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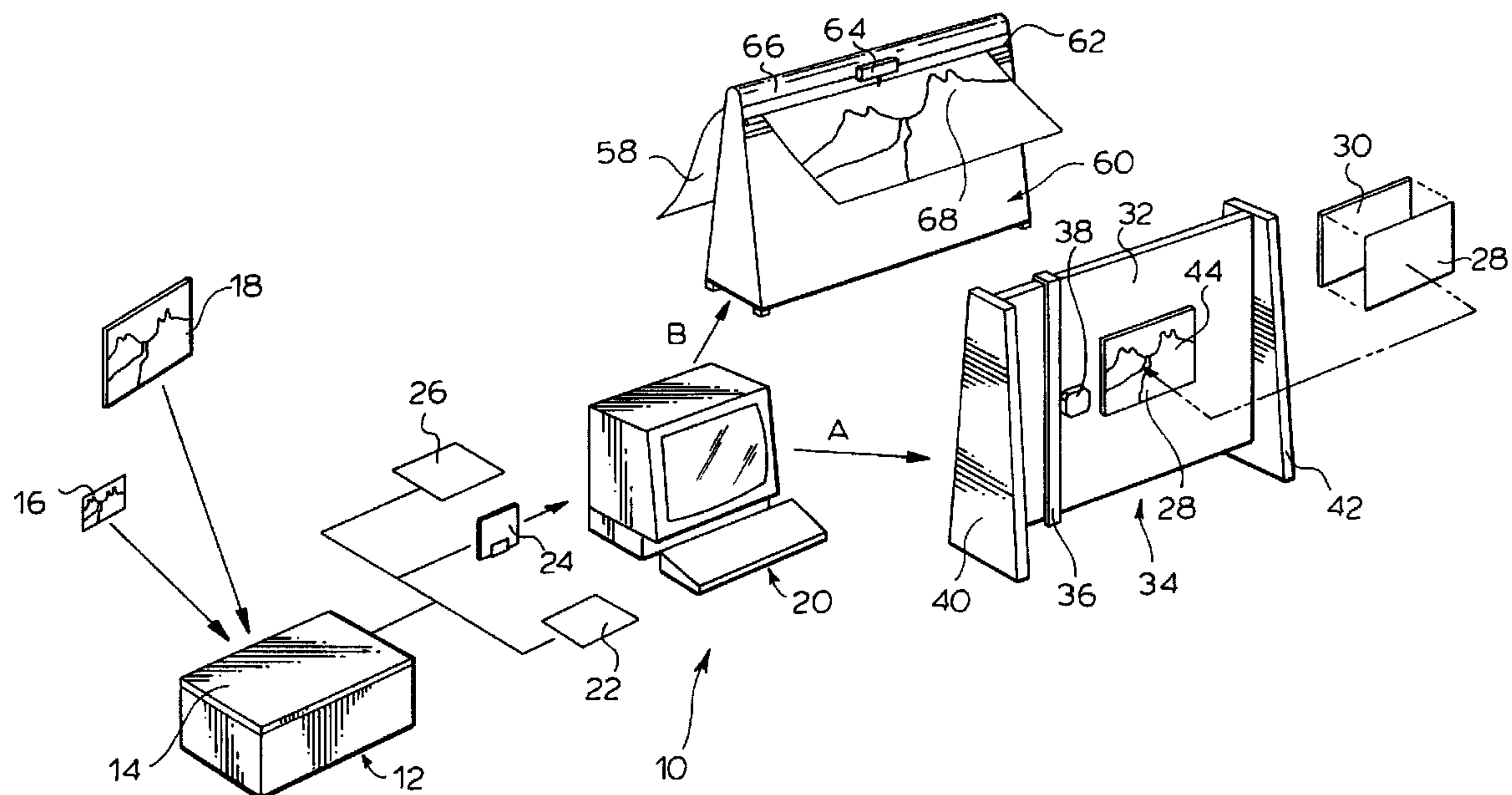
(72) Inventeur/Inventor:
HARDING, GLENN T., CA

(73) Propriétaire/Owner:
BRUSHSTROKES FINE ART INC., CA

(74) Agent: RICHES, MCKENZIE & HERBERT LLP

(54) Titre : SYSTÈME PROGRAMMABLE POUR AGRANDIR ET IMPRIMER UNE IMAGE

(54) Title: PROGRAMMABLE SYSTEM FOR DIMENSIONALLY EXPANDING AND PRINTING A PICTURE IMAGE



(57) Abrégé/Abstract:

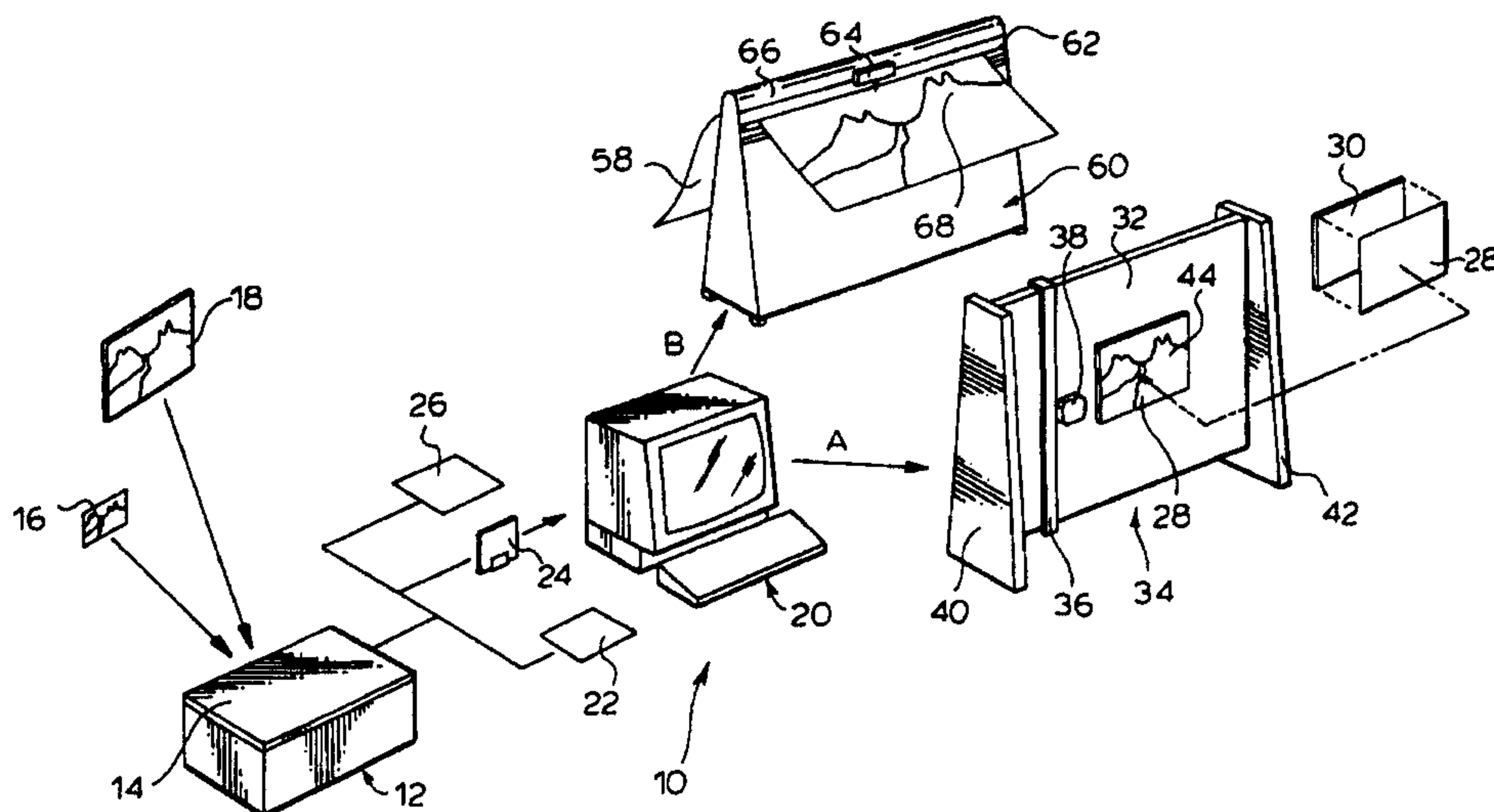
A programmable system for dimensionally expanding and printing a picture image on a printable sheet preferably having a canvas texture for use in making a picture print thermoforming female mold of castible shrinkable material, the programmable system comprising: i) a programmable computer having a memory in which the picture image is digitally stored, ii) a computer driven printer having a moveable printing head for printing the picture image on a sheet as the printing head moves relative to a canvas-textured sheet; iii) the computer having a program for dimensionally expanding a picture image stored in the memory, the program expanding a stored picture image from: a) an original dimensional size having a length and a width identical to a final picture print size on a thermoformable plastic sheet to be molded in such female mold, and to b) an expanded dimensional size having an expanded length and width equal to an extent to which such female mold of such castible shrinkable material shrinks from its original poured state to its hardened state; iv) the computer being actuated to drive the printer to print such expanded image onto the sheet.



