the heated bar produces an enlargement of the bubbles in the vesicular material of card **31**. This heating causes the vesicular material to produce light-scattering centers in the contacted area to form an image or reproduction on card **31** of the configuration of the heated surface. Bars **38** thus produce on card **31**, as shown by card position **31'**, a plurality of marks **38'**, with the position of these marks corresponding to the position of the actuated heated bar. These marks **38'** may then be utilized in some manner, such as by photo-electric scanning of the cards for sorting or other operations normally done with conventional business machine cards.

FIG. 3 illustrates an additional alternative embodiment of the present invention for producing a sheet having a plurality of photo-images of documents to be stored, together with human readable marks on the sheet indicating the nature of the stored documents. In the embodiment of FIG. 3, a sheet **41** of vesicular material has a portion **43** which receives the photo-images to be recorded, and has another portion **42** on which is recorded information concerning the photo-images. Cards **41** may be fed to the illustrated apparatus from a stack by means of a wheel **40** which sequentially directs cards **41** onto a belt **44**.

The documents to be recorded on cards **41** may be in any suitable form, such as the reduced images of documents contained on a reel of film **46**. Film **46** is adapted to be fed over a masking element **47** having a plurality of openings **47***a* therein which establish communication between card **41** and a plurality of ultraviolet light sources **48***a*, **48***b*, **48***c*. The light from sources **48***a*, **48***b*, **48***c* is projected downwardly through film **46** and openings **47***a* through a suitable lens system (not shown) to focus the images of the documents from film **46** on card **41**. In the illustrated embodiment, it is assumed that there are three masking openings **47***a* and three ultraviolet sources **48***a*, **48***b*, **48***c*, and that these sources may be selectively energized to control the creation of latent images **50** under the different masking openings. These projected images

on card **41** produce in the card a plurality of latent images **50** of the projected documents by means of the formation of small bubbles in the vesicular material, as discussed above. The latent images **50** may be of the same size as the reduced images on film **46**, or the latent images may be further reduced with respect to the images on film **46** by means of a suitable lens system.

Card **41** next passes under suitable means for generally heating the portion **43** to develop the latent images **50**. Such heating means may be a heated roller **52** which rolls over the portion **43** of card **41**. Roller **52** may be heated by any suitable means such as a heating coil **53**. As the heated roller **52** passes over the latent images **50** on card **41**, the bubbles in the vesicular material expand and become fixed, to produce a permanent image of the documents, as represented by images **50''**.

After production of the images of the documents to be stored on portion **43**, the card may next be processed in accordance with the present invention to provide a representation thereon containing information concerning the stored documents. Since the photo-images **50''** on card **41** are generally too small to be legible to the human eye, card **41** preferably has provided thereon some human-readable indication or representation concerning the stored documents. This indication may be of any suitable type, such as a digit or character, indicating the nature of the stored document.

To provide this information or representation, the upper portion **42** of card **41** may be first generally exposed to ultraviolet radiation from a source **56** through a masking device **57** to irradiate the portion **42''** of the card. The irradiated portion **42''** then passes under a device for selectively imprinting the information on the irradiated portion **42''**. Such device may, for example, be a wire printer device **58**, in which a plurality of wires are selectively positioned to form different letters, numerals or other characters. The printing wires of devices **58** are heated by means of a heating coil **59** disposed around the wires. As the heated wires of device **58** are selectively positioned to form the different characters, they contact the portion **42''** to produce heating of

the surface in accordance with the configuration of the particular combination of wires. This heating expands and fixes the bubbles produced by the prior irradiation to produce on card **41** a permanent image corresponding to the configuration of the heated printing wires. Card **41''** thus has at the end of its processing a plurality of images **50''** of the documents from film **46** on portion **43''**, together with a representation on portion **42''** indicating the nature of the images stored on portion **43''**.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to the preferred embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art, without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claim.

What is claimed is:

A method of printing on a sheet of vesicular material containing a binder impregnated with a light sensitive diazonium salt which decomposes when exposed to light to evolve nitrogen gas in the form of small bubbles and which forms a multiplicity of larger, light scattering bubbles upon application of heat to said liberated nitrogen gas bubbles, comprising the steps of irradiating with light an area of said sheet of vesicular material to liberate said nitrogen gas bubbles over substantially the said entire area and contacting the thus irradiated area of said sheet with the heated raised portions of a printing element, the configuration of which corresponds to the information to be printed, thus to produce a multiplicity of said light refractive bubbles where said sheet of vesicular material is contacted by the heated, raised portions of said printing element.

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