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(54) Title: PROGRAMMABLE SYSTEM FOR DIMENSIONALLY EXPANDING AND PRINTING A PICTURE IMAGE**(57) Abstract**

A programmable system for dimensionally expanding and printing a picture image on a printable sheet preferably having a canvas texture for use in making a picture print thermoforming female mold of castible shrinkable material, the programmable system comprising: i) a programmable computer having a memory in which the picture image is digitally stored; ii) a computer driven printer having a moveable printing head for printing the picture image on a sheet as the printing head moves relative to a canvas-textured sheet; iii) the computer having a program for dimensionally expanding a picture image stored in the memory, the program expanding a stored picture image from: a) an original dimensional size having a length and a width identical to a final picture print size on a thermoformable plastic sheet to be molded in such female mold, and to b) an expanded dimensional size having an expanded length and width equal to an extent to which such female mold of such castible shrinkable material shrinks from its original poured state to its hardened state; iv) the computer being actuated to drive the printer to print such expanded image onto the sheet.

PROGRAMMABLE SYSTEM FOR DIMENSIONALLY EXPANDING AND PRINTING A PICTURE IMAGE

FIELD OF THE INVENTION

This invention relates to methods and apparatus useful in the development of molds used in vacuum forming in a printed thermoformable plastic sheet, an accurate three-dimensional relief reproduction of an original three-dimensional article.

BACKGROUND OF THE INVENTION

In our U.S. patent number 5667747 issued September 16, 1997 and entitled Vacuum Formed Three-Dimensional Surface Article, we have described:

- 1) a vacuum forming process for molding a thin sheet of thermoformable plastic to produce an accurate three-dimensional relief reproduction of an original artwork or the like;
- 2) an apparatus for vacuum forming a thin sheet of thermoformable plastic into an accurate three-dimensional relief reproduction of an original artwork; and
- 3) methods for producing male molds for use in making female molds which in turn are used in the vacuum forming of thermoformable plastic sheet to form an accurate three dimensional relief reproduction of an original artwork.

There is a significant consumer demand for faithful inexpensive reproductions of art. In making such reproductions it has been found to be very important to reproduce the texture of the work such as the brush stroke, which may reflect light in a particular manner. As described in our U.S. patent 5667747 issued September 16, 1997, various methods have been put forth in an attempt to re-create a three-dimensional relief of the original work. Such techniques are described in U.S. Patent 4,285,744; 4,971,743 and French Patents 1493516 and 1548337. There are however problems associated with the techniques described in those patents and attempts to overcome those problems have been described in Canadian patent application 2,020,206; U.S. Patents 4,001,062; 5,182,063 and 5,201,548. The activities continue in

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respect to overcoming various problems with the prior art processes, such as described in U.S. Patents 4,971,743; 5,116,562 and 4,285,744. The invention defined in our patent number 5667747 issued September 16, 1997 using vacuum-forming has overcome many of the problems associated with the prior art techniques and is able to provide a high quality product in a cost-effective manner. An aspect of our prior methods and apparatus involve the production of the male mold for use in making the female mold which in turn is used in the vacuum forming of the thermoformable plastic sheet. Quite unlike normal vacuum forming techniques, applicants have discovered that a very acceptable product can be made from a female mold and still retain the features of the three-dimensional surface definition and registration of that definition with the image on the plastic sheet. Various techniques are described in U.S. patent number 5667747 issued September 16, 1997 for making the male mold so as to provide on its surface, a surface relief texture which is essentially the same as the original. A female mold is then made by pouring onto the surface of the male mold a suitable castible material which when hardened and released from the male mold provides a female mold having the artistic creation of the surface texture of the original work reproduced therein. The usual type of castible material has the tendency to shrink as it hardens in producing the female female mold. In particular, if the castible material is of an epoxy resin there is considerable shrinking during the curing process so that the female mold in its cured form is smaller than the original work from which the male mold was made.

It is an object of an aspect of this invention to overcome the problems associated with the castible shrinkable material from which the female mold is made and which greatly enhances the flexibility in making of the female mold and greatly accommodates various changes that one would like to make in producing multiples of the male mold from the which the female molds would be made.

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SUMMARY OF THE INVENTION

In accordance with an aspect of the invention, a programmable system for dimensionally expanding and printing a picture image on a printable sheet for use in making a picture print thermoforming female mold of castible shrinkable material, the programmable system comprises:

- i) a programmable computer having a memory in which the picture image is digitally stored;
- ii) a computer driven printer having a moveable printing head for printing the picture image on a sheet as the printing head moves relative to a sheet;
- iii) the computer having a program for dimensionally expanding a picture image stored in the memory, the program expanding a stored picture image from:
 - a) an original dimensional size having a length and a width identical to a final picture print size on a thermoformable plastic sheet to be molded in such female mold, to:
 - b) an expanded dimensional size having an expanded length and width equal to an extent to which such female mold of such castible shrinkable material shrinks from its original poured state to its hardened state,
- iv) the computer being actuated to drive the printer to print such expanded image onto a sheet.

According another aspect of the invention, a method for dimensionally expanding and printing a picture image on a printable sheet and making a picture print thermoforming female mold of castible shrinkable material, the method comprises:

- i) digitally storing the picture image in a computer memory;
- ii) dimensionally expanding the picture image stored in the memory from:
 - a) an original dimensional size having a length and a width identical to a final picture image size on a thermoformable plastic sheet to be molded in the female mold, to:

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b) an expanded dimensional size having an expanded length and width equal to an extent to which the female mold of such castible shrinkable material shrinks from its original poured state to its hardened state,

iii) printing the picture image by use of a computer driven
5 printer having a moveable printing head which prints the image as the printing head is moved relative to such printable sheet;

iv) brushing onto the printed expanded image a hardenable compound to replicate on the printed image, brush strokes of an original image to form a male mold;

10 v) making a female mold by pouring the castible shrinkable material on the male mold, curing the castible shrinkable material whereby the material shrinks a predetermined extent in length and width to take on the original dimensional size of the length and width for the final picture image size.

15 According to a further aspect of the invention, a process for producing a male mold which replicates brush strokes of an original painting, the process comprises:

i) providing a picture image of the painting on a sheet;
ii) brushing onto the picture image a hardenable compound
20 to replicate on the image brush strokes of the original painting;
iii) allowing the compound to harden to produce thereby the male mold.

BRIEF DESCRIPTION OF THE DRAWINGS

25 Preferred embodiments of the invention are described with respect to the drawings wherein:

Figure 1 is a perspective of the programmable system for expanding and printing a picture image on a printable sheet having a canvas texture;

Figure 2 is perspective view of an artist reproducing the brushstrokes on the printed image of Figure 1;

30 Figure 3 is a perspective view in preparing the male mold for receiving a castible material in producing the female mold;

Figure 4 is a perspective view of the male mold receiving the castible material to make the female mold;

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Figure 5 shows the female mold separated from the male mold; Figure 6 shows the extent to which the female mold shrinks relative to the male mold;

Figure 7 shows the preparation of the female mold for use in vacuum forming the printed thermoplastic sheet; and

Figure 8 is a side elevation with a portion thereof removed showing the vacuum forming of the printed sheet in making a reproduction of the original.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As described in U.S. patent number 5667747 issued September 16, 1997, the male mold was preferably formed by projecting an image onto suitable substrate. A cakeable material commonly referred to as artist putty or artist caking commonly made from acrylic polymer is applied to the substrate, in a manner to resemble the brushstrokes of the original piece of art. This technique has proven quite useful in making the male mold because one could apply the artist putty to the substrate and then stand back and see the image overlaying the applied material and determine if the brushstrokes were in the right place. Hence, the male mold was made in an expeditious, fairly accurate manner, however, when it came to casting the female mold, particularly when made of castible, shrinkable material, the female mold was then dimensionally smaller than the male mold and hence when the print was made it had to be scaled down slightly from a standard print size to accommodate the shrinkage in the mold.

The invention sets out to solve this problem and has surprisingly provided some alternatives in how the male mold may be made to provide ultimately a female mold of a shrunk size corresponding to the desired print or image size on the plastic sheet to be thermoformed. The invention provides a programmable system which has as its objective, to expand the dimensional size of the picture print and print it on a suitable substrate to in turn provide a slightly enlarged printed picture image. It is understood that the term print, picture and picture image include a single picture in a field of view or a plurality of picture images in a field of view. Multiple images may be provided on a single print for purposes of artistic effect or for purposes of

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economy in vacuum forming several smaller prints during a single vacuum forming pass using a single female mold.

In use, the artist applies the artist putty directly onto the printed image on the substrate to resemble the brushstrokes of the original work. The system for expanding the dimensional size of the picture image is described with respect to Figure 1. The system 10 comprises an image scanner 12 having an image scanning surface 14. The picture to be scanned may be of various sizes such as represented by photograph 16 or print 18. The picture is laid on the scanning surface 14 and the scanner 12 is actuated by a computer 20 which causes the scanner to convert the image on the photograph 16 or print 18 into a digital image. The digital image may then be stored on various types of mediums such as a compact disk 22, a magnetic storage disk 24 or other forms of memory represented by 26 such as magnetic tape. The digital information may be transferred directly into the computer 20 or via one of the memory mediums be inserted into the computer 20 for reading by the computer. This standard technique is often done in lithography. A transparency or a print or an illustration is scanned on a scanning device such as a Hall scanner or Scitex scanner. The scanner color separates the picture into the four basic colors of cyan, magenta, yellow and black. The electronic files can be manipulated to change colors, enhance sharpness, retouch and the like. The electronic files can also be manipulated to produce the subject in proper size and position either in singles or in multiples of the same print or different prints on a layout for a desired format of the printed job. The four color film produced is used to produce the printing plates for the litho press.

The digitally stored image can be printed on a suitable sheet preferably canvas textured sheet, by choosing a printer in the direction of arrow A or a feed-type printer in the direction of arrow B. Should the operator choose to print the digital image from the source 16 or 18 using the printer of system A, a canvas sheet or a sheet having a canvas texture 28 is preferably mounted on a hard backing 30, although it is understood that sheet 28 may be mounted directly to the printer support face 32. Either way the canvas textured substrate is readied for printing by the computer driven printer 34. It is understood a sheet or length of material having a canvas texture may in

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addition to canvas be any type of substrate which has a canvas texture formed therein such as a sheet of wood byproduct or plastic having a canvas texture formed therein or molded thereon. The printer 34 has a transport beam 36 carrying a printing head 38. The transport beam 36 traverses the entire
5 length of the support surface 32 from side 40 through to side 42. The printer head 38 can move anywhere along the length of the transport beam 36. The printing head 38 may be equipped with suitable colour printing devices which are capable of printing 2, 4 or 6 colour separations. A preferred type of printer for this embodiment is sold by Alpha Merics Corporation under the
10 trade-mark SPECTRUM.

Computer 20 then drives the printer 34 to print the image 44 on the surface of the canvas texture substrate 28. The computer 20 is provided with a program for dimensionally expanding a digitally stored image in the memory of the computer 20. The purpose of the program is to expand the
15 stored picture image whether it be a single or multiple image from an original dimensional size having a length and a width identical to a final picture print size, such as, for example, the original dimensional size as demonstrated in Figure 6. The original print size 46 has a width dimension 48 and a length dimension 50. The computer's program then expands that image from the
20 original size of the image 46 to the expanded size 52 having an enlarged width 54 and enlarged length 56. The extent to which the image 46 is expanded is, in this particular embodiment, determined by the extent to which the castible shrinkable material contracts during the curing process, as will be described with respect to Figures 4 and 5. For example, with a preferred
25 castible material being an epoxy resin having up to 80% by weight of aluminum as a heat conductive filler, the resin shrinks one sixteenth of an inch for every 12 lineal inches of poured resin. Hence, for a print having a length of 12 inches and a height of 6 inches the expanded dimension for the image, that is image 52, would be 12 and one sixteenth inches x 6 and one
30 thirty-seconds of an inch to take into consideration that the castible shrinkable material will shrink to a dimension of 12 inches by 6 inches during the curing process. A preferred epoxy resin having these shrinking characteristics may be obtained from Chemque of Quebec and sold under the trade-mark

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CHEMCAST 402.

The image printed by printer 34 and identified as 44 in Figure 1 has been expanded from its original size, which may be demonstrated by print 18 so as to compensate for shrinkage of the female mold such that when it is
5 cured, the female mold will be essentially the same size as the original picture image 18. The computer driven printer can print directly on the canvas substrate which is preferably an artist canvas 28 where both the printing head 38 and the transport beam 36 moves in creating the desired image 44 on the sheet 28.

10 Alternatively, the computer operator may select printer B which is capable of either feeding individual sheets of canvas textured substrate 58 or a roll of substrate through a printer 60 or the printer 60 may have a sheet feed mechanism 62 which may consist of a form of tractor drive for advancing the sheet 58 through the printer. Alternatively opposing feed rollers are provided
15 which accurately advance the sheet through the printer or may be other suitable feed mechanisms which can advance the sheet through the printer in the necessary increments. The printer 60 includes a moveable printing head 64 which travels along the support beam 66 to create the image 68 on the substrate 58. It is also understood that the substrate 58 instead of being
20 individual sheets fed through the printer can also be a continuous length of canvas removed from a spool of canvas and correspondingly rolled up after the canvas is printed. As with printer 34, printer 60 is capable of printing not only on sheets that have a canvas texture but as well actual artist canvas or the like. The image can be printed in four colour separation to give a fairly
25 accurate reproduction of the colours of the original image. Alternatively, the image could be printed in a one colour duotone, re: black and white.

It is understood that the printed image may instead be transferred to the canvas substrate or the like. As a first step, the printer may print the image on a transfer substrate, using an ink which can be readily transferred to
30 a canvas sheet. This transfer of the image avoids having to print directly on the textured surface of the canvas substrate. The process may be similar to the manner in which a decal would be transferred from the substrate to a canvas surface or the common canvas transfer technique.

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The computer 20, in accordance with its program, dimensionally expands the image 68 printed on the substrate 58. The extent of the expansion again depends on the size of the final image. For example, with the printing system of either 34 or 60, it is understood that images can be printed which may have dimensions up to 6 ft. x 8 ft. Although images of this size would make thermoforming a single sheet very difficult, there would not be a limitation on the production of the expanded images for purposes of making such male molds. It is also understood, as previously mentioned, that the computer 20 may be programmed to generate multiple images on the same substrate whereby a female mold is made having separate multiple molds for the same image or different images. The computer is programmed to correspondingly enlarge each individual image so as to fill the substrate with for example, four images, all of which have been slightly enlarged to compensate for the shrinkage of the mold in respect of each of these smaller multiple images.

The computer 20 is then programmed to expand the image to the desired extent in compensating for shrinkage of the female mold material. It is understood that a variety of scanner devices 12 may be employed which, in some form of another, convert the image of the photograph, painting or the like, into digital format. It is also understood that the program on the computer readily adapts to changing situations. As long as the extent of shrinkage of the female mold material is known, the image or images can be readily expanded to compensate for shrinkage of the female mold relative to the male mold. In printing such enlarged images, as described with respect to printers 34 and 60, it is understood that portions of the entire print may be printed or the printer is programmed to print all of the image for each section of the image as it advances along the substrate. For example, with printer 60, the advance mechanism 62 advances the canvas textured sheet through the printer to present a portion of the canvas texture sheet on which a corresponding portion of an image is printed thereon by the printing head as the sheet is advanced in increments through the printing system.

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With the enlarged printed canvas sheet 70 in hand, an artist, by way of a brush 72, spatula or the like, may apply to the canvas sheet 70, as shown in Figure 2, the artist putty compound 74 stored in the usual container 76. The artist applies to the image 78 the putty compound 74 to reproduce on the
5 image 78 the brushstrokes and other shapes that the artist had employed in painting the original. The artist in applying the putty material to the enlarged image does so in proportion to the enlargement which is not difficult in view of the fact that the image is only slightly enlarged relative to the original 18. As shown in Figure 3, the male mold has had applied thereto a substantial
10 coating of the putty material, generally indicated at 80. In most situations the putty material completely covers the image 78 so that all that is visible on the canvas sheet 70 is the hardened putty which in essence constitutes the male mold or where it is advantageous to the artist's technique some or almost all of the canvas texture may show.

15 The male mold is then sprayed as shown in Figure 3 with a suitable mold release material. The spray 82 may be of a silicone spray from the usual spray can dispenser device 84. The canvas 70 may be mounted on a suitable solid support 86 and then have fastened thereto perimeter frame members 88, which are preferably secured by screws 90 to the solid support
20 86. With the sides 88 in place, a recess is defined equivalent to the thickness 92 of the sides 88.

The recess is then filled by the castible, shrinkable material 94 which is poured ideally from a suitable container 96 in the manner shown in Figure 4. As already described, in accordance with a preferred embodiment, the
25 curable material 94 may be an epoxy resin. The epoxy resin simply flows over the surface of the canvas sheet 70 having the relief provided thereon with the caked putty material 80. The epoxy resin 94 is cured in accordance with the manufacturers suggestions. During that curing process, the material shrinks, as already noted in the range of 1/16 of an inch for 12 inches of
30 lineal length. The resin is heat cured for 1 hour at medium heat to 250°F, then cooled for 2 hours to room temperature. This cycle may be repeated one or more times to ensure a complete cure.

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After the resin is fully cured, as shown in Figure 5, the female mold, as formed by the cured resin 98 is separated from the male mold 80 having the sides 88 retained thereon. The backside of the female mold (not shown) has shrunk in its length, dimension 100 and its width dimension 102 to the extent as expected where the length and width of the surface relief for the image would be equivalent to the original length and width of the image such as demonstrated in Figure 6 by image 46 having a width 48 and length 50. It is understood that the female mold may be a perimeter portion outside of the image relief formed therein. Hence the to shrunken mold, although its exterior dimensions may be larger than the desired print size, has its formed relief of the same size as the desired standard print size.

As is the usual procedure, the female mold 98 is turned over to expose the recess and detents in the surface 104 of the female mold which is a mirror image and corresponds to the surface generated by the male mold 80. In the usual manner, a plurality of vacuum holes 106 are drilled in the female mold 98 by use of appropriate drill 108. The reliefs, detents, grooves, undercuts and the like in the surface of the female mold 104 is then in register with the original size of the printed image so as to provide a relief in the printed image in exact register with the desired brushstrokes for the final image itself. Such vacuum forming of the relief in the sheet is shown in Figure 8. The female mold 98 is provided in a vacuum box 110 where vacuum is withdrawn from the box through vacuum line 112. The thermoformable plastic sheet 114 is positioned slightly above the mold 98 and heated by the retractable heater 116 by way of the radiant heat indicated by arrows 118. As described in the aforementioned U.S. patent number 5667747, the sheet is heated in accordance with a prescribed technique, vacuum applied, the sheet cooled, the vacuum released and the sheet removed wherein the relief is vacuum formed into the plastic sheet in register with the image.

Hence, by use of the programmable system, a convenient, accurate arrangement is provided for making the male mold from which the female mold is ultimately made while taking into consideration shrinkage of the castible material for making the female mold. The programmable system

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allows an operator to vary the size of the image or plurality of images at will to format the single or several images on or to be transferred to a single canvas substrate for making the male mold. The system can be programmed to immediately adjust the enlargement of the image depending upon the
5 selected finish size for the image. By scanning the image and storing it electronically, the same information may be transposed over to the printer to print the image of the exact enlarged size as the required enlarged male mold.

Although preferred embodiments of the invention are described herein in detail, it will be understood by those skilled in the art that variations may
10 be made thereto without departing from the spirit of the invention or the scope of the appended claims.

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1. A method for dimensionally expanding and printing a picture image on a printable sheet and making a picture print thermoforming female mold of castible shrinkable material, said method comprising:
 - i) converting said picture image into a digital format and digitally storing said picture image in a computer memory;
 - ii) dimensionally expanding said picture image stored in said memory from:
 - a) an original dimensional size having a length and a width identical to a final picture image size on a thermoformable plastic sheet to be molded in said female mold to:
 - b) an expanded dimensional size having an expanded length and width equal to an extent to which said female mold of such castible shrinkable material shrinks from its original poured state to its hardened state,
 - iii) printing said picture image by use of a computer driven printer having a moveable printing head which prints said image as said printing head is moved relative to said printable sheet;
 - iv) brushing onto said printed expanded image a hardenable compound to replicate on said printed image, brush strokes of an original image to form a male mold;

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(v) making a female mold by pouring said castible shrinkable material on said male mold, curing said castible shrinkable material whereby said material shrinks a predetermined extent in length and width to take on said original dimensional size of said length and width for said final picture image size.

2. A method according to claim 1 wherein said method additionally comprises in step iii), printing said image with an ink which is transferable onto another sheet which is used in step iv).

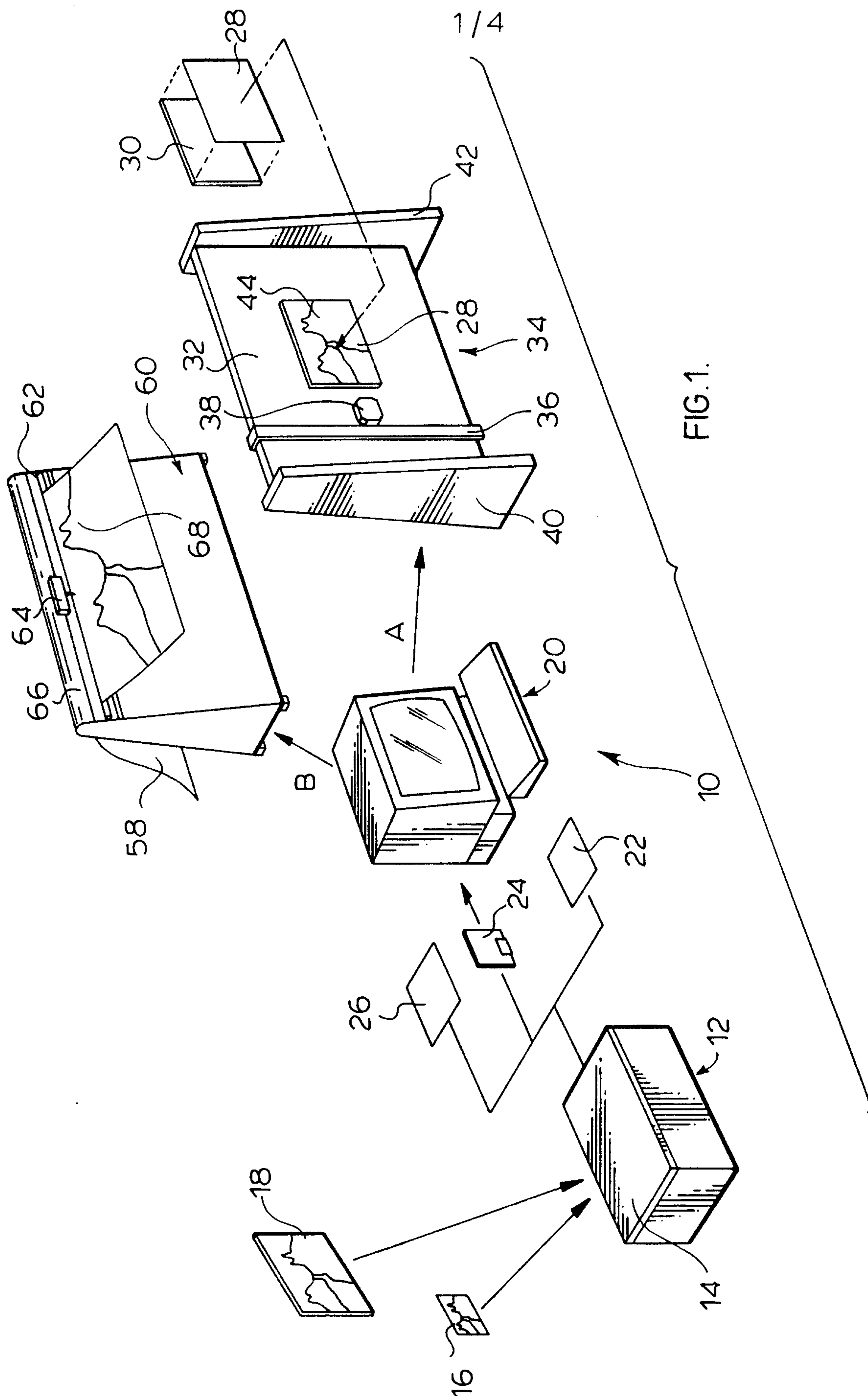
3. A method according to claim 2 wherein said other sheet is a canvas sheet.

4. A method according to any one of claims 1 to 3, wherein said castible shrinkable material is an epoxy resin, said step of curing, shrinking said resin a consistent pre-determined extent in its length and width dimensions.

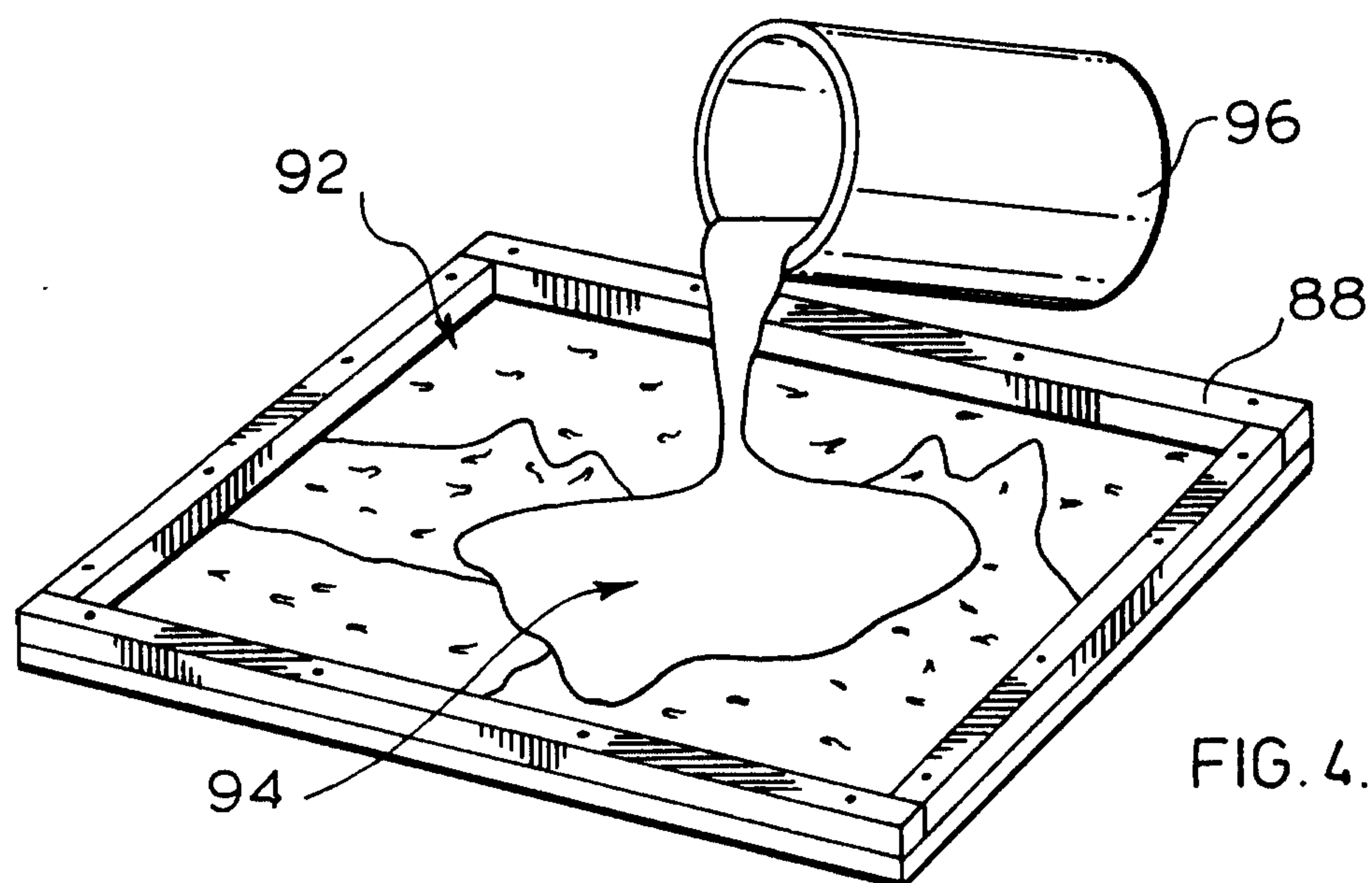
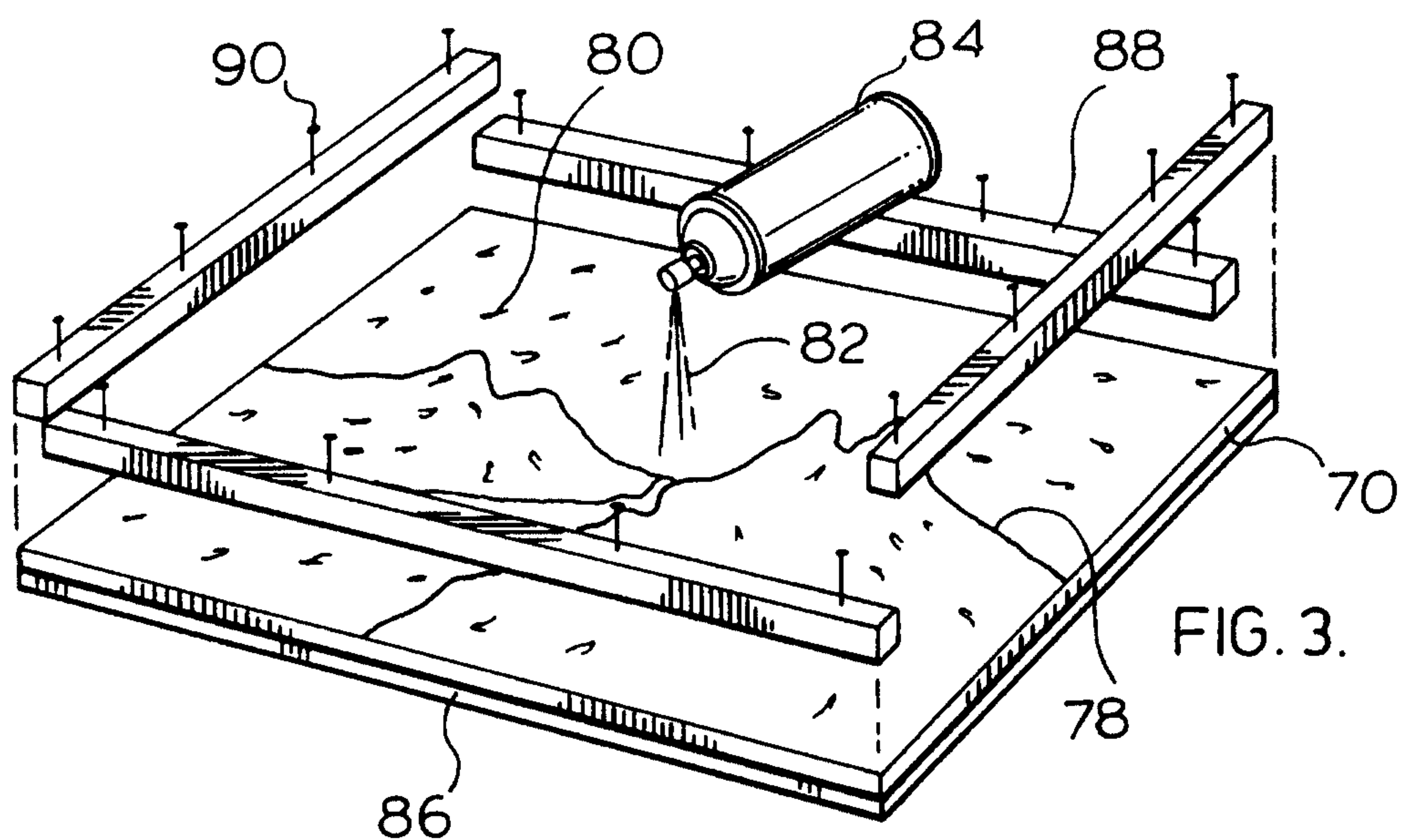
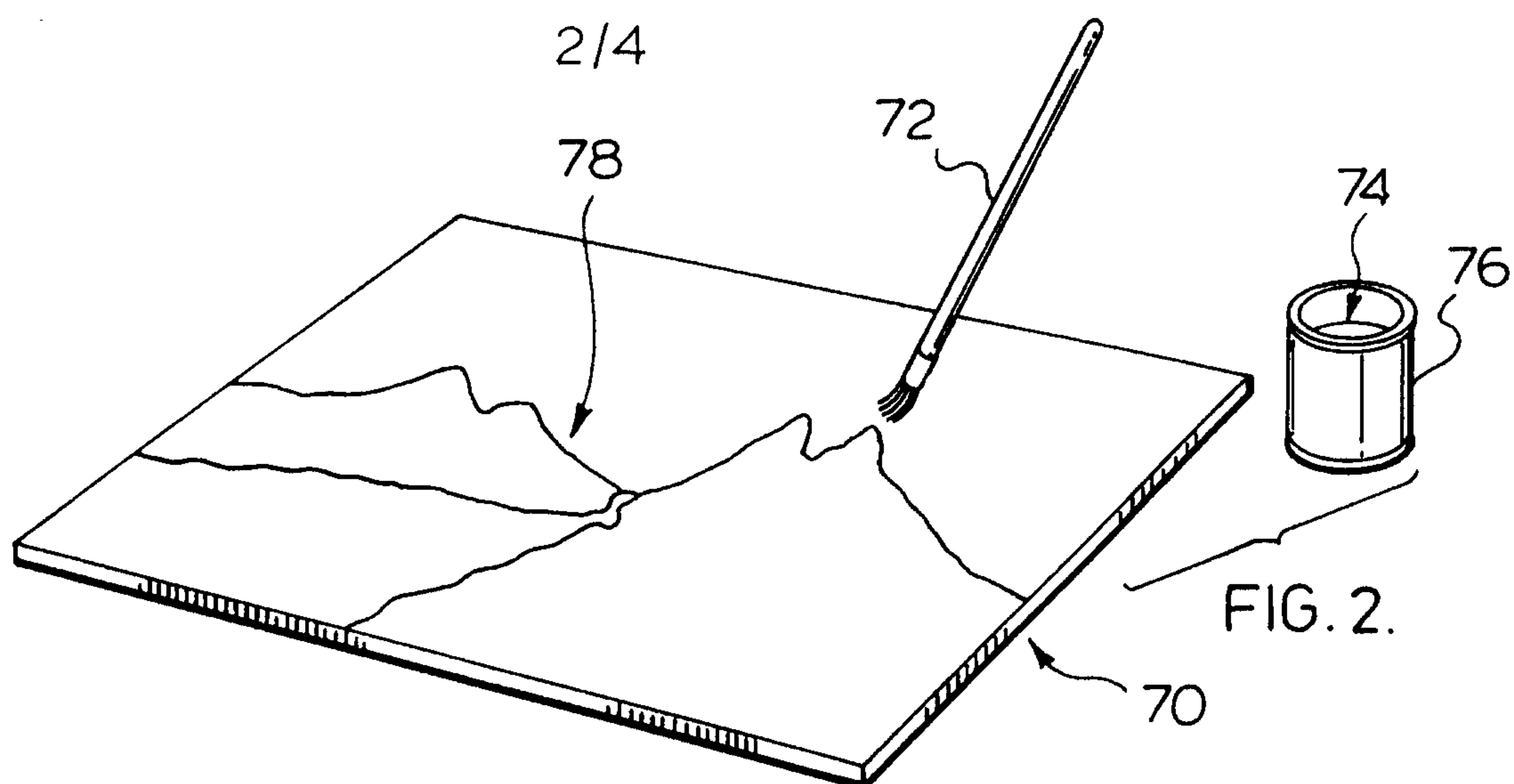
5. A method according to claim 4 wherein curing of said resin to a hardened state shrinks said resin about one sixteenth of an inch for every twelve inches of poured resin in its length and width dimensions.

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6. A method according to any one of claims 1, 4 or 5 wherein said printable sheet is an artist's canvas.
7. A method according to claim 6 wherein said canvas is mounted on a solid substrate to provide thereby a dimensionally stable mounting of said canvas as said printing head prints said expanded image on said canvas.
8. A method according to claim 6 wherein said canvas is advanced to expose a portion of said canvas on which a corresponding portion of said image is printed.
9. A method according to any one of claims 1 to 8 wherein said final picture image includes a plurality of discrete prints.
10. A method according to any one of claims 1 to 8 wherein said original electronic picture image includes a plurality of discrete prints.



SUBSTITUTE SHEET (RULE 26)



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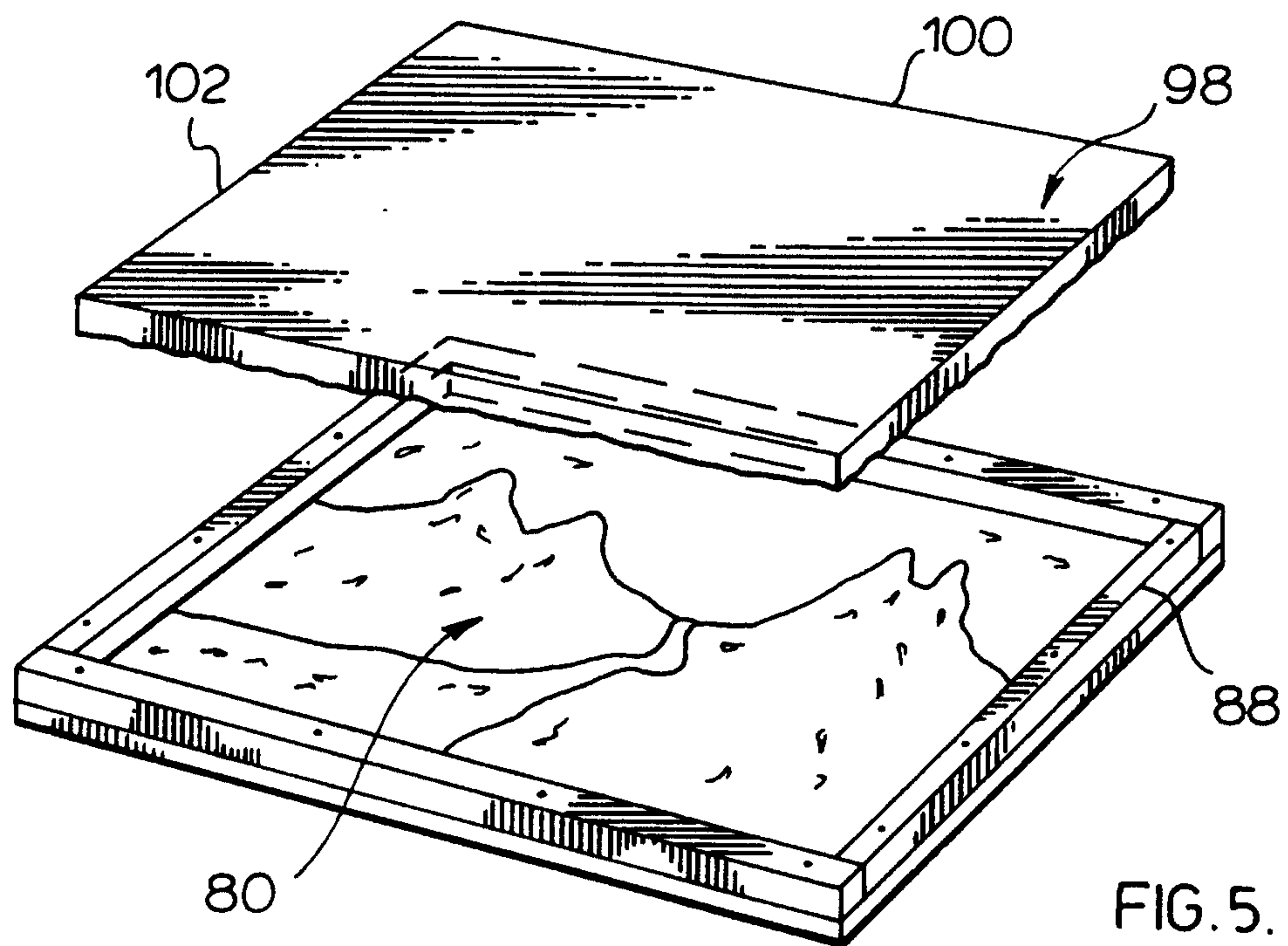


FIG. 5.

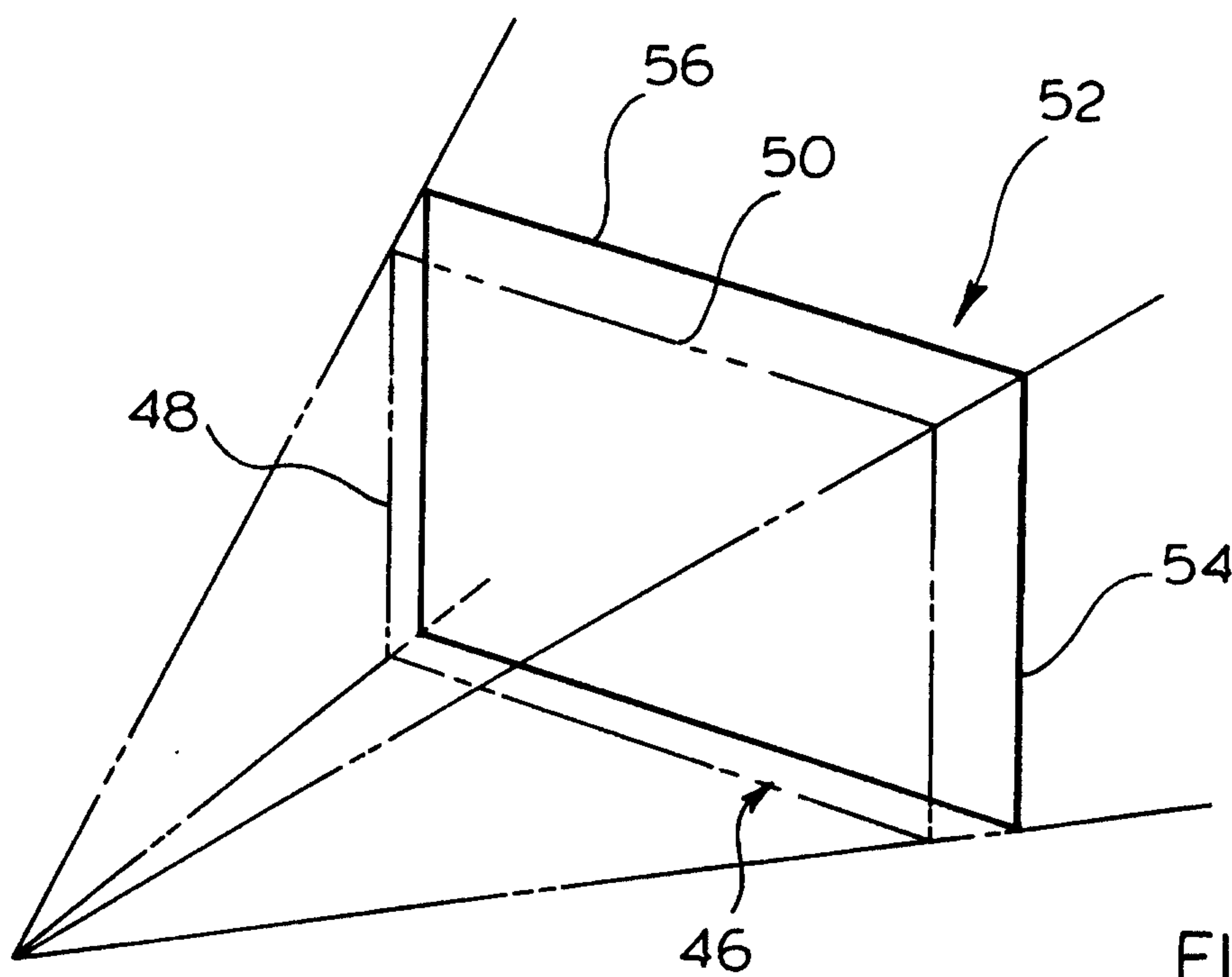


FIG. 6.

